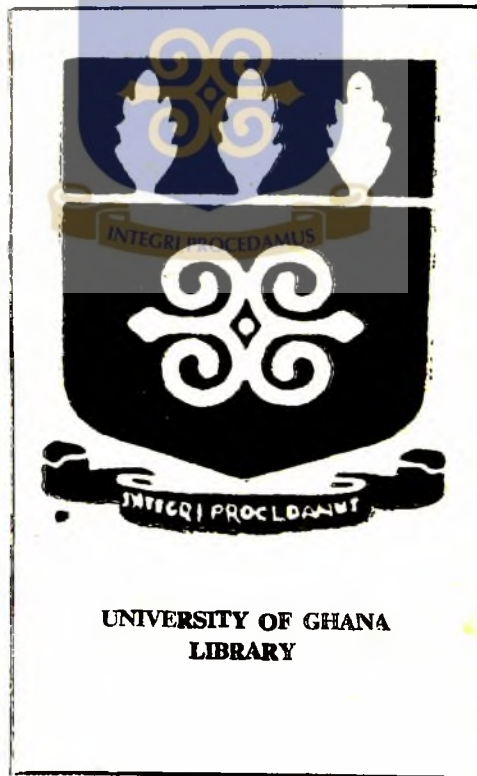

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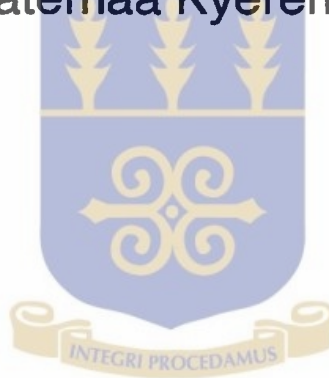
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**A REVIEW OF THE *RHEOTANYTARSUS*
CURTISTYLUS GROUP,
WITH A GENERIC DIAGNOSIS OF THE GENUS *RHEOTANYTARSUS*
THIENEMANN ET BAUSE, AND A DESCRIPTION OF 7 NEW
AFROTROPICAL SPECIES (Diptera: Chironomidae)**

Rosina Abena Kwatema Kyerematen



**Thesis for the Master of Philosophy degree,
Department of Zoology, University of Ghana.
Legon, 1996.**



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This thesis was funded by the Norwegian Universities Committee for Development, Research and Education (NUFU) in collaboration with the Department of Zoology, University of Ghana; the Institute of Aquatic Biology (IAB), Ghana and the Museum of Zoology, University of Bergen, Bergen, Norway.



DECLARATION

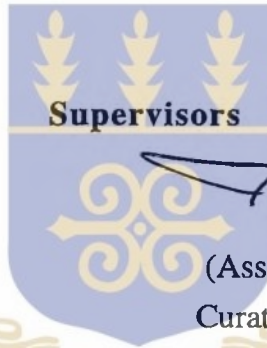
This is to certify that this thesis has not been submitted for a degree to any university and is entirely my own work under the supervision of Professor Ole A. Sæther and Associate Professor Trond Andersen both of the Department of Zoology, University of Bergen, Norway.



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Bergen, Norway.

DEDICATION

To Sally Abon Brentuo-Lartey, my mother whom I love and adore with all my heart.

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ABSTRACT

A revised generic diagnosis of the genus *Rheotanytarsus* Thienemann et Bause is given. Seven new Afrotropical species are described, *R. kjaerandseni* sp. n. as male, female, pupa and larva; *R. plerusinguisus* sp. n. as male and female; *R. aquilus* sp. n., *R. atrius* sp. n., *R. saetheri* sp. n., *R. abonae* sp. n., and *R. weijensis* sp. n. as males only. One species is redescribed, *R. fuscus* (Freeman, 1954).

The genus can be divided into 7 species groups primarily based on the pupal morphology: the *ceratophylli* group, the *distinctissimus* group, the *globosus* group, the *curtistylus* group, the *pentapoda* group, the *nigricauda* group, and the *reissi* group. A phylogenetic treatment using the manual Hennigian method gives the *ceratophylli* group as the sister group of the remaining groups. The *distinctissimus* and the *globosus* groups combined form the sister group of the remaining groups, where as the *curtistylus* and *pentapoda* groups combined, and the *nigricauda* and the *reissi* groups combined are sister groups.

A key to males of the *Rheotanytarsus curtistylus* group from the Afrotropical region is given. The biology, ecology and distribution of the genus are outlined. Generally, the Ghanaian species of *Rheotanytarsus* are smaller with lower antennal ratios and lower chaetotaxy than the species from Eastern and Southern Africa and temperate areas. This might be an adaptation to the warm, humid climate in the rain-forests of Ghana, whereas the species from Eastern and Southern Africa come from either montane habitats or from localities with a much cooler climate, respectively.

The genus apparently is of Pangaean origin fragmenting into species group following the division into Laurasia and Gondwanaland and subsequent fragmentations of Gondwanaland. More recent speciation may have been caused by climatic changes during the Quaternary period which led to refuges of forest which persisted

during the dry and cold periods. The principal core areas were the main centres of forest which survived during the severe arid period around 18, 000 BP. Also later events such as the creation of the Dahomey gap may have played a significant role in speciation.

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Chapter 1

INTRODUCTION

Chironomids or non-biting midges are the most widely distributed insects in freshwater (Armitage *et al.*, 1995). There are estimated to be about 15, 000 species of chironomid world-wide of which about 6, 000 are described. Chironomids are adapted to highly differing environments and they usually constitute the essential part of the aquatic insect fauna, in some cases up to 70 % or more of the total diversity and biomass. There are stenotopic as well as eurytopic species and they may be terrestrial, marine, parasitic or symbiotic, or living in hot springs, hyperhaline waters, plant cavities (phytotelmata), etc. In normal freshwater habitats they occupy a variety of ecological niches from arctic and alpine glacial waters to tropical ponds, from the clearest most nutrient-poor waters to cess pools. They are able to tolerate extremes of temperature, pH, salinity, depth, current velocity and productivity. Chironomids live for instance in the glaciated areas of the highest mountains, including elevations of up to 5, 600 m in the Himalayan (Koshima, 1984; Sæther & Willassen, 1987) and are the only flying insects present on the Antarctic continent. Some chironomids tolerate high osmotic levels in brackish and shoreline saline pools and, unusually amongst the insects, several genera include intertidal and marine species. A substantial number of genera include species that are considered to be fully terrestrial. These use predominantly humic soils as habitats, but some are found in decaying vegetation and a few even live in greenhouse vegetation (Cranston, 1987).

Chironomids are extraordinarily well suited as indicators of e.g. environmental deterioration. In fact, some of the biological part of the science of limnology, is based upon the use of chironomid communities as indicators of the trophic state of freshwaters (Brundin, 1949; 1956; Sæther, 1979a; 1980b). They

also constitute a very old group where most present day genera date from the time period between the Cretaceous and the Jurassic periods, 63-170 million years ago (Brundin, 1966). Thus they are well suited as test animals for hierarchical and biogeographical reconstructions as well, and the theory of plate tectonic (continental drift) did not become generally accepted among biologists until the work by Brundin (1966) on transantarctic relationships as evidenced by chironomid midges.

Eleven subfamilies are recognised within Chironomidae: *Telmatogetoninae* Brundin, 1966; *Chilenomyiinae* Brundin, 1983; *Aphroteniinae* Brundin, 1966; *Podonominae* Thienemann, 1937; *Buchonomyiinae* Brundin et Sæther, 1978; *Usambaromyiinae* Andersen et Sæther, 1994; *Tanypodinae* Thienemann et Zavrel, 1916; *Diamesinae* Kieffer, 1923; *Prodiamesinae* Sæther, 1976; *Orthoclaadiinae* Edwards, 1929; and *Chironominae* Macquart, 1838. The *Chironominae* appear to be the most abundant and the most species rich of the subfamilies in the tropics.

Three tribes usually are recognised within *Chironominae*: *Chironomini*, *Tanytarsini* and *Pseudochironomini*. *Tanytarsini* is divided into the subtribes *Zavreliina* and *Tanytarsina*. *Rheotanytarsus* belongs to the subtribe *Tanytarsina*. Worldwide, 56 species of *Rheotanytarsus* have been described, mostly from the Palaearctic region, while 7 species each are from the Australian and Oriental regions, 6 each from the Neotropical and Afrotropical regions and 5 species from the Nearctic region. The larvae of the genus *Rheotanytarsus* live in flowing waters and also occur in the wave swept littoral zones of lakes, where they live as filter feeders using nets suspended between arms at the anterior end of the cases (Thienemann, 1954).

The major studies of benthic communities in West Africa mostly have been limited to standing waters and large rivers. Chironomids are important components of the freshwater fauna of the Afrotropical region (Amakye, 1980; 1993; Petr, 1970a). The benthic fauna of Volta Lake was studied by Petr (1969), of Lake Bosumtwi in Ghana by Whyte (1975), of Kariba Lake in Nigeria by McLachlan (1965, 1969), and of Lake Chad by Dejoux (1968) and Hopson (1967).

Some chironomid records from various parts of Ghana can be found (Amakye, 1993). Thomas (1966) recorded 17 species of chironomids from a small man-made lake, Petr (1970b) reported 52 species of chironomids from Volta Lake, while Whyte (1971) studied the ecology of chironomids in a small tropical man-made lake, the Danfa Reservoir, and recorded 69 species. The chironomid larvae collected by Hynes (1972) were identified only to the subfamily level. Whyte (1980) studied 34 species of chironomids collected from all over Ghana. According to Amakye (1993) 87 species in 31 genera belonging to 3 subfamilies had been recorded from Ghana by 1993. The subfamilies were represented by 12 species (14%) of Tanypodinae, 6 species (7%) of Orthoclaadiinae and 69 species (79%) of Chironominae.

Up till now, little has been published on the Afrotropical species of *Rheotanytarsus*. Only six species previously have been described from the Afrotropical region (Freeman & Cranston 1980, Lehmann 1979), namely *Rheotanytarsus ceratophylli* (Dejoux, 1973); *R. fuscus* (Freeman, 1954); *R. guineensis* Kieffer, 1918; *R. montanus* Lehmann, 1979; *R. ororus* Lehmann, 1979; and *R. samaki* Lehmann, 1971. None of these have previously been recorded in Ghana (Amakye 1993).

R. fuscus and *R. guineensis* are in need of redescription, while *R. ororus*, *R. samaki* and *R. montanus* are in need of re-examination. Freeman (1956) and Kieffer (1918) based their descriptions mainly on colour differences. Since colour is relative and changes with time on preserved species, this parameter is very unreliable. The only measurements they used were those of wing length (WL) and the only ratios the antennal ratio (AR) and leg ratio (LR). Their drawings were probably based on pinned specimens and thus not detailed, which makes it difficult to differentiate between species. The number of specimens used is not stated. In the redescriptions, measurements are made for all parts of the insect body that can be measured since certain species can be very similar apart from differences in body proportions.

Several new species were found in Ghana during the collection done in connection with the Norwegian University Committee for Development, Research

and Education (NUFU) project in collaboration with the Zoology Department, University of Ghana and the Institute of Aquatic Biology (IAB) in Ghana. The new species were all collected from freshwater localities, namely: Agumatsa Stream in the Volta Region, Ankasa Resource Reserve in the Western Region, Boti Falls in the Eastern Region, Densu River near Weija in the Greater Accra Region, Kakum National Park in the Central Region, Kintampo Falls in the Brong Ahafo Region and Subri Stream near Kibi in the Eastern Region. A description is made of these new species from Ghana as well as two other new species from Tanzania and Zimbabwe.

Chapter 2

MATERIAL

The material examined consists of Ghanaian specimens of *Rheotanytarsus* collected during the NUFU programme. In addition, specimens from Tanzania, collected during an expedition by the Museum of Zoology, University of Bergen, to North-East Tanzania in 1990 and lodged in the Museum (ZMBN) have been examined.

Twelve African *Rheotanytarsus* specimens all supposed to be either *R. fuscus* or *R. guineensis* from The British Museum (Natural History), London (BMNH) were borrowed. Those supposed to be *R. fuscus* are used for the descriptions below.

Also examined was material from Zoologisches Staatsammlung, Munich, Germany (ZSM). This consisted of two specimens of *R. montanus* from Zaire, and the following Palaearctic specimens:

- R. curtistylus* ♂: GERMANY: Schögesing, Kellerbach, 11. ix. 1992, W. Schacht.
- R. curtistylus* ♂: SPAIN: 28. vii. 1953, E.-J. Fittkau.
- R. ringei* ♂: AUSTRIA: Böhmer Wald, Stift Schlägl, 11. ix. 1982, H. Malicky.
- R. distinctissimus* ♂: GERMANY: Bayern, Oberbayern, Murnauer Moos, Ramsach, 11. vii. 1977, F. Reiss.
- R. pentapoda* ♂: AUSTRIA: Böhmer Wald, Stift Schlägl, 11. ix. 1982, H. Malicky.
- R. nigricauda* ♂: AUSTRIA: Lunz, Seebach, 31. iii. 1973, H. Malicky.
- R. muscicola* ♂: GERMANY: 15. ix. Glastroh.
- R. photophilus* ♂: GERMANY: Hessen, River Fulda, 3. viii. 1962.
- R. photophilus* ♂: GERMANY: Hessen, River Fulda, 26. viii., E. J. Fittkau.

The holotypes of the new species are deposited at the Museum of Zoology, University of Bergen (ZMBN). Paratypes are deposited at the Zoology Department, University of Ghana, Legon, Accra; Zoologisches Staatssammlung, Munich; and the Museum of Zoology, University of Bergen, Norway.

Chapter 3

LOCALITIES

During the NUFU project, collections of aquatic insects were made from various localities in Ghana, and *Rheotanytarsus* spp. were taken in seven localities, (Fig. 1).

Agumatsa Stream, (Plate 1), originates in Togo and runs southwards through the Agumatsam Wildlife Sanctuary (○) in the Wli area in the Volta Region. The upper part of the river has two large cascades and is rather fast flowing with stone and gravel as bottom substrate. In this section, the river is approximately 5 m wide and quite shallow. Further downstream the river flows more slowly and the bottom material consists of sand and mud. According to Hall & Swaine (1981) the forests in the area belong to the Dry Semi-Deciduous Fire Zone Subtype. The sanctuary is surrounded by steep-sided hills, the upper levels of which are covered by savanna woodland, while the bottom of the riverine valleys are covered by dense moist semi-deciduous forest. Mean annual rainfall exceeds 1,500 mm especially in the higher hills in the Volta Region (Hall & Swaine, 1981).

Ankasa Resource Reserve (◆) is located in the south western corner of Ghana in the Western Region close to the Ghana-Ivorian border. This part of Ghana lies within the Wet Evergreen Forest Type (Hall & Swaine, 1981). The area has an annual rainfall in excess of 1,750 mm and in some places even higher than 2,000 mm (Hall & Swaine, 1981). Many streams and small rivers run through the reserve, both rather fast flowing with stony substratum and more slow flowing with

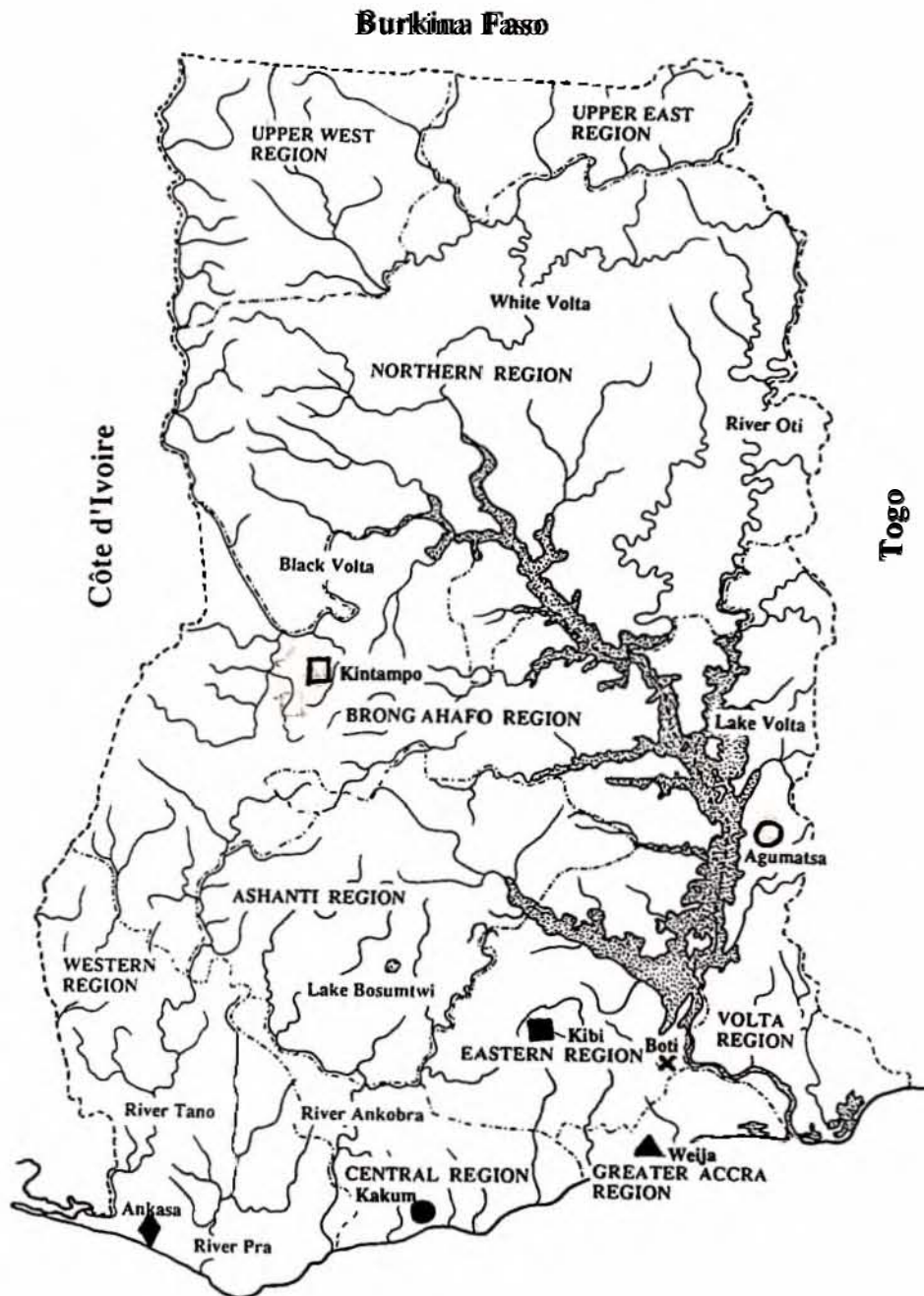


Fig. 1. Map of Ghana showing the localities where *Rheotanytarsus* spp. were collected.



Plate 1. Wli Waterfalls in the Agumatsa Wildlife Sanctuary in the Volta region of Ghana (Photo Jostein Kjærandsen).



Plate 2. Fast flowing river at Ankasa Resource Reserve in the Western Region of Ghana (Photo Jostein Kjærandsen).

muddy or sandy substratum, (Plate 2).

Boti Waterfalls, (Plate 3), is located near Boti (✕), in the Eastern Region and lies within the Moist Semi-Deciduous South-East Subtype (Hall & Swaine, 1981). Annual rainfall in this area is between 1, 200 and 1, 800 mm. The Boti River cascades down into a ravine from where it continues down the valley. Trapping was done below the waterfall. Here the river forms a small, rather shallow pool with sandy bottom. Closer to the waterfall there are rocks and stones. Downstream, the river flows rather rapidly and the bottom substratum consists both of sand and gravel and also of larger stones and rocks.

Kakum National Park (●), is located north-west of Cape-Coast in the Central Region. According to Hall & Swaine (1981), this area falls within the Moist Ever-green Forest Type. Annual rainfall varies between 1, 200 and 1, 800 mm. In the park there are many streams and small rivers, mostly rather slow flowing with sandy substratum, (Plate 4).

Kintampo Falls (☐), is located in the Brong-Ahafo Region. The locality is situated just north of the Dry Semi-Deciduous Fire Zone forest subtype and is thus somewhat influenced by this type of vegetation. Rainfall in this area unlike that of the higher hills of the Volta region does not exceed 1, 000 mm annually (Hall & Swaine, 1981). Chironomids were trapped just below the cascade and here the river is fast flowing with rocky and stony bottom substratum.

Subri Stream is located in the Eastern Region. Trapping was done near Kibi (■), at a site where the river is moderately fast and the bottom substratum consists mostly of pebbles and gravel with some larger stones. The area lies within the Upland Evergreen forest type, which occurs in isolated hill ranges (500-750 m elevations) within the Moist Semi-Deciduous Forest Type (Hall & Swaine, 1981). The hills here are isolated and steep-sided with more or less flat summits. Elevation of the hill summits leads to reduced temperatures, increased rainfall and mistiness.

Densu River near Weija (▲), is located in the Accra plains in the Greater Accra Region. At Weija the river is dammed and forms a large reservoir.

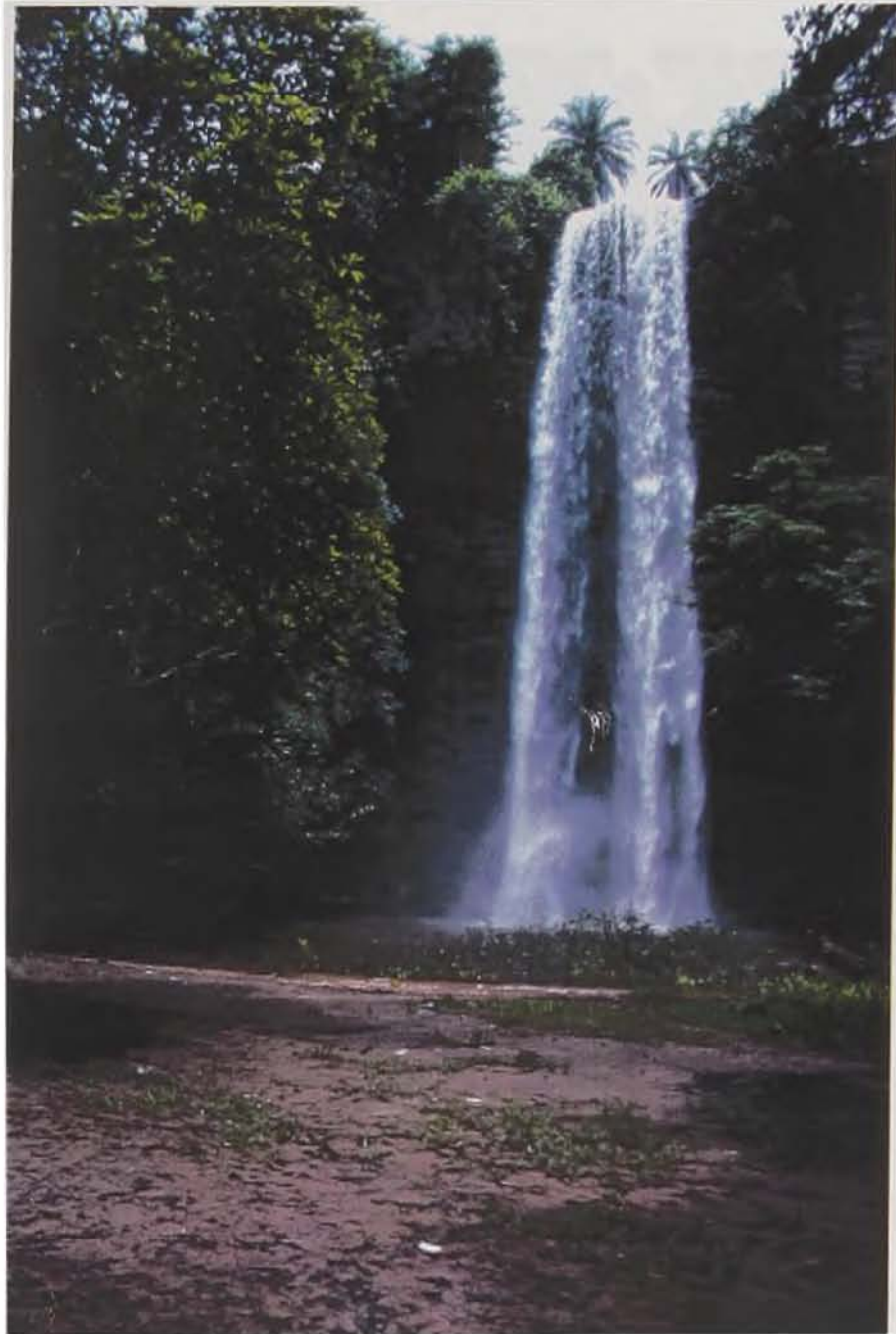


Plate 3. The waterfalls at Boti in the Eastern Region of Ghana (Photo by Geir E. E. Soli).



Plate 4. Small, turbid stream at Kakum National Park in the Central Region of Ghana (Photo Geir E. E. Sølvi).

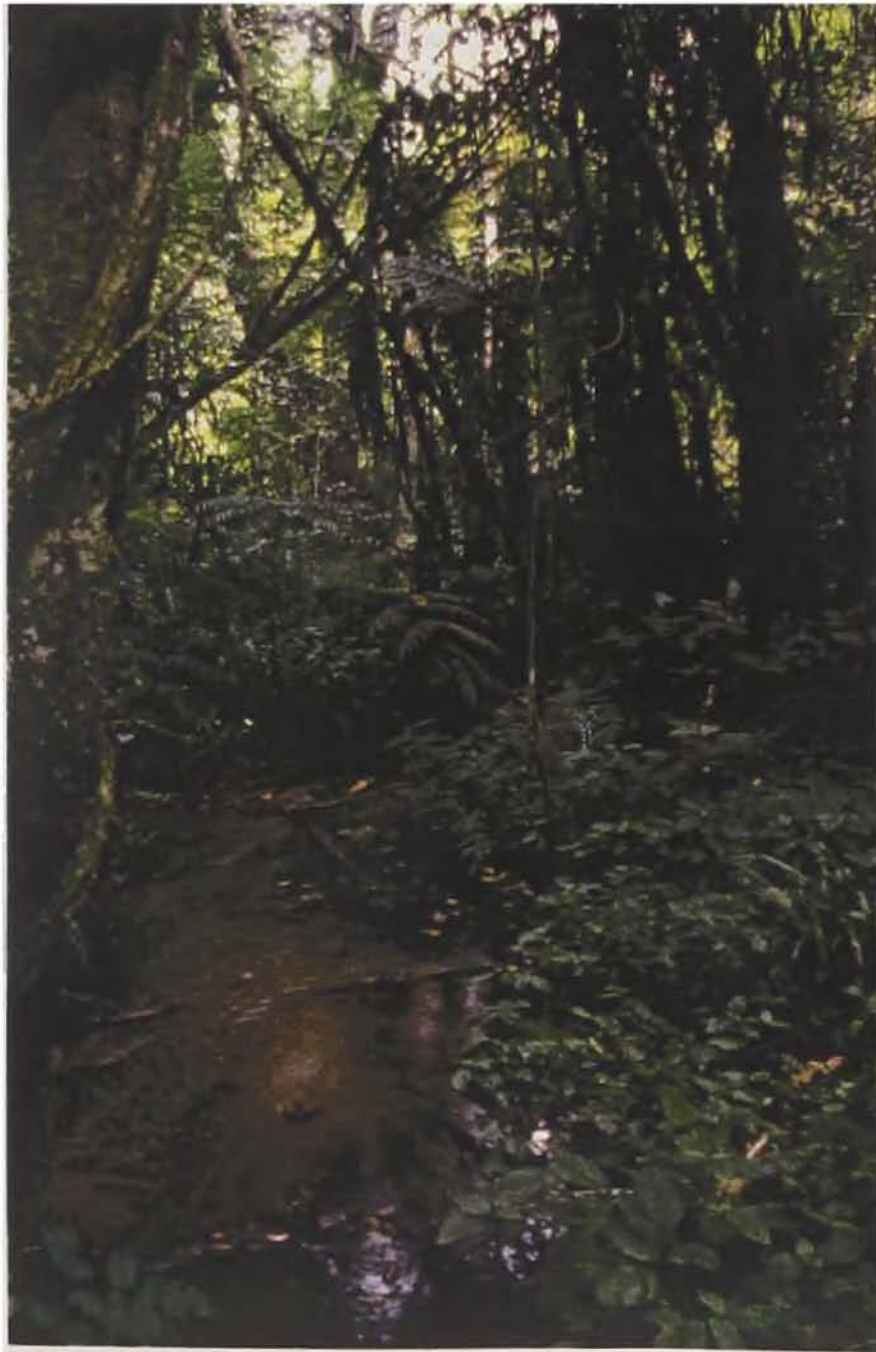


Plate 5. Kuputu Stream in the Mazumbai Forest Reserve in the West Usambara Mountains, North-Eastern Tanzania (Photo Geir E. E. Söli).

Vegetation in this area is of the Grassland Savanna type, and rainfall is minimal. The area of the Densu river near Weija is surrounded by gentle-sloping hills which are part of the Akuapim Range.

The material of *Rheotanytarsus* from Tanzania originates from two localities. Most species were taken at the Kaputu Stream, (Plate 5), near Mazumbai in the West Usambara Mountains, Tanga Region, in North-Eastern Tanzania. The trapping sites along the stream are described by Andersen & Johanson (1993). The West Usambara Mountains belong to the Eastern Arc, a chain of mountains stretching along the east coast of Tanzania. The mountains are covered with montane evergreen forest and due to a stable and most favourable coastal climate these forests are supposed to be very old and are among the most interesting endemic centres in Africa. One species was taken in the outskirts of the city of Arusha, Arusha Region, in Northern Tanzania at a small, rapidly-running river, with stony substratum, originating in Mount Mehru.

Chapter 4

METHODS

FIELD METHODS

Chironomids were collected with different methods. Adult chironomids were taken with Malaise traps, light traps and sweep nets; whereas dip nets and drift nets were used to collect larvae and exuviae.

Terrestrial

Malaise traps

Malaise traps collect flying insects. The insects enter the net through the open sides and are directed into the collecting bottle by the sloping net. The Malaise traps used during the NUFU project are of the "Woodhouse" type and are constructed of black nylon net, Plate 6. The insects are killed in 75% ethanol in the collecting bottle. The traps were attached to poles or trees and left for a few days to about two weeks at the various sampling sites. They were usually emptied every 3-5 days, and the catches were later sorted out in the laboratory.



Plate 6. The Malaise traps used are constructed of black mylon net (Photo Jostein Kjerandson).



Plate 7. The light trap used had a 250 watt mercury vapour and tungsten bulb as a light source (Photo Jostein Kjaerandsen).

Light traps

The light trap used during the NUFU project consists of a light source made up of a 250 watt mercury vapour and tungsten bulb, a metal funnel and a collecting jar containing 75% ethanol, Plate 7. Electricity was provided by a generator. A white calico sheet was tied to two poles to form a screen and was placed approximately 1 m from the light source. The traps were usually operated from dusk until 21⁰⁰ hours. Insects were either collected directly in the collecting jar or sampled on the white screen using pooters or test tubes with ethanol.

Sweep nets

The aerial net consists of a fine mesh (250 μ m) nylon net fitted on to a metal ring and attached to a wooden or metal handle, (Fig. 2A). The net used was 60 cm in diameter and 90 cm deep. Swarming chironomids were spotted and collected. Many specimens were also taken by sweeping around vegetation. The insects caught were removed from the net either using putters or test tubes with 75% ethanol.

Aquatic.

Dip nets

The dip net used consists of a net made of 250 μ m plankton net cloth fitted on to a metal ring attached to a metal handle, (Fig. 2B). The net is approximately 20 cm in diameter and 15 cm deep. The dip net is used to sample larvae, pupae or exuviae floating on the surface along fringes of rivers and streams or on the surface of ponds and lakes. The content of the dip net was emptied into a collecting tray with some water. After allowing the contents to settle, pipettes were used to collect live chironomid larvae and pupae into collecting bottles filled half way with water from the stream or river to rear in the laboratory. Dead larvae, pupae and exuviae were collected with the pipette and put in vials containing 75% alcohol.

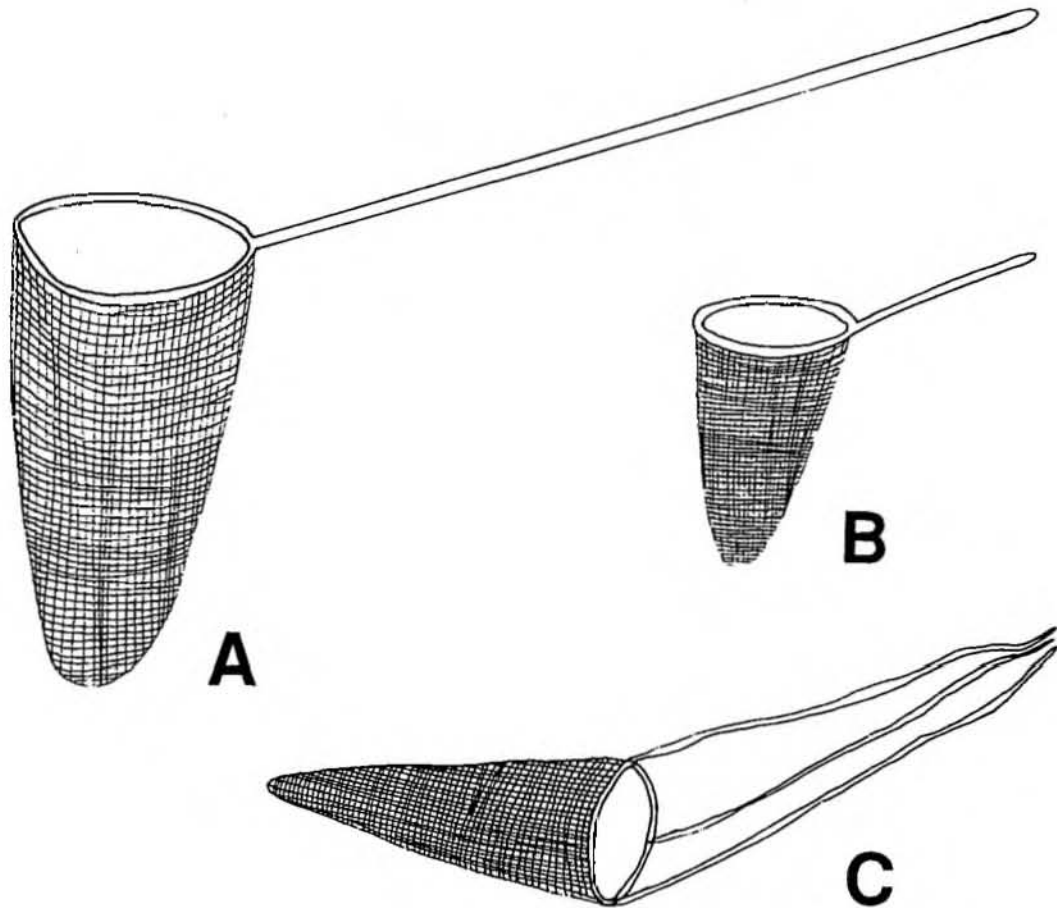


Fig. 2. Sampling nets. - A. Aerial net. - B. Dip net. - C. Drift net.

Drift nets

The drift net or Brundin net used consists of a net made of 250 μm plankton net cloth fitted to a metal ring onto which are attached strings, (Fig. 2 C). The nets are approximately 30 cm in diameter and 75 cm deep. The net was partially submerged in streams or rivers with the opening facing the current and was tied to nearby vegetation or rocks to ensure that it was not swept away by the current, and left for between 15 minutes to 1 hour depending on the amount of debris or silt in the water. The catches were handled in the same way as those from the dip nets.

Sampling of live larvae

Small stones, wood fragments and other bottom material from the streams and rivers were emptied into a collecting tray with some water. After allowing the contents to settle, pipettes were used to collect live chironomid larvae and pupae into collecting bottles filled half way with water from the stream or river to rear in the laboratory.

LABORATORY METHODS**Rearing of larvae**

The live larvae and pupae collected from the dip nets and drift nets were sorted out in the field and transported to the laboratory in ice chests to provide a stable environmental condition for their survival. Those larvae that survived the transportation were reared in petri dishes filled half way with water from the various rivers and streams from which the larvae were collected. The petri dishes were covered in such a way as to allow free exchange of air and left in the laboratory under the laboratory conditions with a temperature of about 26^o C.

The death rate of the larvae and pupae was high probably due to the drastic change in the conditions from the rivers or streams to the laboratory, or from at-

tacks of fungus. A few larvae managed to pupate, but could not survive to the adult stage. Those that survived to the adult stage usually did so during a few days, but some larvae stayed alive for several weeks without pupating. When successfully reared, the petri dish was put in the freezer for a few minutes to immobilize the insect; then the adult, the exuviae and the larval skin were preserved in 75% ethanol awaiting slide preparation.

Sorting

The preserved adults from the Malaise traps, lights traps and aerial nets were sorted out using a stereo-microscope. Due to their small size, it is usually not possible to identify adult chironomids beyond subfamily or tribe level without mounting them on slides for microscopy.

Larvae, pupae, exuviae and reared material were also mounted following the same procedure.

Slide preparation of adults

Slides of adults were prepared using the following method outlined in Sæther (1969:1):

- Both wings were removed and placed in glacial acetic acid for at least 15 minutes.
- The body was heated in an 8% KOH-solution until fat and muscle tissue were dissolved, usually 3-45 minutes.
- The adult bodies were placed in the glacial acetic acid for neutralization for at least 15 minutes.
- The wings and body were placed in 75% ethyl alcohol for dehydration for at least 10 minutes.
- The wings and body were placed in absolute ethyl alcohol for dehydration for at least 10 minutes.
- The wings and body were placed in a mixture of absolute ethyl alcohol and cedar wood oil for clearing for at least 10 minutes.
- The body was dissected using a stereo-microscope. Both antennae, the head, the thorax, the legs on one side and the abdomen were separated.

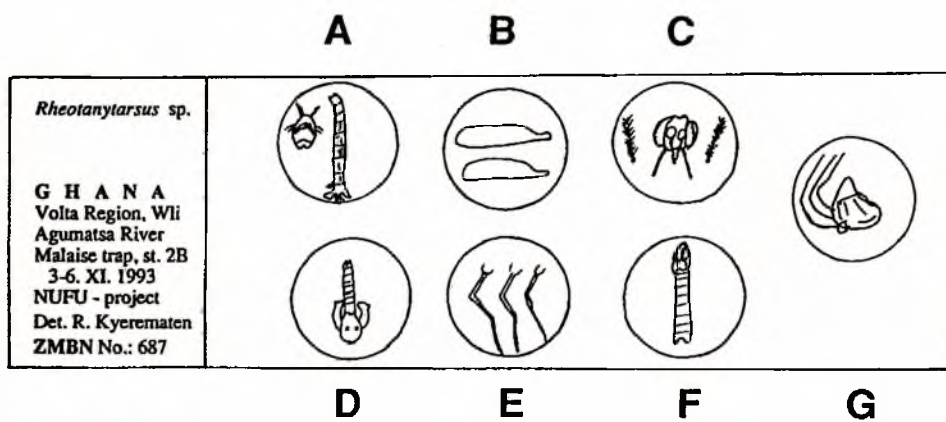


Fig. 3. Microscope slide preparation of reared adult male. - A. Larval skin. - B. Wings. - C. Head and antennae. - D. Pupal exuviae. - E. Legs of one side. - F. Abdomen and hypopygium. - G. Thorax with one set of legs attached.

- The wings and the various body parts were placed in cedar wood oil for clearing for at least 10 minutes.
- The wings and the various body parts were mounted in Canada balsam on slides. To secure a correct position, the head, thorax and abdomen were usually allowed to dry 1-3 days before they were covered with coverslips. The different parts of the insect body were mounted in positions as shown in Fig. 10.
- The slides were left in an oven at 40°C for about two weeks to dry.

Slide preparation of larvae and pupae

Slides were made for the larvae and pupae using the same technique as for the adults (Sæther, 1969). The head of the larva is usually removed from the body before heating in KOH, to secure a good result.

Slide preparation of larval skins and pupal exuviae

Larval skins and pupal exuviae are not heated in KOH, but placed directly in glacial acetic acid (Sæther, 1969). The rest of the method follows the procedure for the adults. They are mounted in the same positions as shown for larvae and pupae.

Mounting of reared specimens

The procedure follows that of slide preparation of adults and of larval skins and pupal exuviae. The specimen is mounted as shown in Fig. 3.

Identification

After mounting, the chironomids were identified to genus level using the keys in Pinder & Reiss (1983, 1986) and Cranston *et al.* (1989). For the identification, a phase contrast microscope fitted with a camera lucida, either a Leica Dialux 20 or a Nikon Optiphot X2, were used.

Calibration of measuring scale

Measurements were taken using the phase contrast camera lucida microscope. The scale on the eye piece in the microscope was calibrated using a calibration

slide. The scale on the calibration slide measured was 2 mm and divided in 20 intervals, i.e. every interval corresponded to 0.1 mm.

When calibrating the scale on the eye piece, the number of units corresponding to 0.1 mm on the calibration scale was measured for each magnification on both microscopes and the length, in microns (μm), of each unit was calculated using the simple proportion (Table 1).

Table 1. The calibration (in μm) of the various objectives of the Nikon Optiphot X2 and Leica Dialux 20 microscopes.

Microscope	Objectives (magnification)						
	4X	10X	20X	25X	40X	60X	100X
Leica Dialux 20	22.22	9.091		3.571	2.222		
Nikon Optiphot X2		8.170	4.000		2.050	1.380	0.800

Drawing techniques

Large scale pencil drawings of the various structures were made using drawing tubes mounted on the microscopes. The drawings were reduced usually to 80-60% using a copying machine and pasted in correct position on A2 sized cards. The drawing were then inked on tracing paper, using Rotring pens nos.: 0.18, 0.25, 0.35 and 0.50.

Before reproducing, the drawings were reduced to A4 size using a photocopier.

Chapter 5
**MORPHOLOGY AND
TERMINOLOGY**

Morphological nomenclature follows Sæther (1977, 1980a) with the additions mentioned in Sæther (1990a, b) with some of them illustrated in Wiederholm (1983, 1986, 1989). The broad flattened setae of the pupal exuviae are called taenia(e) in accordance with Langton (1994). This terminology will appear from Figs 4-6.

MEASUREMENTS AND RATIOS

Measurements are given as ranges followed by a mean, if more than three specimen were measured, followed by number measured in parenthesis. The measurements and ratios used are described below and shown in Figs 4-6.

Imagines

- Total length (TL): Length of abdomen + length of thorax. Abdomen is measured from the concave anteriomedian margin of segment I to the apex of the gonostylus, while the thorax is measured from the posterior margin of the postnotum to the anterior apex of the scutum in lateral view.
- Wing length (WL): Distance from arculus to apex of wing.

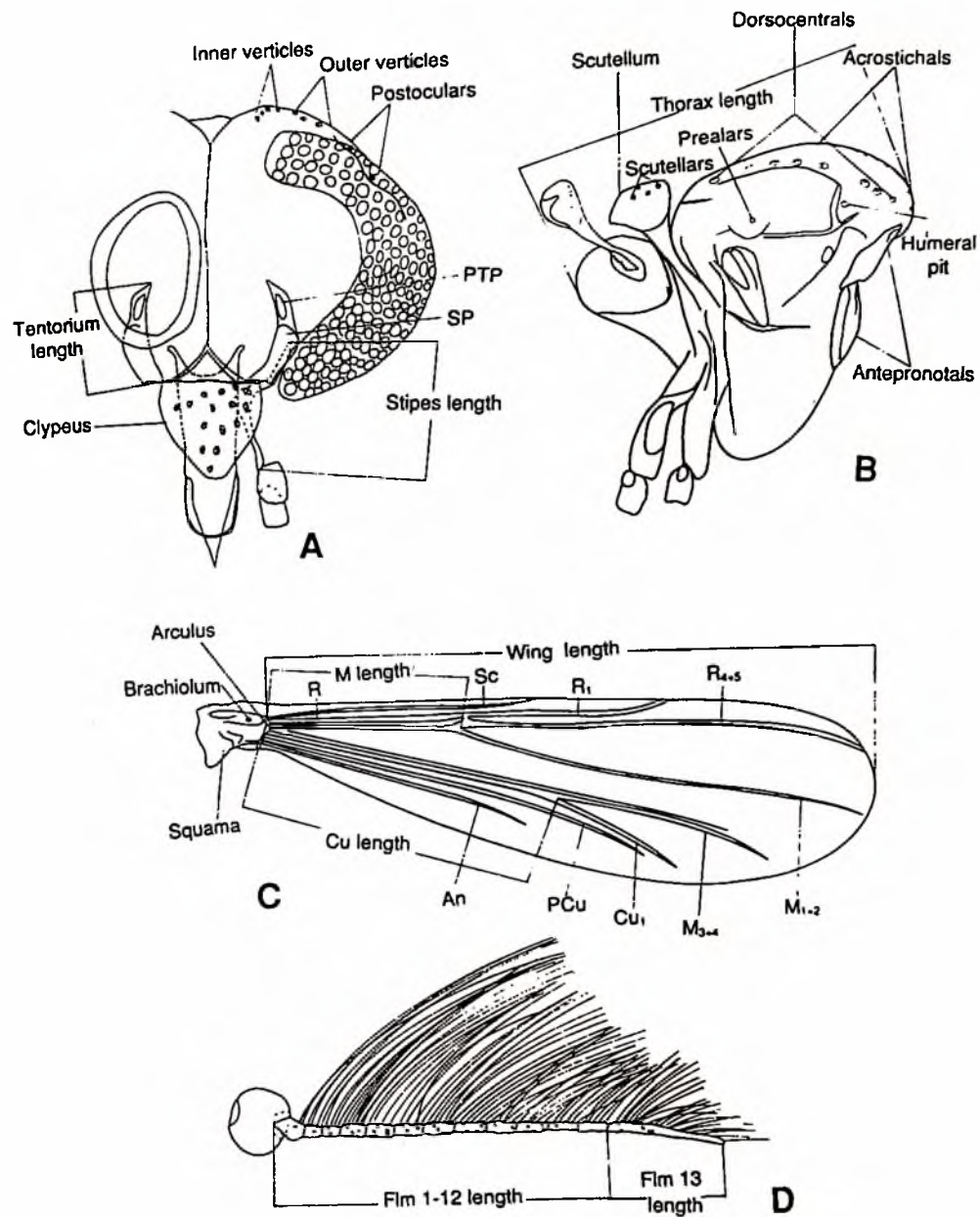


Fig. 4. Measurements of male imago. - A. Head. B. Thorax. - C. Wing. - D. Antenna.

-
- VR, venarum ratio: Length of Cu / length of M.
 - Media (M) length: Measured from arculus to the outer margin of the RM crossvein.
 - AR, antennal ratio: Length of thirteenth flagellomere / combined length of flagellomeres 1-12 for male and length of fifth flagellomere / length of flagellomeres 1-4 for female. The length of each flagellomere, when measured separately, is, except for the basal one, taken from the apex of one flagellomere to the apex of the next.
 - Tentorium length: The total longitudinal length.
 - Sieve pore width: Width of tentorium at the sieve pore, i.e. widest width of the tentorium.
 - Posterior tentorial pit width: Width at narrowest point of tentorium.
 - Stipes length: The total longitudinal length.
 - Stipes width: Width at widest part of the stipes including the often weakly sclerotized mediolateral plate.
 - Palp segment lengths: Total lengths.
 - Leg segment lengths: The length of the legs are not measured as total lengths, but as lengths of each leg segment according to Schlee (1966). This is taken from the comb begins. The measurements of the lengths of the spurs and comb as well as he legs are illustrated in Fig. 5B.
 - Width of tibia (front, middle and hind): Total maximal width at the apices.
 - LR, leg ratio: The ratio ta_1 / ti .
 - BV, "Beinverhältnisse": The ratio $fe + ti + ta_1 / ta_2 - ta_5$.
 - SV, "Schenkel-Schiene-Verhältnis": The ratio $fe + ti / ta_1$.
 - BR, "Bristle ratio": The ratio longest seta / width of ta_1 (measured 1 / 3 way from distal part of ta_1).

Males

- Anal point length: Measured from base to apex.
- Width at base of anal point: Width at the widest point at base.
- Width at apex of anal point: Width at the tip.

- Lengths of phallapodeme and transverse sternapodeme: Measured as illustrated in Fig. 5D.
- Length of gonocoxite: Measured from the apex where it overlaps the gonostylus to where it comes into contact with the other gonocoxite.
- Length of gonostylus: Measured from the apex to where it comes into contact with the gonocoxite.
- Length of superior volsellae: Total length.
- Length of median volsellae: Total length.
- Length of inferior volsellae: Total length.

Females

- Length of cercus: Total length measured in lateral view.
- Length of seminal capsule: Total length excluding neck.
- Width of seminal capsule: Total width.
- Length of the neck of seminal capsule: Measured as shown in Fig. 6A.
- Length of gonapophysis: Measured as shown in Fig. 6A.

Pupa

- Total length: Length of abdomen + length of thorax.
- Setae (taeniae) lengths: Total lengths.
- Nose length: Measured as shown in Fig. 6F.
- Number of spines on tergites: The number of spines in each spine patch of the tergite.
- Caudal spur length: Total length.
- Anal lobe overreach: The distance that the male genital sac overreaches the anal lobe measured from the apex of the anal lobe to the apex of the genital sac. In females the distance from the apex of the female genital sac to the apex of the anal lobe.

Larva

- Total length: Total length of head capsule + total length of abdomen.

- Antennal ratio: Total length of basal antennal segment / combined length of segments 2-5. When measured separately, each antennal segment measured from its base to the base of the next segment.
- Width of basal antennal segment: Maximum width.
- Length of blade: Total length.
- Length of accessory blade: Total length.
- Length of apical style: Total length.
- Length of second segment: Total length.
- Length of Lauterborn organ: Total length.
- Length of pedicel: Total length.
- Premandible length: Total length.
- Mandible length: Total length.
- Width of median teeth: Total width.
- Width of mentum: With at widest point.
- Postmentum length: Measured from apex of median tooth to posteriomedian occipital margin.
- Length of procercus: Total length.
- Length of posterior parapod: Total length.
- Length of anal tubuli: Total length.
- Length of supraanal setae: Total length.
- Length of anal seta: Total length.

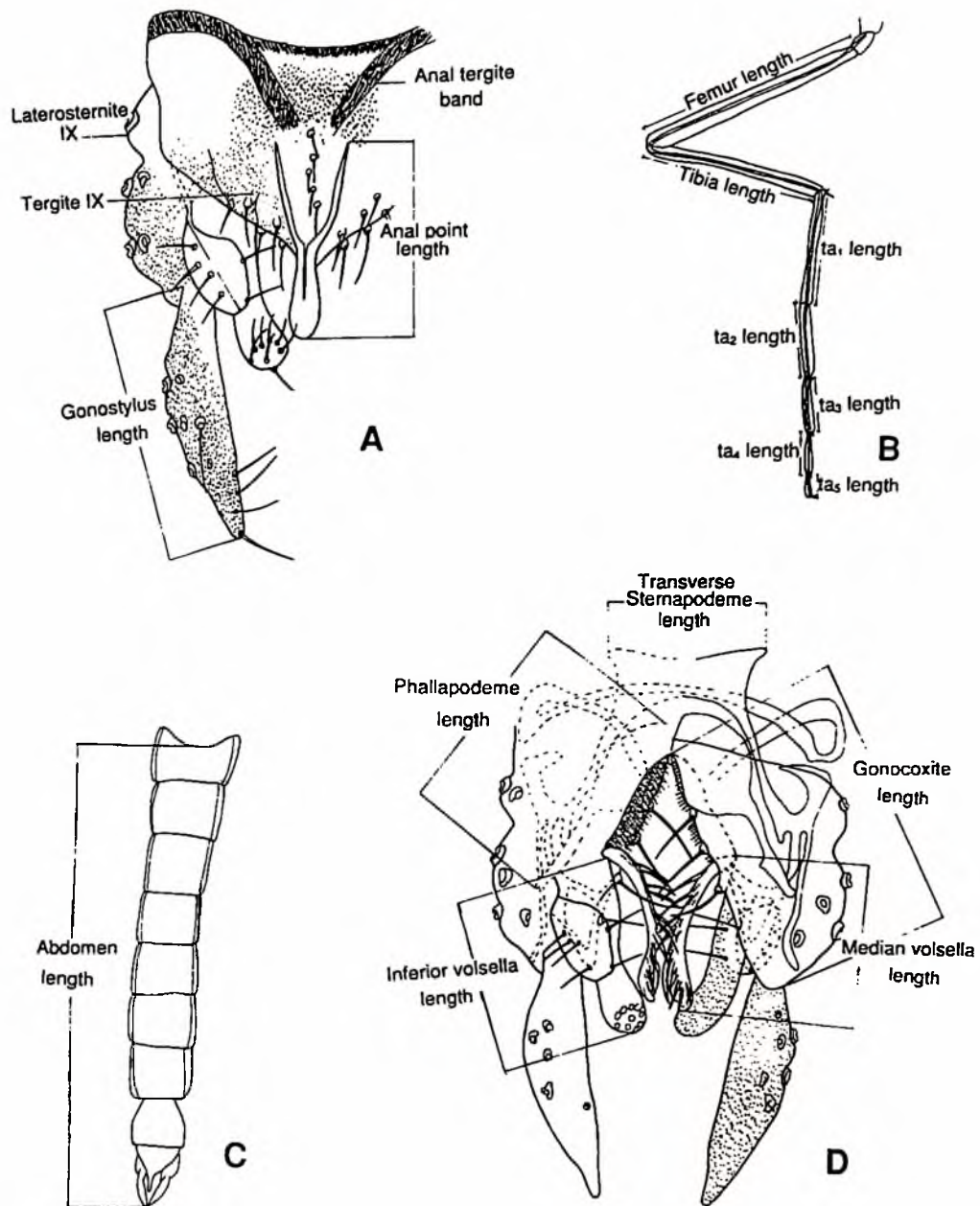


Fig. 5. Measurements of male imago. - A. Hypopygium, dorsal view. - B. Leg. - C. Abdomen. - D. Hypopygium, ventral view.

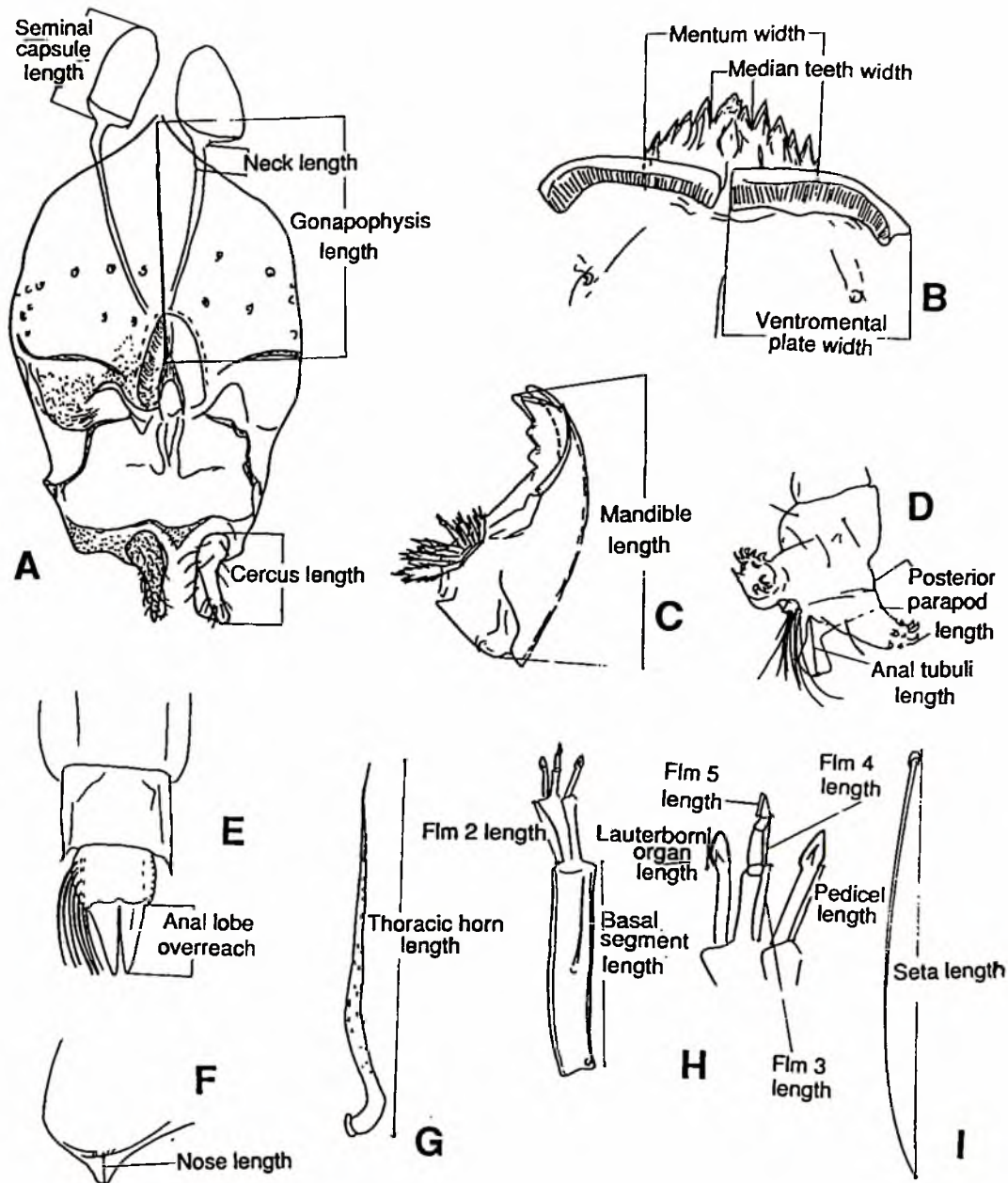


Fig. 6. Measurements of female (A), larva (B-D, H) and pupa (E-G, I). - A. Genitalia. - B. Mentum. - C. Mandible. - D. Posterior area. - E. Anal lobe. - F. Nose of wing sheath. - G. Thoracic horn. - H. Antenna. - I. Seta.

Chapter 6

RESULTS

Introduction to systematic part

The format below is in accordance with the rigid set up of modern works in chironomids (see for example Sæther, 1990b).

The generic diagnostic characters and diagnosis follow Sæther, 1977; Pinder & Reiss, 1983; 1986; and Cranston *et al.*, 1989. The generic description is based on the examination of all available material of *Rheotanytarsus* including both undescribed Afrotropical species and already described species from other parts of the world.

***RHEOTANYTARSUS* THIENEMANN ET BAUSE**

Rheotanytarsus Thienemann et Bause in Bause 1913: 120.

Syantanytarsus (*Rheotanytarsus* Thienemann & Bause), in Bause 1913: 120.

Tanytarsus (*Rheotanytarsus*) auct.

Rheotanytarsus Thienemann & Bause, Fittkau 1960: 397.

Type species: *Tanytarsus pentapoda* Kieffer, 1909, by subsequent designation of Goetghebuer in Goetghebuer & Lenz (1954: 132).

DIAGNOSTIC CHARACTERS

The imagines are separable from other Tanytarsini by having bare eyes with strong dorsomedial extension; no frontal tubercles; maxillary palpus 5-segmented, with 2 short blunt-tipped sensilla clavata at apex of third palpal segment; ante-

pulvilli absent or, in a few tropical species, vestigial. The male imagines are easily recognised by the characteristic shape of the gonostylus, which is abruptly narrowed distally. The shape of the anal point is also sufficient to distinguish them from the closely related genera of Tanytarsini (e.g. *Paratanytarsus* Thienemann et Bause). The fusion of the subulate or foliate setae of the median volsellae into platelike structure is also characteristic of most members of the genus. The female imagines have gonapophysis VIII clearly divided into ventrolateral and dorsomesal lobes; apodeme lobe distinct, and apparently with weak microtrichia; floor under vagina small to moderately sized; notum more than 2.5 times as long as seminal capsules.

The pupae can be separated from those of other genera by the presence of a single posterolateral spur or at most three spurs on segment VIII, and the spines on the tergites arranged in paired anterior point patches. All other genera with similar arrangement of spines have relatively complex posterolateral combs, usually with many combs and additional dorsal teeth.

The larvae construct a case or house; the case bears a few to at most six arm-like extensions at the unattached end. The larvae can also be separated from those of other genera by the pecten epipharyngis, which is a single, broad, distally serrated plate, which may however be deeply divided into 3 lobes.

DIAGNOSIS

Imago

Small to medium-sized species. Body yellowish green, pale, to dark; vittae, postnotum and preepisternum pale to dark; vittae separated.

Antenna. Male antenna usually with 13, very rarely with 12 flagellomeres, with antennal groove reaching flagellomere 2. Female with 5 flagellomeres.

Head. Eyes bare, with strong dorsomedial extension. Frontal tubercles absent. Palp developed normally with third palpal segment bearing 2 short blunt-tipped sensilla clavata. Tentorium without microtrichia. Temporals consisting of inner and outer verticals and postorbitals.

Thorax. Antepronotum with lobes widely separated. Scutum overreaching antepronotum; tubercle absent. Antepronotals absent; biserial acrostichals and uniserial dorsocentrals present; supraalars absent; 1 prealar and uniserial scutellars present. Preepisternum and anepisternum bare.

Wing. Membrane densely setose especially in distal 1 / 2. Costa not extended; R_{4+5} lying very close to R_1 ; R_{2+3} absent; R_{4+5} ending 1 / 4-1 / 2 way between apices of M_{1+2} and M_{3+4} , all veins setose. RM well proximal to FCu. Wing cuneiform without anal lobe, or if present, weakly developed. Brachiolum bearing one seta, squama bare.

Legs. Apex of fore tibia with short, slender spur. Mid and hind tibia with two separate combs usually each bearing a spur, rarely one or both combs lacking spurs. No to few sensilla chaetica on distal part of tarsomere 1 of mid leg. Pulvilli absent or vestigial (in a few tropical species).

Male hypopygium.

Anal tergite bands almost always separate, or if fused (rarely), then V-shaped. Anal point short to rather long, usually slender and slightly expanded distally, occasionally broader and tapering in distal 1 / 2, rarely darkened with finely scalloped dorsolateral ridges. Anal crests well developed, never with patches of short spines between. Superior volsella oriented parallel with body axis; roughly oval to rounded, sometimes of variable shape, or with posterior margin produced, tending to give hook-shaped appearance, sometimes with inner margin bilobed. Digitus absent or vestigial. Inferior volsella well developed, roughly cylindrical-shaped and slightly expanded distally, extending well beyond base of gonostylus. Median volsella well developed, apically with lamelliform subulate or foliate setae, often partially or fully fused to form plate-like structure with or without apical points. Gonostylus typically abruptly narrowed in apical 1 / 2, less commonly broadest at mid point with outer margin gradually tapering to rounded apex, sometimes hooked at apex .

Female genitalia

Gonocoxapodeme VIII straight or nearly straight, ends on base of dorsomesal lobe of gonapophysis VIII. Sternite VIII forms a very small to moderately sized floor under anterior part of vagina. Gonapophysis VIII divided into small to moderately large ventrolateral lobe with long apical microtrichia and well developed dorsomesal lobe. Apodeme lobe distinct, occasionally with apparent apical microtrichia. Notum very long, more than 2.5 times as long as seminal capsules. Tergite IX bluntly triangular to low and semicircular, with weak or moderately strong shoulders. Gonocoxite small, projecting caudally, without or with a few setae. Segment X normal. Postgenital plate small to medium sized and triangular in shape. Cercus normal, small, short to medium in length and slender. Seminal capsules bare, oval to cylindrical-shaped, with or without a short neck. Spermathecal ducts with long loops or sharp curves.

Pupa

Small to medium sized pupae. Exuviae pale with cephalothorax, anal segment and margins of VIII somewhat slightly darkened.

Cephalothorax. Frontal setae slender and elongate, seated apically on extremely short conical cephalic tubercles. Frontal apotome smooth, somewhat wrinkled, or slightly granulose apically or over most of apotome. Thoracic horn of the simple type, slender and elongate with tiny projections on distal half, occasionally bare and short, occasionally with median sharp bend; horn arising from dome-like base. Thorax smooth or with narrow, granulose band along dorsal suture. Prealar tubercle absent to weakly developed. Scutal tubercle lacking. Wing sheath with prominent nose; pearl row absent.

Two very long taeniate precorneals and the other filiform and short, 2 taeniate antepnotals and 2 pairs of dorsocentrals, each pair well separated from the other.

Abdomen. Tergite I without shagreen; II-IV, II-V or II-VI with anterior pair of transversely arranged point patches or bands of dark spines. Abdomen otherwise with at most isolated patches of shagreen, or tergite II often with posterior sha-

green, rarely with two posterior plates with a small number of points. Row of caudal hooklets not divided medially, occupying $1/7-1/2$ width of segment. Con-junctives and pleura without shagreen. Pedes spurii A and pedes spurii B absent. Sternite I without anterolateral or anteromedian tubercles. Sternites without con-spicuous armature. Segment VIII with posterolateral spur, single or cleft, rarely with additional minute teeth dorsally; occasionally with 3-6 curved, thorn-like spurs.

Abdominal segments II-V each with 3 L setae, VI with 3-4, VII with 4, VIII with 4-5 L setae; all taeniate, all hair-like, or normally 1 taeniate on IV and all taeniate on V-VIII. Anal lobe well developed usually with complete fringe of medium to long taeniae, rarely fringe confined to posterior $1/2$ of lobe or, in one Nearctic species at least, fringe absent; dorsal taenia or hair-like setae present or absent.

Larva

Small to medium sized, pale-coloured larvae.

Antenna 5 segmented; placed on tall pedestal without apical spur or tooth; basal segment much longer than flagellum with proximal ring organ and well deve-loped seta about halfway along; segment 2 slightly wedge-shaped and longer than more distal segments; with style and moderately large Lauterborn organs placed on pedicels which extend only slightly, if at all, beyond antennal apex. Blade arising from apex of basal segment with short, basally fused accessory blade.

Labrum. S I comb-like, bases fused; S II distally plumose, situated on long pedestal; S III fine, seta-like; S IV present. Labral lamella well developed. Pecten epipharyngis either a simple broad comb, or incompletely divided into 3 parts. Premandible distally bifid; with well developed brush.

Mandible. Dorsal tooth dark brown, similar in colour to apical tooth and 2 or 3 inner teeth. Seta subdentalis long, slender. Seta interna consisting of 4 plu-mose branches. Pecten mandibularis with numerous long lamellae.

Mentum. Median tooth with 1 or 2 notches laterally, occasionally distinctly trifid; with 5 pairs of lateral teeth, regularly decreasing in size laterally. Ventro-

mental plates almost in contact medially, somewhat wider than mentum with strongly curved anterior margin.

Body. Claws of posterior parapods all simple. Procercus short bearing medium to long anal setae; anal tubules normal.

DESCRIPTION

Male

Small to medium sized species. Total length 1.1-3.5 mm. Wing length 0.7-3.0 mm.

Head. Antenna with 12-13 flagellomeres. Antennal ratio 0.13-1.52. Temporal setae 5-10. Tentorium 33-132 μm long, stipes 55-150 μm long. Clypeus with 11-22 setae.

Thorax. Dorsocentrals 7-17, acrostichals 12-26. Scutellum with 3-13 setae.

Wing. Membrane with 480-1500 setae in all. VR 1.31-1.72.

Legs. LR of p_1 1.50-3.05, of p_2 0.48-0.65, of p_3 0.53-0.76.

Female

Small to medium sized species. Total length 1.68-2.50 mm. Wing length 1.00-2.50 mm.

Head. Antenna with 5 flagellomeres. Antennal ratio 0.29-0.31. Temporal setae 7-8. Tentorium 45-119 μm long, stipes 57-133 μm long. Clypeus with 15-24 setae.

Thorax. Dorsocentrals 11-14, acrostichals 16-24. Scutellum with 5-10 setae.

Wing. Membrane with up to about 1500 setae in all. VR 1.30-1.49.

Legs. LR of p_1 1.56-2.77, of p_2 0.47-0.65, of p_3 0.53-0.75.

Pupa

Small to medium sized pupa, 3.0-4.0 mm long.

Cephalothorax. Thoracic horn 160-500 μm long.

Abdomen. L setae on abdominal segments: II 3, III 3, IV 2. LS setae on abdominal segments: IV 1, V 3-4, VI 4, VII 4, VIII 4-5. Anal fringe with 6-43 setae.

Larva

Small to medium-sized larvae. Total length 1.8-5.0 mm.

BIOLOGY

The larvae of *Rheotanytarsus* are rheobiontic, filter feeding using nets suspended between arms at the anterior end of their characteristic cases (Pinder & Reiss, 1983). They are case dwellers inhabiting small brown cases (Walshe, 1950; 1951; Thienemann, 1954). The houses may be made of diatoms glued together by secretions and attached to the substrate for their full length, as in some Oriental and Nearctic species (Thienemann, 1954, Figs 14, 31); or, more usually, made out of sand grains or mud particles. Characteristically there are arm-like apical extensions between which silk strands are suspended to catch particles of suspended detritus which are utilised both as food and for case building. Occasionally these arms are rudimentary or lacking, normally there are from 1-6 such arms (Thienemann, 1954). The arms normally are about half as long as the houses, but may reach 3/4 the length or even the full length of the houses.

The larvae live in moderately fast to moderately slow flowing rivers, streams, creeks and ponds. On the contrary though, *R. ceratophylli* larvae live in temporary stagnant waters (Dejoux 1973). During an ecological survey of the Great Berg River by Harrison & Elsworth (1958) and Harrison (1958), larvae which according to Scott (1967), belonged to *R. fuscus* were found usually to occur in stony runs and trickles during the drier months of the year, particularly where the stones were overgrown with *Scirpus digitatus* Boeck, to whose whip-like leaves *fuscus* cases were often attached.

Scott (1967) reared *R. fuscus* in the laboratory and collected many imagos in the field from the Berg River area during the years 1951-1955, and found that the larval cases of *R. fuscus* varied in number according to the strength of the current, being commonest in places where the current was fairly strong but not maximal and the water shallow, and decreasing in abundance as the current diminished in speed. They were rare in very fast current and absent from quiet backwaters. In this experiment it was found that the larval cases were small, flat tubes,

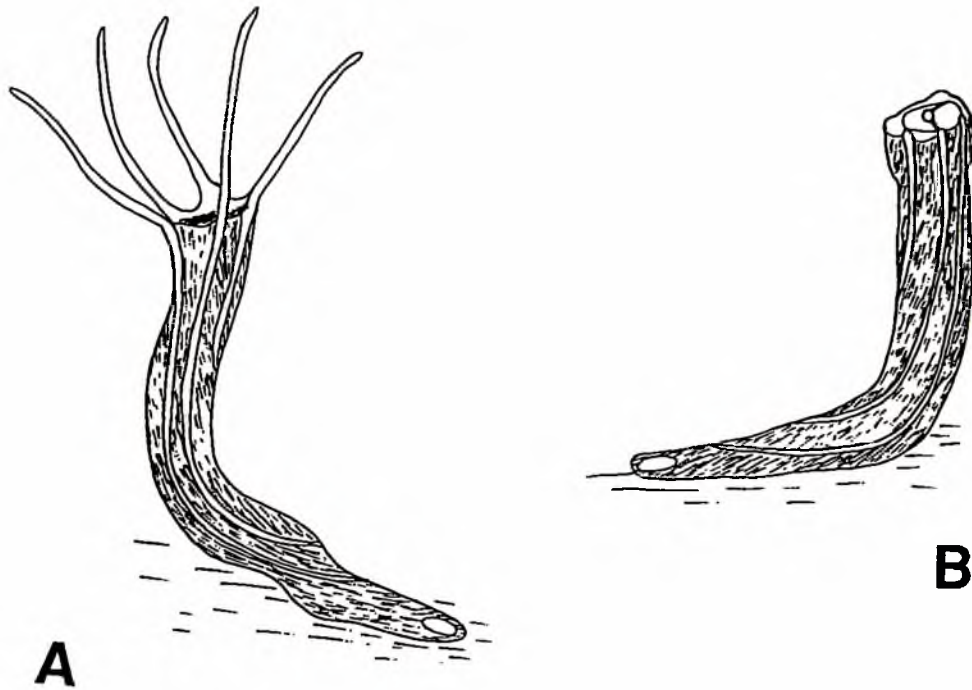


Fig. 7. - A. Larval house. - B. Pupal house with pupa inside.

semicircular in cross-section, laid flat against the substratum, without ribs or arms when the larvae were young, but generally built more and more upright, finally standing erect as the larvae reached full maturity. As the case increased in length, one or more arms were added ending in projecting arms up to five in number (Fig. 7 A).

The larvae were extremely active, constantly engaging in one activity after another. The salivary nets were used to trap food (including plankton and detritus). This part was then eaten and replaced by the larvae. The larvae kept a current flowing through the case when not otherwise occupied.

Prepupal larvae removed the arms from the cases smoothing the entrance hole and neatening it with secretions, but some left the arms on. There was a small central hole within the thickened outer ring of the case through which the prothoracic horns protruded.

The pupal cases were usually upright, facing upwards towards the surface of the water. Occasionally, pupal cases were seen lying flat on the substratum or inclined to it at various angles (Fig. 7 B).

The hinged lid was pushed open by the pupa on emergence, and the pupa swam directly to the surface of the water where eclosion took place and the imago immediately flew away. Emergence took place during the day as well as at night.

SYSTEMATICS

Previously described species

The genus *Rheotanytarsus* belongs to the subtribe Tanytarsina of the tribe Tanytarsini of the subfamily Chironomidae. The genus *Paratanytarsus* apparently forms its phylogenetic sister group (Sæther, 1977: 137, fig. 62). Up to now 56 species have been described from all zoogeographical regions, (Table 2).

Table 2. List of previously described species of *Rheotanytarsus* Thienemann et Bause, with their distribution.

Palaeartic species:

- aestuarius* (Tokunaga, 1938: 360, as *Tanytarsus*). Japan, China.
curtistylus (Goetghebuer, 1921: 121, as *Tanytarsus*). Europe, Lebanon.
distinctissimus (Brundin, 1947: 88, as *Stempellinella*). Europe, North-Africa, Mongolia, Nearctic.
dogoensis Ree et Kim, 1988: 21. Korea.
fluminis Kawai et Sasa, 1985: 20. Japan.
illiesi Siebert, 1979: 165. Germany.
kibunexpandus Sasa, 1989: 56. Japan.
kuramasimplex Sasa, 1989: 51. Japan.
kyotoensis (Tokunaga, 1938: 345, as *Tanytarsus*). Japan.
musciicola Thienemann, 1929: 113. Europe, Mongolia, China, Algeria, Morocco.
nigricauda Fittkau, 1960: 397. Europe.
okisimplex Sasa, 1993: 130. Japan.
parvicrinis (Tokunaga, 1938: 343, as *Tanytarsus*). Japan.
pentapoda Kieffer, 1909: 51. Europe.
photophilus Goetghebuer, 1921: 115. Europe.
reissi Lehmann, 1970: 368. Europe.
rhenanus Klink, 1983: 136. Europe.
ringei Lehmann, 1970: 370. Europe, Morocco.
rivulophilus Kawai et Sasa, 1985: 21. Japan.
tamasecundus Sasa, 1980: 13. Japan.
tamatertius Sasa, 1980: 14. Japan.
tamaquartus Sasa, 1980: 16. Japan.
tamaquintus Sasa, 1980: 18. Japan.
thermae (Tokunaga, 1940: 304, as *Tanytarsus*). Japan.
yufualbus Sasa et Suzuki, 1991: 98. Japan.

Nearctic species:

- akrina* (Roback, 1960a: 1, as *Calopsectra*). USA (Kansas).
distinctissimus (Brundin). Canada, USA, Europe, North-Africa, Mongolia.
exiguus (Johannsen, 1905: 294, as *Tanytarsus*). Canada, USA.
magnini Cloutier et Harper, 1986: 1. Canada (Quebec).
pellucidus (Walker, 1848: 21, as *Chironomus*). Canada (Ontario).

Australasia and Oceania species:

- annulatus* Glover, 1973: 419. Australia.
christinae Glover, 1973: 420. Australia.
flabellatus Glover, 1973: 420. Australia.
johnstoni Glover, 1973: 422. Australia.
juliae Glover, 1973: 424. Australia.
ogilbyi (Skuse, 1889: 273, as *Tanytarsus*). Australia.

underwoodi Glover, 1973: 425. Australia.

Oriental region:

acerbus (Johannsen, 1932: 547, as *Tanytarsus*). Indonesia (Sumatra),
China.

additus (Johannsen, 1932: 548, as *Tanytarsus*). Indonesia (Java, Sumatra).

adjectus (Johannsen, 1932: 547, as *Tanytarsus*). Indonesia (Java).

tobaseptidecimus Kikuchi et Sasa, 1990: 317. Indonesia (Sumatra).

formosae Kieffer, 1921: 592. Taiwan.

tamaquartus Sasa. Japan, China.

thailandensis Moubayed, 1990: 29. Thailand.

trivittatus Johannsen, 1932: 546. Indonesia (Sumatra).

Neotropical species:

abbreviatus Kieffer, 1925: 82. Argentina.

breda Roback, 1960b: 103. Peru.

globosus Reiss, 1972: 64. Chile, Argentina.

lamellatus Reiss, 1972: 67. Chile.

pela Roback, 1960b: 105. Peru.

hamatus Sublette et Sasa, 1994: 52. Guatemala.

Afrotropical species:

ceratophylli (Dejoux, 1973: 66, as *Tanytarsus*). Chad, Sudan.

fuscus (Freeman, 1954: 25, as *Tanytarsus*). South Africa.

guineensis Kieffer, 1918: 73. Guinea, Rhodesia, Senegal, Uganda, Zaire.

montanus Lehmann, 1979: 62. Zaire.

ororus Lehmann, 1979: 64. Zaire.

samaki Lehmann, 1979: 65. Zaire

Species groups

The described species can be grouped into seven more or less distinct groups primarily based on pupal features. Many species remain to be associated and placement of all imagines is not possible for the moment. However, some features allow placement of some of the species.

The pupae of the *distinctissimus* group are characterized by having paired patches on tergites II-IV only, granulose frontal apotome and paired spine patches posteriorly on T II. The known male imagines have a very long median volsella with the subulate lamellae often extending far beyond the apex of the superior volsella. The male gonostylus is sometimes hook-like, recurved at apex. Included in this group are *R. distinctissimus*, *R. thailandensis*, and possibly *R. acerbus* (Wang & Zheng 1993), *R. flabellatus*, and *R. yufualbus* and one new species from Ghana to be described later.

The pupae of the *curtistylus* group are characterized by having paired circular patches on tergites II-V, and a posterior patch of spinules or shagreen on tergite II. The frontal apotome often is apically granular. At least some larvae have lateral notches on a median mental tooth and an undivided pecten epipharyngis. The male imagines have a more or less S-shaped median volsella with distal lamellae fused into a single plate with or without terminal points, or possibly a very short median volsella with separate distal subulate or foliate setae if *R. hamatus* and similar species belong here. The gonostylus sometimes may be hooked at apex if *R. hamatus* and related species belong here. Included in this group are *R. curtistylus*, *R. atrius* sp. n., *R. fuscus*, *R. juliae*, *R. muscicola*, *R. ororus*, *R. photophilus*, *R. kjaerandseni* sp. n., *R. weijensis* sp. n., and possibly *R. aquilus* sp. n., *R. christinae*, *R. hamatus*, *R. plerusinguisus* sp. n., *R. saetheri* sp. n., *R. tobaseptidecimus* and *R. abonae* sp. n.

The pupae of the *globosus* group have paired circular patches on tergites II-V, but tergite II without posterior armament and tergites IV or V-VI with posterolateral rugose area (Reiss, 1972). The male imagines have a slightly curved median volsella with several apical subulate or foliate lamellae not fused into plate. Included in this group are *R. globosus* and *R. magnini*.

The pupae of the *pentapoda* group are characterized by having circular or elliptical spine patches on tergites II-VI and single posterolateral spur on segment VIII. The male imago has a curved, not markedly recurved, median volsella, with several short ovoid distal lamellae without apical points. Only one species so far has been shown to belong to this group: *R. pentapoda*.

The pupae of the *ceratophylli* group also have circular spine patches on tergites II-VI. However, different from other pupae of the genus there are 4-6 curved spurs posterolaterally on segment VIII. At least some larvae have lateral notches on a median mental tooth and an undivided pecten epipharyngis. The male imago has a very short median volsella with apical foliate setae not fused into plate. Included in this group are *R. ceratophylli*, *R. johnstoni* and possibly *R. kuramasimplex* and *R. okisimplex*.

The pupae of the *nigricauda* group have transversely elongate or rectangular spine patches on all of tergites II-VI. The thoracic horn at least sometimes is relatively short and completely bare. The anal lobe carries a long dorsal seta. The L- setae on the segments are not taeniate. The gonostylus is evenly tapered in distal half (in contrast to other species of the genus). Included in this group are *R. nigricauda*, and probably *R. aestuarius*.

The pupae of the *reissi* group also have transverse elongate or rectangular spine patches on tergites II and III (IV), while those on IV (V)-VI are more circular. The thoracic horn is narrower and with at least some apical spinules. The L- setae are taeniate on posterior abdominal segments. The male imagines may have the superior volsella sickle-shaped. Included in this group are *R. reissi*, *R. rhenanus*, *R. montanus*, and probably *R. guineensis*, *R. kibunexpandus*, *R. lamellatus*, *R. ringei*, *R. samaki*, and four new Afrotropical species to be described later.

Phylogeny of the species groups

A complete phylogeny of the genus will not be included here since in order to do that, all previously described species would have to be re-examined and re-described. However, a phylogeny of the relationship between the different groups has been attempted.

The genus *Rheotanytarsus* belongs to a well defined monophyletic group together with *Paratanytarsus* (Sæther, 1977). The sister group relationship between *Paratanytarsus* plus *Rheotanytarsus* and *Micropsectra* Kieffer and related genera is equally clear as shown for instance by the similarly divided female gonapophyses VIII with a brush-like ventrolateral lobe. The distinct apodeme lobe of gonapophysis IX is an objective synapomorphy (Sæther, 1983; 1986; 1990a, c) for *Paratanytarsus* plus *Rheotanytarsus* and there are several other putative synapomorphies between the two genera.

Due to the lack of associated material for many species, the following attempt to delineate the cladogenesis of the species groups can only be regarded as tentative. Nevertheless, in order to obtain at least a preliminary picture of the phylogenetic relationship and to pinpoint future areas of investigations, a tentative scheme of argumentation is desirable (Fig. 8). In the figure, trends showing the same directions are grouped. The trends are polarized using a series of nested sets in relevant outgroups at each level of the analysis, (Sæther, 1983; 1990a, c). All characters included in the data matrix are judged according to their absence or presence and distribution in outgroups. The following trends are used (a = apomorphic, p = plesiomorphous):

- Trend 1. Superior volsella with posterior margin produced giving hook-like appearance (a); rounded (p).
Parallelism takes place in a few members of the *curtistylus* group.
- Trends 2. Pupal thoracic horn short and bare (a); longer, with apical spinules (p).
Anterior patches on tergites IV and V of pupa transverse elongate (a); patches circular or absent (p).
No pupal L setae taeniate (a); at least some taeniate (p).

-
- Trend 3. Anterior patches on tergites II and III of pupa transverse, elongate(a); patches circular (p).
- Trends 4. Apical plates of median volsella without spines in most species (a); with (p); gonostylus with apex hooked in most species (a); not hooked (p).
Both these autapomorphies are underlying as they do not include all species and there are outside parallelisms.
- Trend 5. Apical plate of median volsella without setae at base and without apical spines (a); apical plate either with apical spines or with setae at base (p).
- Trend 6. Frontal apotome of pupa rugulose anteriorly (a); smooth (p).
Parallelism takes place in the *distinctissimus* group.
- Trend 7. Setae of median volsella fused into apical plates (a); not fused (p).
- Trends 8. Pupal thoracic horn with median bend or break (a); without (p).
Anal crests long, not completely fused posteriorly (a); more rounded anteriorly, when long median margins fused posteriorly (p).
- Trend 9. Pupal tergites IV-VI or V-VI with posterolateral rugose area (a); without (p).
- Trends 10. Tergite V of pupa without anterior spine patches (a); with (p).
Tergite II of pupa with posterior shagreen arranged as two groups of spinule patches (a); no shagreen or shagreen not arranged as spinule patches (p).
Apical setae of median volsella extend well beyond apex of inferior volsella (a); extend at most slightly beyond (p).
- Trend 11. Pupal tergite VIII with spur (a); with comb (p).
- Trend 12. Median volsella very short, ending far short of apex of superior volsella (a); longer, at least reaching close to apex of superior volsella (p).
- Trends 13. Pupal tergite II with paired anterior patches and weak or no shagreen lateral of patches (a); with extensive shagreen, no patches (p).
Segment VIII of pupa with single or cleft caudolateral spur or comb of 3-6 curved, thorn-like spines (a); with 3-11 teeth in a single row (p).

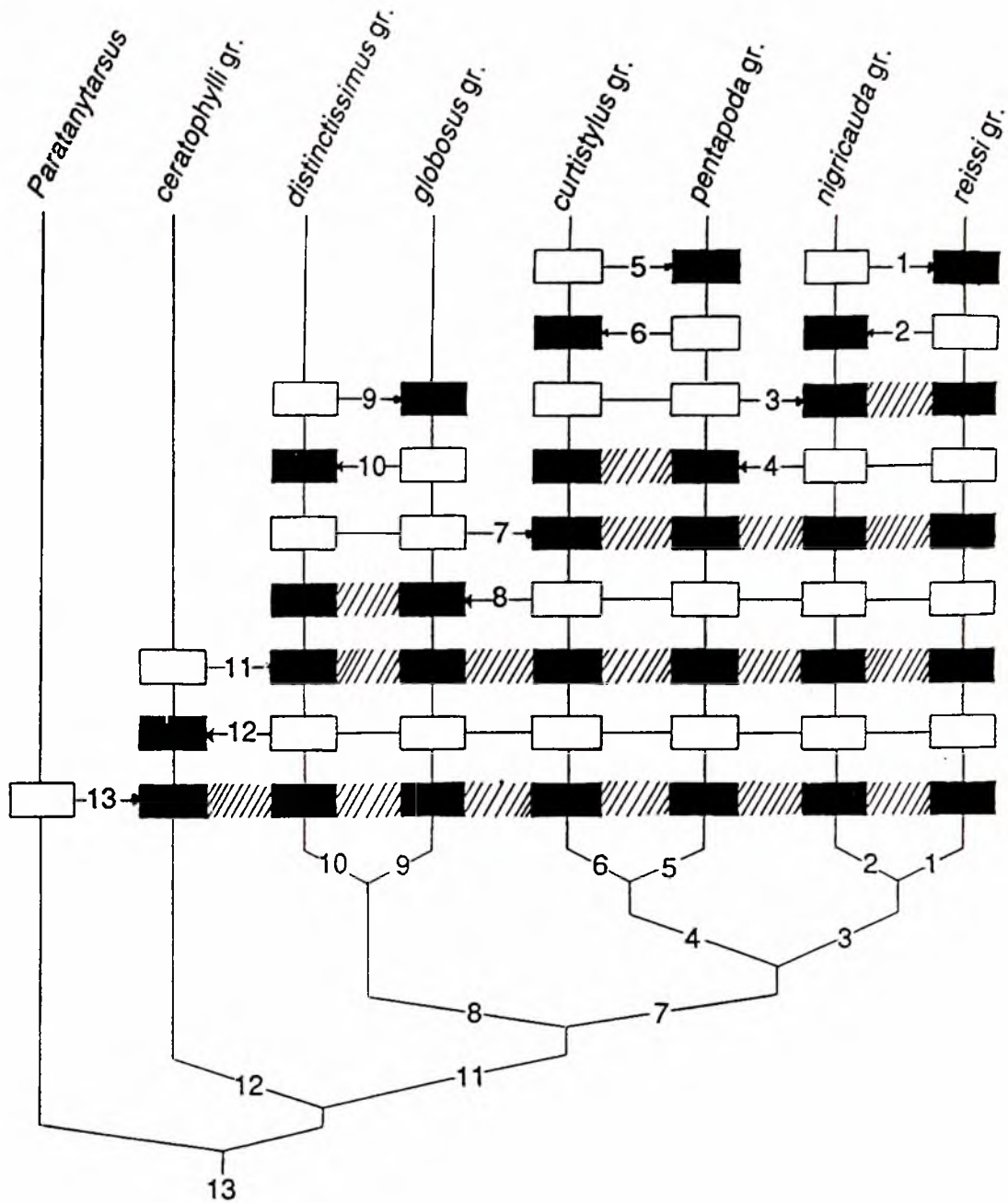


Fig. 8. Scheme of argumentation delineating the cladogenesis of the species groups of *Rheotanytarsus* by means of trends 1-13. □ Pleisiomorphic, ■ Apomorphic.

The above analysis is incomplete particularly because of the lack of knowledge about the immatures and females. The *reissi* group plus the *nigricauda* group combined is well delimited and undoubtedly monophyletic. Also the monophyly of the *curtistylus* group plus the *pentapoda* group is relatively clear as is the monophyly of the *distinctissimus* group plus the *globosus* group, but the mutual relationship between these groups may be different from that suggested here.

KEY TO THE MALE IMAGES OF AFROTROPICAL MEMBERS OF THE *RHEOTANYTARSUS CURTISTYLUS* GROUP

1. Antenna with 12 flagellomeres; sieve pore of tentorium jutting outwards
..... *R. aquilus* sp. n.
- Antenna with 13 flagellomeres, sieve pore normal 2
2. VR of wing > 1.70, anal point with long open V-shaped crest
..... *R. abonae* sp. n.
- VR of wing < 1.70, anal crest different 3
3. Superior volsella oblong in shape 4
- Superior volsella sickle, ovoid, sub-triangular or rectangular in shape 5
4. Abdomen of male strongly banded; anal tergite bands joined
..... *R. weijensis* sp. n.
- Abdomen of male not banded; anal tergite bands not joined
..... *R. plerunguisus* sp. n.
5. Superior volsella sickle-shaped; AR 0.36-0.52 *R. fuscus* (Freeman)
- Superior volsella ovoid, sub-triangular or somewhat rectangular in shape..... 5
6. Vestige of digitus conspicuous beyond margin of superior volsella.....
.....*R. saetheri* sp. n.
- Vestige of digitus not conspicuous beyond margin of superior volsella.....7
7. Median volsella with apical plate spoon-shaped without apical points.....
.....*R. atrius* sp. n.
- Median volsella shaped differently 8

-
8. Median volsella very long with apical pediform plate turned outwards
without apical points *R. kjaerandseni* sp. n.
- Median volsella not with apical pediform plate.....
.....*R. ororus* Lehman

DESCRIPTION OF SPECIES

The Afrotropical species of *Rheotanytarsus* belong to three species groups, the *distinctissimus* group, the *curtistylus* group, and the *reissi* group..

curtistylus group

The pupae of the *curtistylus* group are characterized by having paired circular patches on tergites II-V, and a posterior patch of spinules or shagreen on tergite II. The frontal apotome often is apically granular. The male imagines have a more or less S-shaped median volsella with distal lamellae fused into a single plate with or without terminal points, or possibly a very short median volsella with separate distal foliate setae if *R. hamatus* and similar species belong here. The gonostylus sometimes may be hooked at apex if *R. hamatus* and related species belong here.

Rheotanytarsus abonae sp. n.

(Figs 9-10)

Type locality. - Tanzania: Tanga Region, W. Usambara Mts., Mazumbai, Kaputu Stream.

Type material. - Holotype ♂, Tanzania: Tanga Region, W. Usambara Mts., Mazumbai, Kaputu Stream, loc. 10, 1420 m a.s.l., xi. 1990, Malaise trap, ZMBN's Tanzania expedition (ZMBN).

Diagnostic characters. - The wing has a VR > 1.70 which is quite distinct since all the other species have a VR which is much smaller.

Etymology. - Named after my mother Abon Brentuo - Lartey, who has made me into what I am now and to whom I owe everything and love dearly.

Description

Male imago (n = 1).

Total length 2.03 mm. Wing length 1.25 mm. Total length / wing length 1.63. Wing length / length of profemur 2.06. Colouration: thorax, abdomen and legs pale.

Head (Fig. 9 A). AR 0.23. Thirteenth flagellomere 118 μm long. Temporal setae 7; including 3 inner verticals, 2 outer verticals, and 2 postorbitals. Clypeus with 16 setae. Tentorium 49 μm long, 15 μm wide at sieve pore and 9 μm wide at posterior tentorial pit. Stipes 78 μm long, 7 μm wide. Lengths of palp segment 1 and 2 (in μm): 27, 33; segments 3 to 5 lacking.

Thorax (Fig. 9 B). Dorsocentrals 10, acrostichals 18. Scutellum with 4 setae.

Wing (Fig. 9 C). VR 1.72. Membrane with about 1400 setae in all. Brachiolum with 1 seta, R with 15 setae, R_1 with 28, R_{4+5} with 63, Sc and M bare; RM with 1, M_{1+2} with 53, M_{3+4} with 30, Cu with 18, Cu_1 with 16, PCu with 47, and An with 25 setae. Cells m with 17 setae, r_{4+5} with about 350, m_{1+2} with about 300, m_{3+4} with about 150, cu with 98, and an with 52 setae.

Legs (Fig. 9 D-F). Spur of front tibia 22 μm long, spurs of middle tibia 7 and 13 μm long, of hind tibia 13 and 15 μm long, all excluding comb. Comb of middle tibia 11 μm long, of hind tibia 13 μm long. Width at apex of front tibia 38 μm , of middle tibia 31 μm , of hind tibia 35 μm . Length of front femur 607 μm , of middle femur 589 μm , of hind femur 643 μm ; length of front tibia 325 μm , of middle tibia 428 μm , of hind tibia 528 μm ; all tarsi lacking.

Hypopygium (Fig. 10 A-D). Tergite IX with 14 setae. Anal point 55 μm long, 18 μm wide at base with a long, open V-shaped crest. Width at apex of anal point 7 μm . Laterosternite IX with 1 setae. Phallapodeme 67 μm long, transverse sternapodeme 40 μm long. Gonocoxite 78 μm long, gonostylus 73 μm long. Superior volsella 27 μm long, inferior volsella 58 μm long, median volsella 51 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella ovoid in shape. Median volsella not markedly recurved, with several short ovoid distal plates without apical points. HR 1.07; HV 2.79

Remarks. - *R. abonae* sp. n. is close to *R. saetheri* sp. n., but can be easily separated on the crest of the anal point which is longer, open and V-shaped at the base. Also the vestige of the digitus does not extend conspicuously beyond the

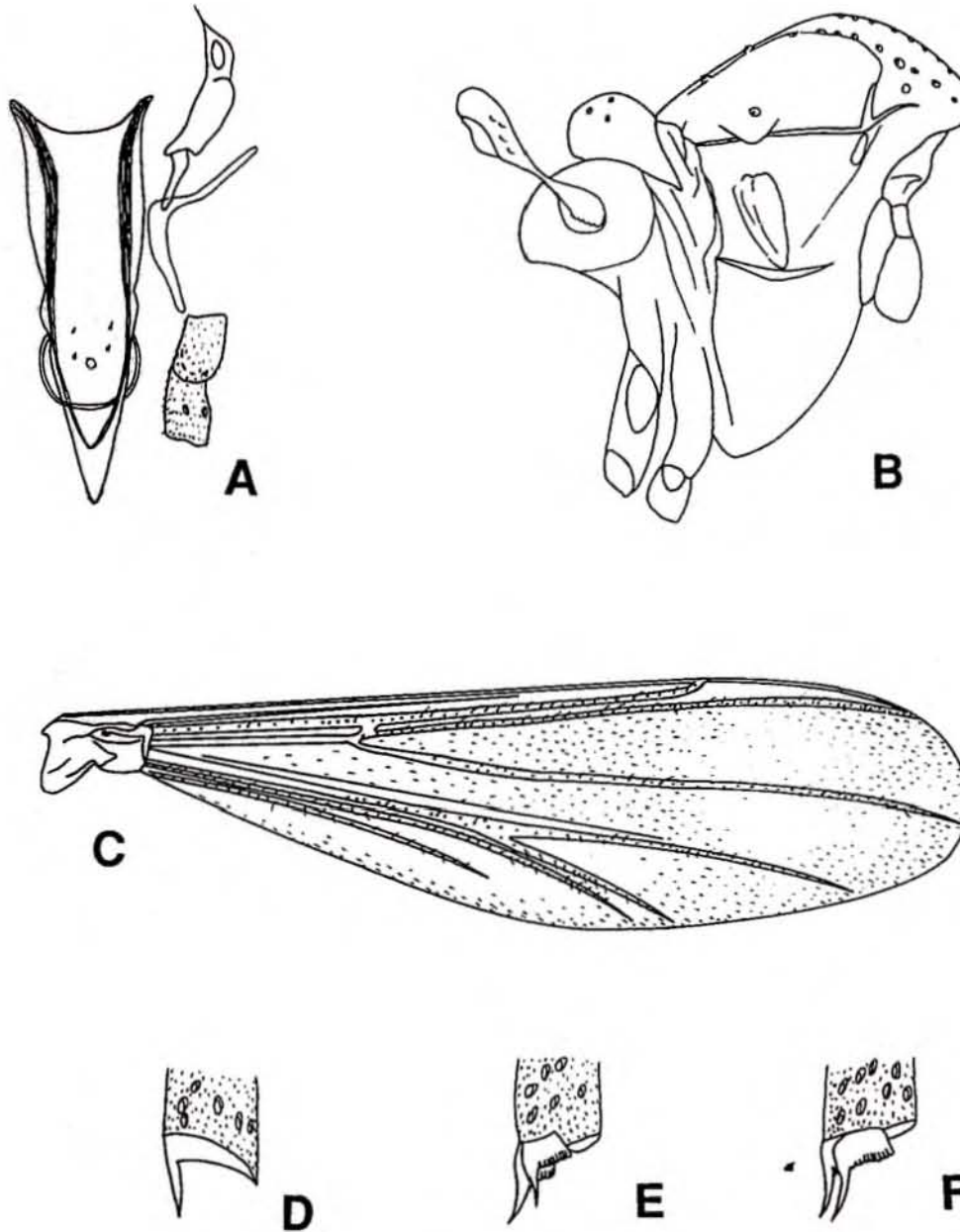


Fig. 9. *Rheetanytarsus abonae* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Thorax. - C. Wing. - D-F. Apex of fore, mid and hind tibia.

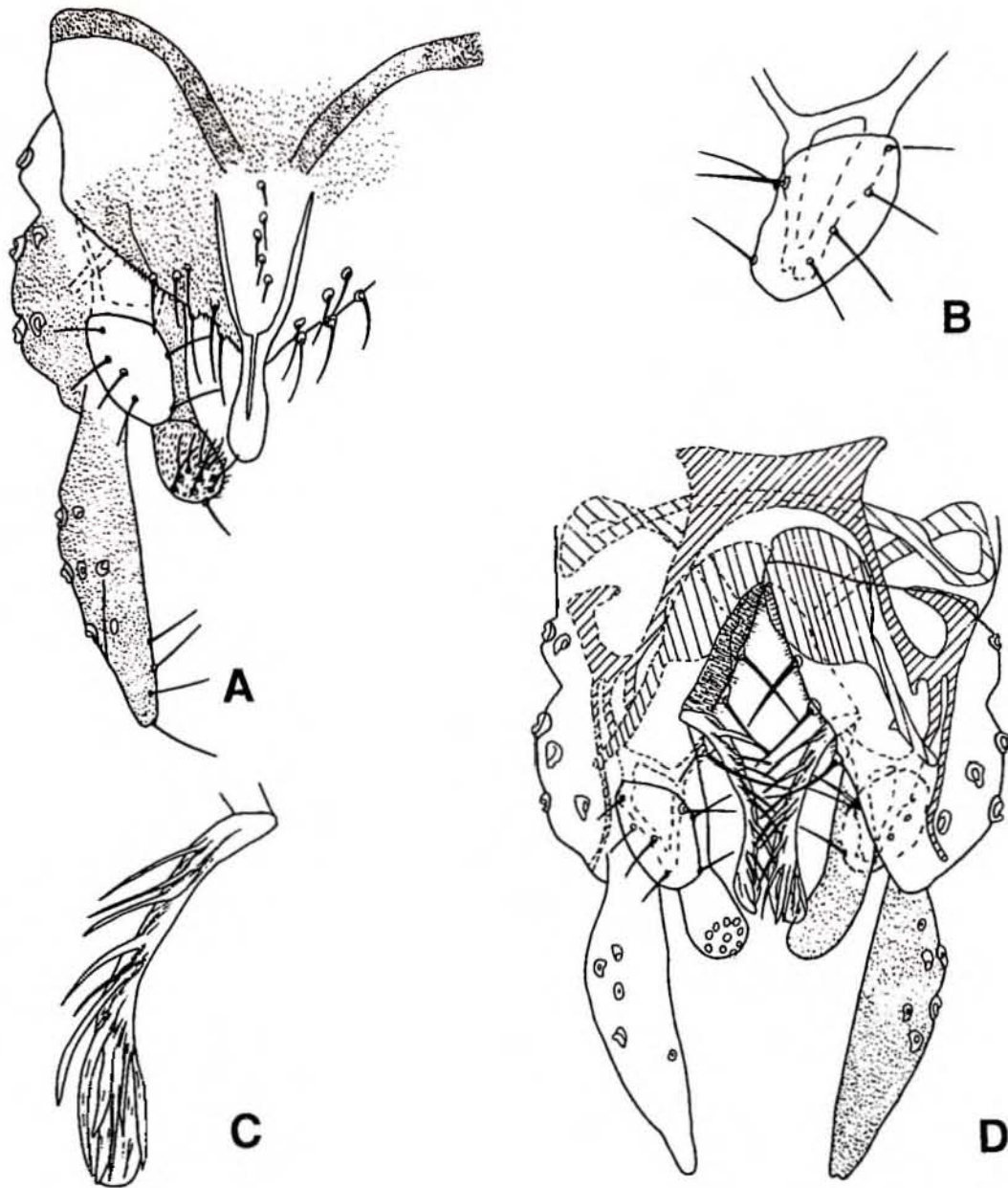


Fig. 10. *Rheotanytarsus abonae* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

margin of the superior volsella in *R. abonae* sp. n. as it does in *R. saetheri* sp. n

Distribution. - The species is known only from a small river in the West Usambara Mts. in North-East Tanzania. At the trapping site the river had moderate flow over mud, fine sand and larger stones.

***Rheotanytarsus aquilus* sp. n.**

(Figs. 11-12)

Type locality. - Ghana: Brong - Ahafo Region, Kintampo falls.

Type material. - Holotype ♂, Ghana: Brong - Ahafo Region, Kintampo Falls, 13. ii. 1993, sweep net, NUFU project (ZMBN). Paratype: ♂, Ghana: Eastern Region, Kibi, Subri Stream, 4. ii. 1993, light trap, NUFU project.

Diagnostic characters. - Antennae with 12 flagellomeres. Sieve pore of tentorium juts outwards.

Etymology. - From Latin *aquilus*, dark - coloured, referring to the very dark colour of the thorax of the species.

Description

Male imago (n = 2, except when otherwise stated).

Total length 1.14-1.32 mm. Wing length 0.70-0.74 mm. Total length / wing length 1.62-1.79. Wing length / length of profemur 2.40-2.43. Colouration: thorax dark brown vittae and postnotum; abdomen pale; legs pale brown with apical 1 / 3 of femur darker.

Head (Fig. 11 A-B). Antenna with 12 flagellomeres. AR 0.14 (1). Twelfth flagellomere 64 µm long. Temporal setae 8-10; including 4 inner verticals, 2-3 outer verticals, and 2-3 postorbitals. Clypeus with 11-17 setae. Tentorium 44-62 µm long, protruding laterally at sieve pore which is 11-22 µm wide and 7-9 µm wide at posterior tentorial pit. Stipes 55-67 µm long, 4-7 µm wide. Palp segment lengths (in µm): 15-18, 18, 42, 60, 107-111. Fifth palpal segment / third palpal segment 2.50-2.53.

Thorax (Fig. 11 C). Dorsocentrals 12-13 in single row, acrostichals 14.

Scutellum with 4 setae

Wing (Fig. 11 D). VR 1.54-1.56. Membrane with 487-490 setae in all

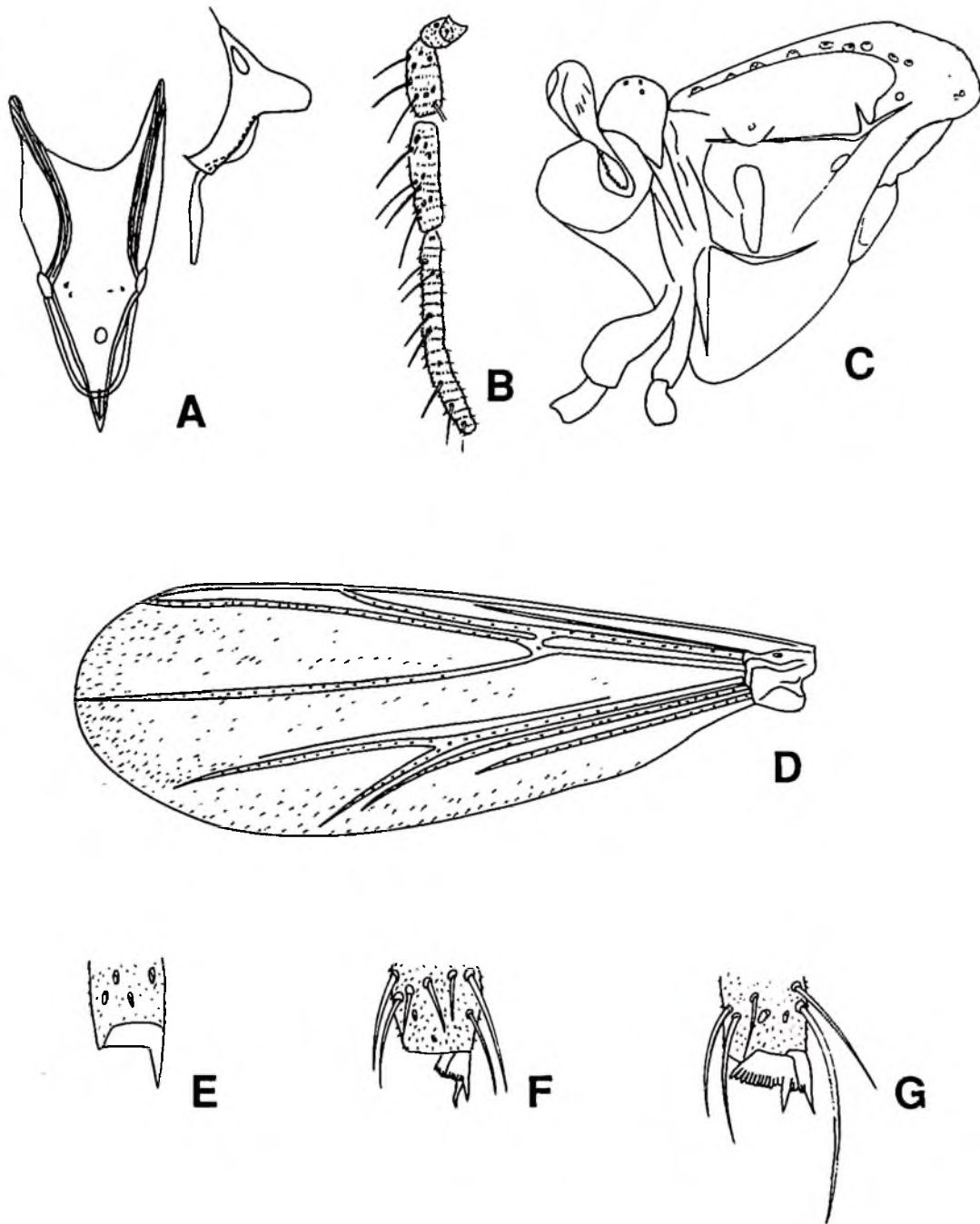


Fig. 11. *Rheotanytarsus aquilus* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

Brachiolum with 1 seta, R with 11-13 setae, R₁ with 9-11, R₄₊₅ with 29-30 setae, Sc and M bare, RM with 1, M₁₊₂ with 27-29, M₃₊₄ with 16, Cu with 9-12, Cu₁ with 9-10, PCu with 27-28, and An with 17-20 setae. Cells m with 21-22 setae, r₄₊₅ 107-127, m₁₊₂ with 130-150, m₃₊₄ with 21-22, cu with 37-38 and an with 6-15 setae.

Legs (Fig. 11 E-G). Spur of front tibia 13 (1) μm long, spurs of middle tibia 7-9 and 11 (1) μm long, of hind tibia 7-9 and 7-13 μm long, all excluding comb. Comb of middle tibia 9-11 μm long, of hind tibia 9-15 μm long. Width at apex of front tibia 24-33 μm , of middle tibia 22-31 μm , of hind tibia 27-31 μm . Lengths and proportions of legs as in Table 3.

Hypopygium (Fig. 12 A-D). Tergite IX with 15-22 setae. Anal point 40-44 μm long, 18 μm wide at base. Width at apex of anal point 7 μm . Laterosternite IX with 5-6 setae. Phallapodeme 42-47 μm long, transverse sternapodeme 29-33 μm long. Gonocoxite 67-71 μm long, gonostylus 53-60 μm long. Superior volsella 24 μm long, inferior volsella 44-47 μm long, median volsella 33-38 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella oval in shape. Median volsellae slightly S-shaped with distal lamellae fused into single plate with terminal points. HR 1.18-1.25; HV 2.21-2.23.

Remarks.- *R. aquilus* sp. n. can easily be separated from other Afrotropical species of the genus on the number of antennal flagellomeres (12) and the distinct shape of the tentorium at the sieve pore.

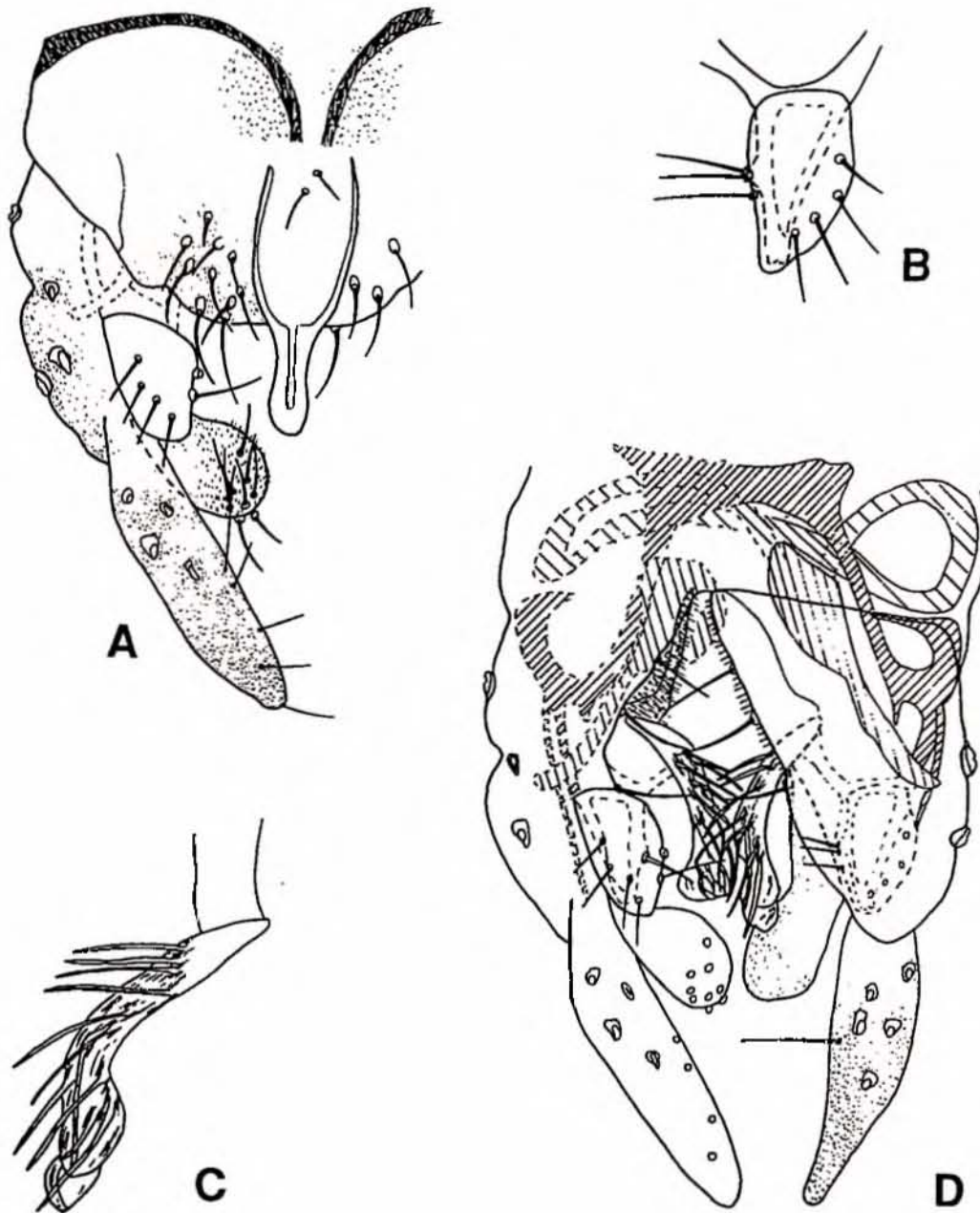


Fig. 12. *Rheotanytarsus aquilus* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

Table 3. Lengths (in μm) and proportions of legs of *Rheotanytarsus aquilus* sp. n. (n = 1-2).

	fe	ti	ta1	ta2	ta3	ta4
p1	293-303	164-168	382	178	136	100
p2	357	239-250	129-139	54	43-46	32
p3	368-378	278-303	164-178	104-107	100-111	57-64
	ta5	LR	BV	SV	BR	
p1	57	2.28	1.81	1.23	3.2	
p2	29	0.54-0.56	4.61-4.64	4.36-4.64	2.9-3.8	
p3	36-43	0.59	2.65-2.73	3.82-4.04	3.7-4.4	

Distribution. - The species is known only from two small rivers in southern Ghana.

Rheotanytarsus atrius sp. n.

(Figs 13-14)

Type locality. - Ghana: Western Region, Ankasa Resource Reserve.

Type material. - Holotype j , Ghana: Western Region, Ankasa Resource Reserve, 10 - 12. xii. 1993, light trap, NUFU project (ZMBN). Paratypes: 15 j , as holotype; Ghana: Eastern Region, Boti Falls, j , 28. x. - 4. xi. 1994, Malaise trap, NUFU project.

Diagnostic characters. - Median volsella with distal setae fused into plate in the distinct shape of a spoon.

Etymology. - From the Twi *atre* meaning spoon, referring to the teaspoon - like shape of the median volsella and the suffix - *us* denoting the gender of the genus.

Description

Male imago (n = 10, except when otherwise stated).

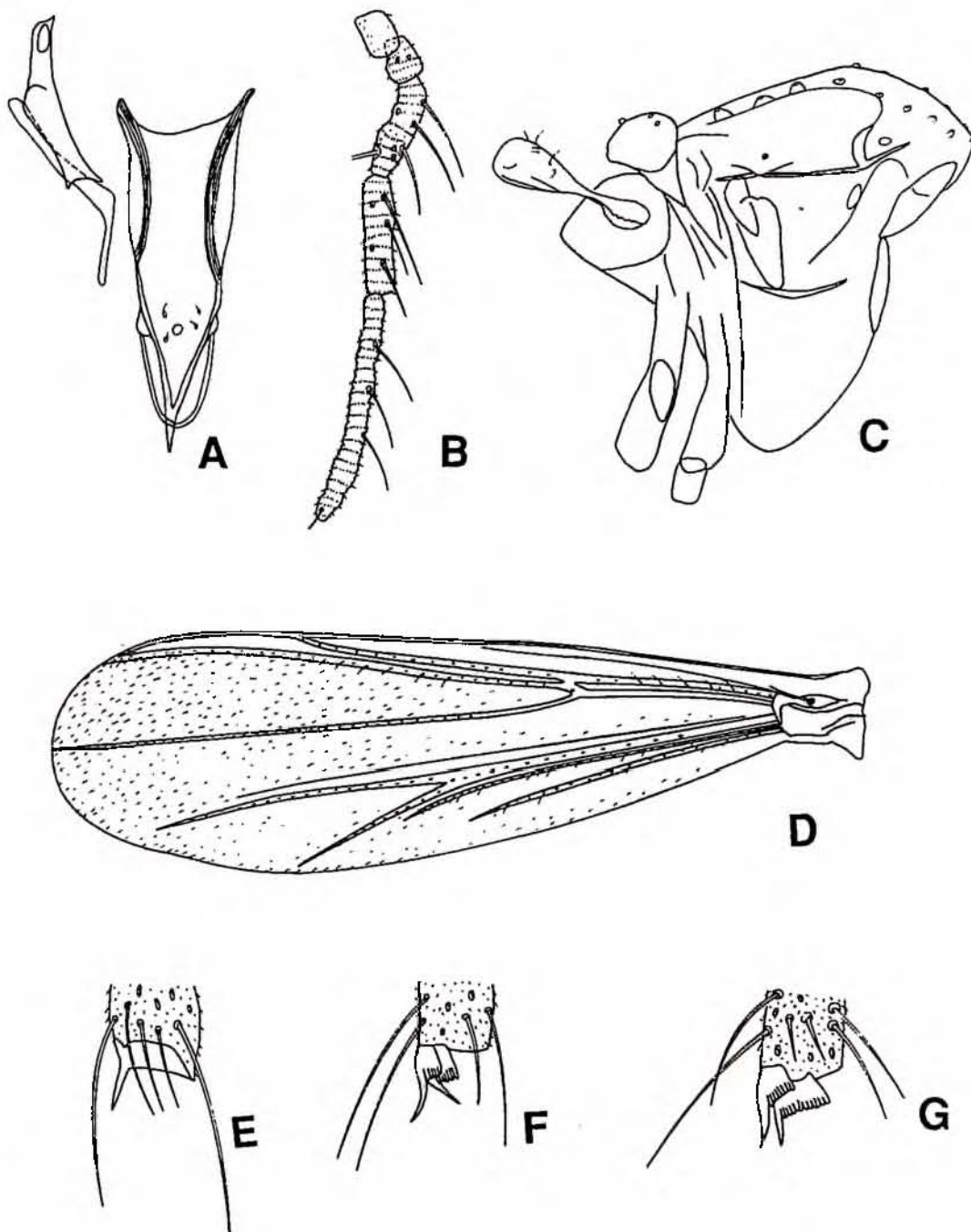


Fig. 13. *Rheotanytarsus atrius* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

Total length 1.43-1.63, 1.53 mm. Wing length 0.85-0.97, 0.93 mm. Total length / wing length 1.56-1.76, 1.65. Wing length / length of profemur 1.92-2.09, 2.01 (9). Colouration: Thorax pale around vittae and postnotum, abdomen pale, legs pale.

Head (Fig. 13 A-B). AR 0.20-0.25, 0.22. Thirteenth flagellomere 86-111, 97 μm long. Temporal setae 5-7, 6; including 2-3, 3 inner verticals; 2 outer verticals; and 1-2, 2 postorbitals. Clypeus with 14-17, 15 setae. Tentorium 33-58, 51 μm long; 11-20, 13 μm wide at sieve pore and 7-9, 9 μm wide at posterior tentorial pit. Stipes 64-78, 71 μm long; 4-11, 7 μm wide. Palp segment lengths (in μm): 22-27, 24; 18-24, 21; 44-55, 53; 53-87, 62; 100-120, 111. Fifth palpal segment / third palpal segment 1.88-2.41, 2.14.

Thorax (Fig. 13 C). Dorsocentrals 8-10, 9; acrostichals 12-16, 14. Scutellum with 3-5, 4 setae.

Wing (Fig. 13 D). VR 1.60-1.69, 1.65. Membrane with about 817-893, 851 setae in all. Brachiolum with 1 seta; R with 9-13, 11 setae; R_1 with 11-17, 14; R_{4+5} with 34-43, 40; Sc and M bare; RM with 0-2, 1; M_{1+2} with 33-45, 38; M_{3+4} with 16-22, 19; Cu with 10-15, 12; Cu_1 with 10-14, 12; PCu with 26-38, 32; and An with 17-21, 19 setae. Cells m with 11-19, 15 setae, r_{4+5} with about 300, m_{1+2} with about 250, m_{3+4} with 36-66, 49; cu with 43-69, 54; and an with 9-18, 13 setae.

Legs (Fig. 13 E-G). Spur of front tibia 18-24, 20 μm long; spurs of middle tibia 4-11, 8 and 11-13, 12 μm long; of hind tibia 9-15, 13 and 11-18, 15 μm long, all excluding comb. Comb of middle tibia 9-13, 11 μm long; of hind tibia 11-15, 13 μm long. Width at apex of front tibia 29-33, 31 μm ; of middle tibia 24-31, 27 μm ; of hind tibia 29-40, 31 μm . Lengths and proportions of legs as in Table 4.

Hypopygium (Fig. 14 A-D). Tergite IX with 9-14, 11 setae. Anal point 42-62, 53 μm long, 15-22, 18 μm wide at base. Width at apex of anal point 4-9, 7 μm . Laterosternite IX with 1-2, 1 setae. Phallapodeme 44-58, 50 μm long; transverse sternapodeme 29-38, 34 μm long. Gonocoxite 64-71, 68 μm long; gonostylus 58-67, 63 μm long. Superior volsella 22-31, 27 μm long; inferior volsella 42-51, 48 μm long; median volsella 38-44, 42 μm long. Inferior volsella with microtrichia,

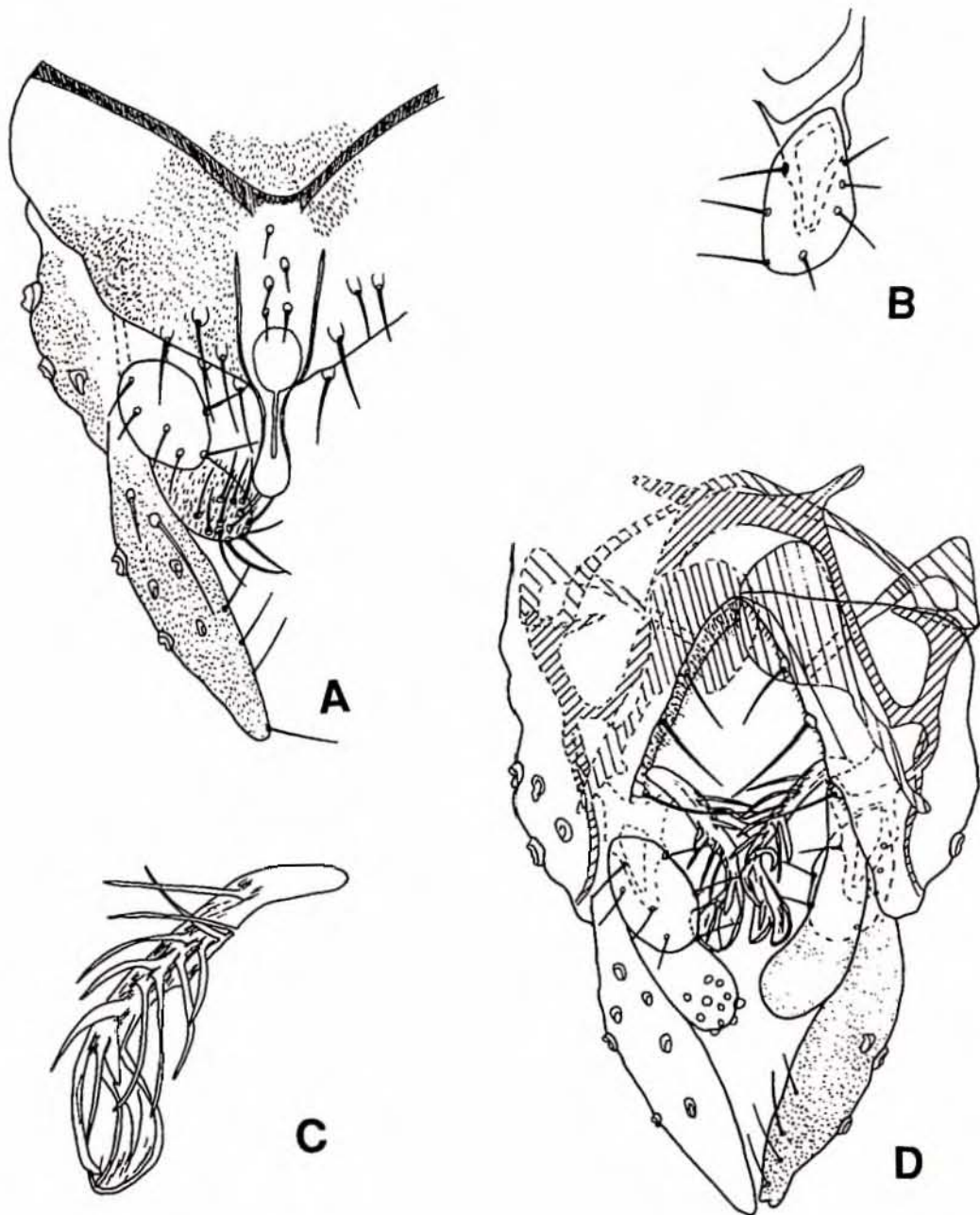


Fig. 114 *Rheotanytarsus catinus* sp. n., male maggo.--A. Hypopygium, dorsal view.--
 B. Superior volsella.--C. Median volsella.--D. Hypopygium, ventral view.

Table 4. Lengths (in μm) and proportions of legs of *Rheotanytarsus atrius* sp. n.

	fe	ti	ta1	
p1	443-496, 468	200-221, 211	575-643, 614	
p2	343-503, 453	250-350, 324	146-182, 169	
p3	464-525, 491	364-400, 381	218-250, 235	
	ta2	ta3	ta4	ta5
p1	271-314, 294	200-225, 214	157-182, 172	71-89, 81
p2	57-86, 79	46-68, 61	32-43, 40	25-36, 31
p3	129-153, 143	118-132, 125	82-96, 90	43-57, 49
	LR	BV	SV	BR
p1	2.75-3.05, 2.89	1.65-1.74, 1.70	1.07-1.18, 1.11	2.6-3.6, 3.1
p2	0.50-0.58, 0.52	4.32-4.69, 4.51	4.05-4.79, 4.59	4.6-7.1, 5.6 (9)
p3	0.57-0.66, 0.61	2.64-2.84, 2.72	3.49-3.98, 3.74	5.7-7.6, 6.4 (9)

superior and median volsellae without microtrichia. Superior volsella ovoid in shape. Median volsella strongly S-shaped with distal lamelliform setae fused into single plate without apical points. HR 1.07-1.15, 1.10; HV 2.31-2.72, 2.32.

Remarks.- *R. atrius* sp. n. is close to *R. kjaerandseni* sp. n., but can be easily separated on the length and shape of the median volsella which is shorter and S-shaped.

Distribution.- The species is known only from two rivers in southern Ghana.

Rheotanytarsus fuscus (Freeman)

(Figs 15-16)

Tanytarsus (*Rheotanytarsus*) *fuscus* Freeman, 1954: 25; 1955: 281; Scott 1967: 174.
Tanytarsus (*Rheotanytarsus*) *fuscus* Freeman, 1958: 347, pro parte.
Rheotanytarsus fuscus (Freeman), Freeman & Cranston, 1980: 200, pro parte.

Rheotanytarsus fuscus (Freeman), Freeman & Cranston, 1980: 200, pro parte.

Material examined. - ♂, South Africa: Cape province, Tulbagh Barrage, 23. x. 1953, K. M. F. Scott, (B. M. 1954 - 180) (BMNH); 2 ♂, South Africa: Natal province, Shooters Hill, 22. vii. 1956, B. Stuckenberg (BMNH).

Diagnostic characters. - Median volsella sickle - shaped, AR 0.36 - 0.52.

Description

Male imago (n = 2-3).

Total length 2.32-2.92 mm. Wing length 1.35-1.87 mm. Total length / wing length 1.56-1.72. Wing length / length of profemur 2.28-2.75. Colouration: thorax dark brown around vittae and postnotum, abdomen pale, legs pale with apical 1 / 4 of femur darker.

Head (Fig. 15 A-B). AR 0.36-0.52. Thirteenth flagellomere 196-225 μm long. Temporal setae 9; including 3-4 inner verticals, 3 outer verticals and 2-3 postorbitals. Clypeus with 18-21 setae. Tentorium 89-111 μm long, 22-32 μm wide at sieve pore and 11-13 μm wide at posterior tentorial pit. Stipes 96-107 μm long, 15-24 μm wide. Palp segment lengths (in μm): 29-32, 32-33, 91-104, 82-111, 171-173. Fifth palpal segment / third palpal segment 1.62-1.88.

Thorax (Fig. 15 C). Dorsocentrals 12-13, acrostichals 20. Scutellum with 8-10 setae.

Wing (Fig. 15 D). VR 1.56-1.57. Membrane with about 1500 setae in all. Brachiolum with 1 seta, R with 19-28 setae; R_1 with 41-46; R_{4+5} with 64-70 setae; Sc bare; RM with 0-2; M with 0-1; M_{1+2} with 57-64; M_{3+4} with 37-39; Cu with 17-23; Cu_1 with 19-21; PCu with 70-81, and An with 40-41 setae. Cells m with 26-31 setae, r_{4+5} with about 400, m_{1+2} with about 350, m_{3+4} with about 200, cu with 144-175, and an with 96-120 setae.

Legs (Fig. 15 E-G). Spur of front tibia 20-24 μm long, spurs of middle tibia 9-11 and 11 μm long; of hind tibia 11-13 and 13-15 μm long, all excluding comb. Comb of middle tibia 13-15 μm long, of hind tibia 15-20 μm long. Width at apex of front tibia 40-42 μm , of middle tibia 33-42 μm , of hind tibia 42-51 μm . Lengths and proportions of legs as shown in Table 5.

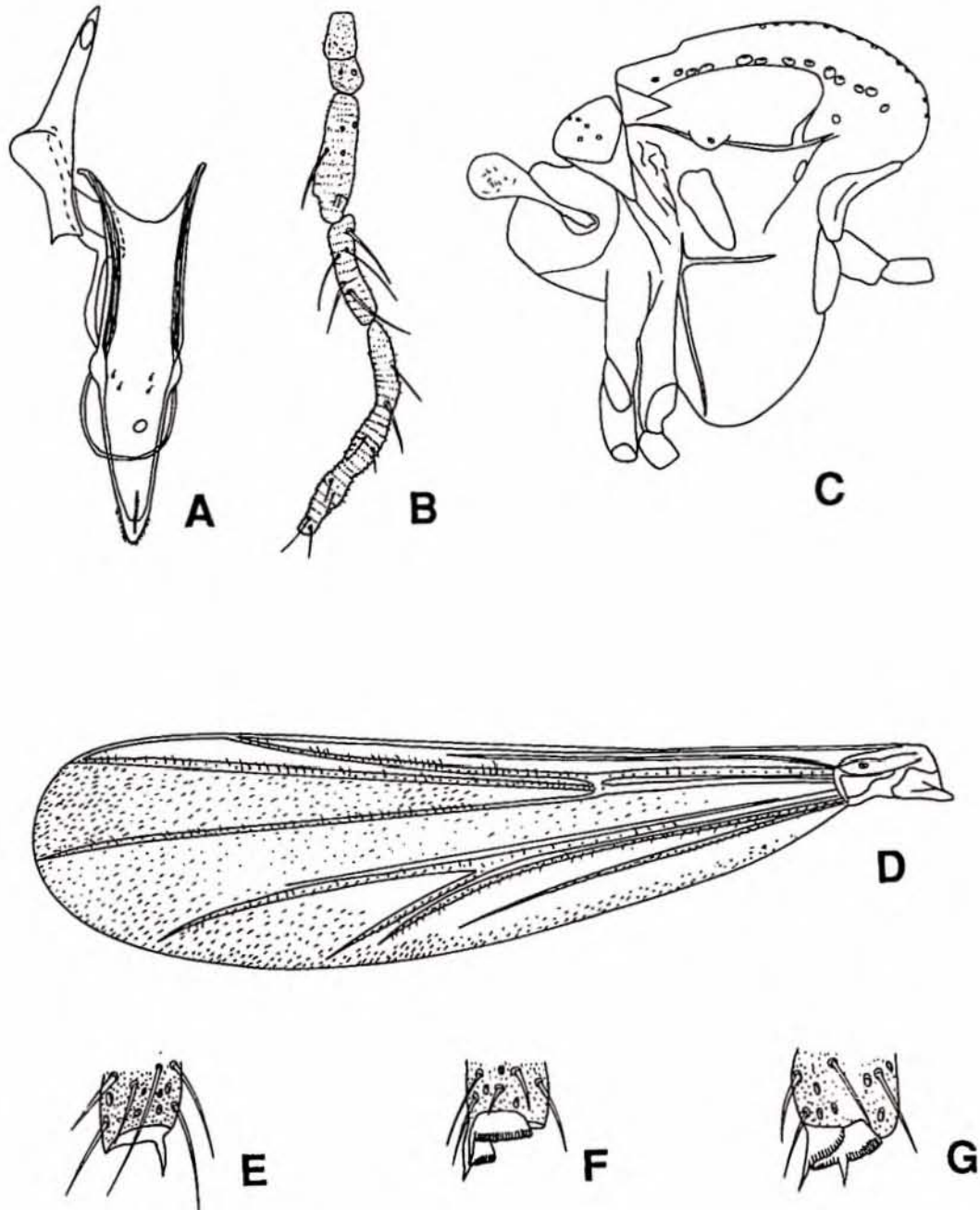


Fig. 15. *Rhectomyia tarsus fuscus* (Freeman), male imago. - A. Clitellar pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

Table 5. Lengths (in μm) and proportions of legs of *Rheotanytarsus fuscus* (Freeman).

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄
p1	589-678	336-375	664-821	393-439	268-303	211-243
p2	578-721	464-578	271-328	136-161	96-114	71-75
p3	643-786	571-714	357-446	253-286	200-232	139-168
	ta ₅	LR	BV	SV	BR	
p1	86-104	1.99-2.20	1.65-1.74	1.28-1.39	3.0-3.3	
p2	54-57	0.57-0.59	3.77	3.79-3.96	4.6-5.0	
p3	68-86	0.62-0.65	2.39-2.57	3.30-3.40	5.5-6.3	

Hypopygium (Fig. 16 A-D). Tergite IX with 11-14 setae. Anal point 60-69 μm long, 22-27 μm wide at base. Width at apex of anal point 7-13 μm . Latero-sternite IX with 2 setae. Phallapodeme 73-80 μm long, transverse sternapodeme 53-71 μm long. Gonocoxite 107-122 μm long, gonostylus 100-111 μm long. Superior volsella 40-48 μm long, inferior volsella 62-71 μm long, median volsella 60-69 μm long. Inferior volsella with microtrichia, superior and median volsella without microtrichia. Superior volsella sickle-shaped. Median volsellae slightly S-shaped with distal lamellae fused into single plate without terminal points. HR 1.06-1.12; HV 2.32-2.68.

Remarks. - *R. fuscus* is close to *R. ororus*, but can easily be separated on the shape of the superior volsella which is very much sickle-shaped and the median volsella which has no apical points on the distal plate.

Distribution. The species is known only from streams in Cape and Natal provinces in South Africa.

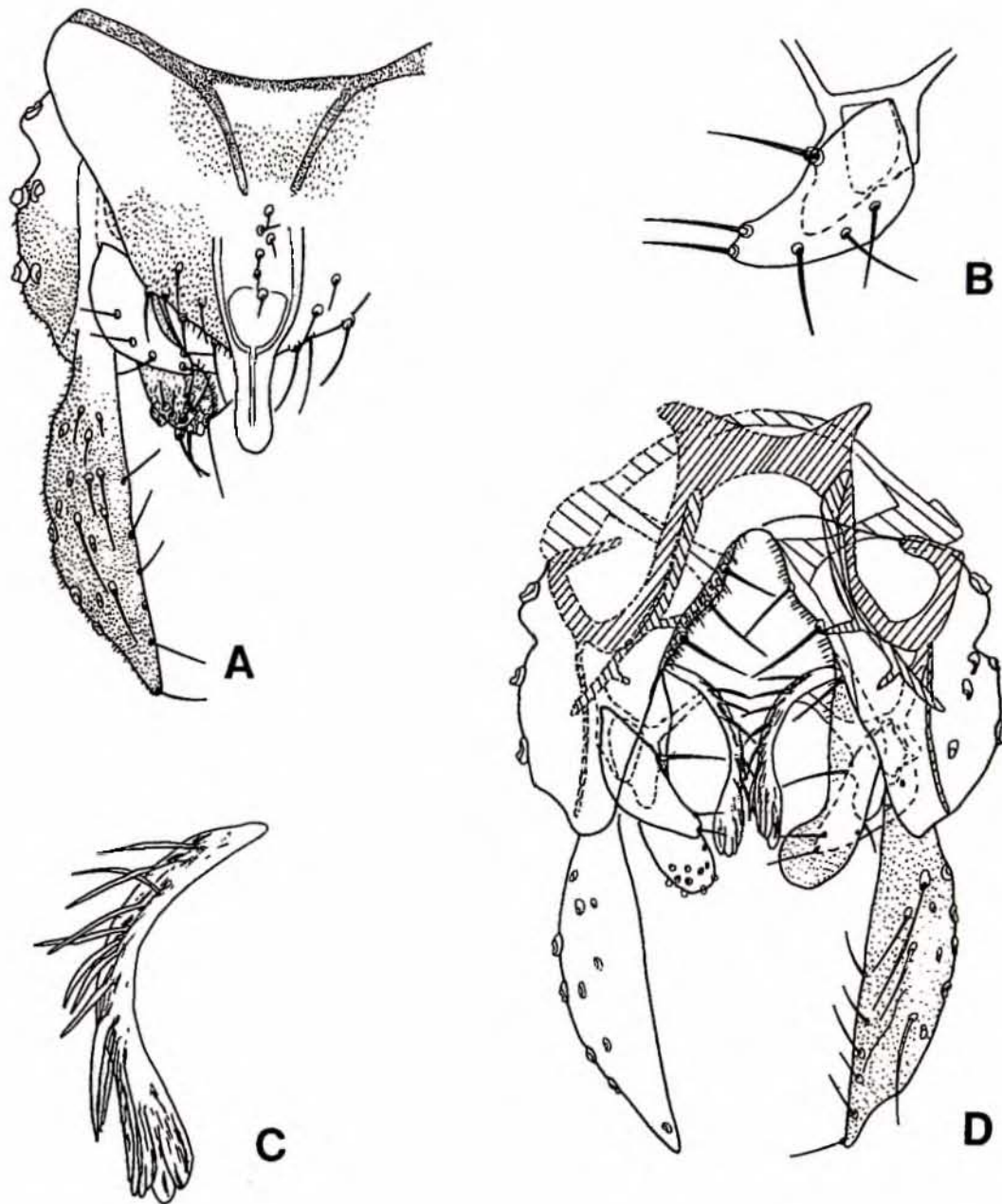


Fig. 116. *Rheotanytarsus fuscus* (Freeman), male imago.--A. Hypopygium, dorsal view.--B. Superior volsella.--C. Median volsella.--D. Hypopygium, ventral view.

***Rheotanytarsus kjaerandseni* sp. n.**

(Figs 17-21)

Type locality. - Ghana: Volta Region, Wli, Wli Waterfalls.

Type material. - Holotype σ , Ghana: Volta Region, Wli, Wli Waterfalls, 17-20. xi. 1993 Malaise trap loc. 5, NUFU project (ZMBN). Paratypes: σ , as holotype; σ , except 4-13. iii. 1993, 3 σ reared from pupa, TM reared from pupa, 10 pupal exuviae, 13 larvae, as holotype except 12. xii. 1993, drift sample station 1, NUFU project; Western Region, Ankasa Resource Reserve, 3 σ , 6-12. xii. 1993, Malaise trap loc. 1, NUFU project; Western Region, Ankasa Resource Reserve, 3 σ , 10-12. xii. 1993, light trap, NUFU project; Eastern Region, Kibi, Subri Stream, σ , 4. ii. 1993, light trap, NUFU project.

Diagnostic characters. - Pecten epipharyngis of larva a simple undivided comb. Posterior chaetulae laterales with conspicuously long branches. Median mental tooth with 1-2 lateral notches. Median volsella very long with lamelliform setae fused into single pediform plate.

Etymology. - Named after Jostein Kjærandsen who did a lot of the collecting in the Agumatsa and Ankasa areas.

Description

Male imago ($n = 10$, except when otherwise stated).

Total length 1.56-2.34, 1.82 mm. Wing length 0.90-1.11, 0.95 (9) mm.

Total length / wing length 1.69-1.84, 1.77 (9). Wing length / length of profemur 1.67-1.98, 1.84 (9). Colouration: thorax dark brown vittae and postnotum, abdomen pale, legs pale brown.

Head (Fig. 17 A-B). AR 0.16-0.36, 0.25. Thirteenth flagellomere 71-178, 112 μm long. Temporal setae 6-7, 7; including 2-3, 3 inner verticals; 2-3, 2 outer verticals and 1-2, 2 postorbitals. Clypeus with 14-19, 17 setae. Tentorium 49-73, 61 μm long; 11-20, 15 μm wide at sieve pore; and 9-11, 9 μm wide at posterior tentorial pit. Stipes 66-89, 78 μm long; 4-11, 7 μm wide. Palp segment lengths (in μm): 20-27, 24; 20-29, 24; 53-71, 62; 53-71, 64; 118-144, 129 (8). Fifth palpal segment / third palpal segment 1.90-2.38, 2.11 (8).

Thorax (Fig. 17 C). Dorsocentrals 9-12, 11; acrostichals 14-24, 18.

Scutellum with 3-6, 5 setae.

Wing (Fig. 17 D). VR 1.60-1.67, 1.63 (9). Membrane with 757-1137, 1022 (9) setae in all. Brachiolum with 1 seta; R with 12-17, 14 (9) setae; R_1 with 17-25,

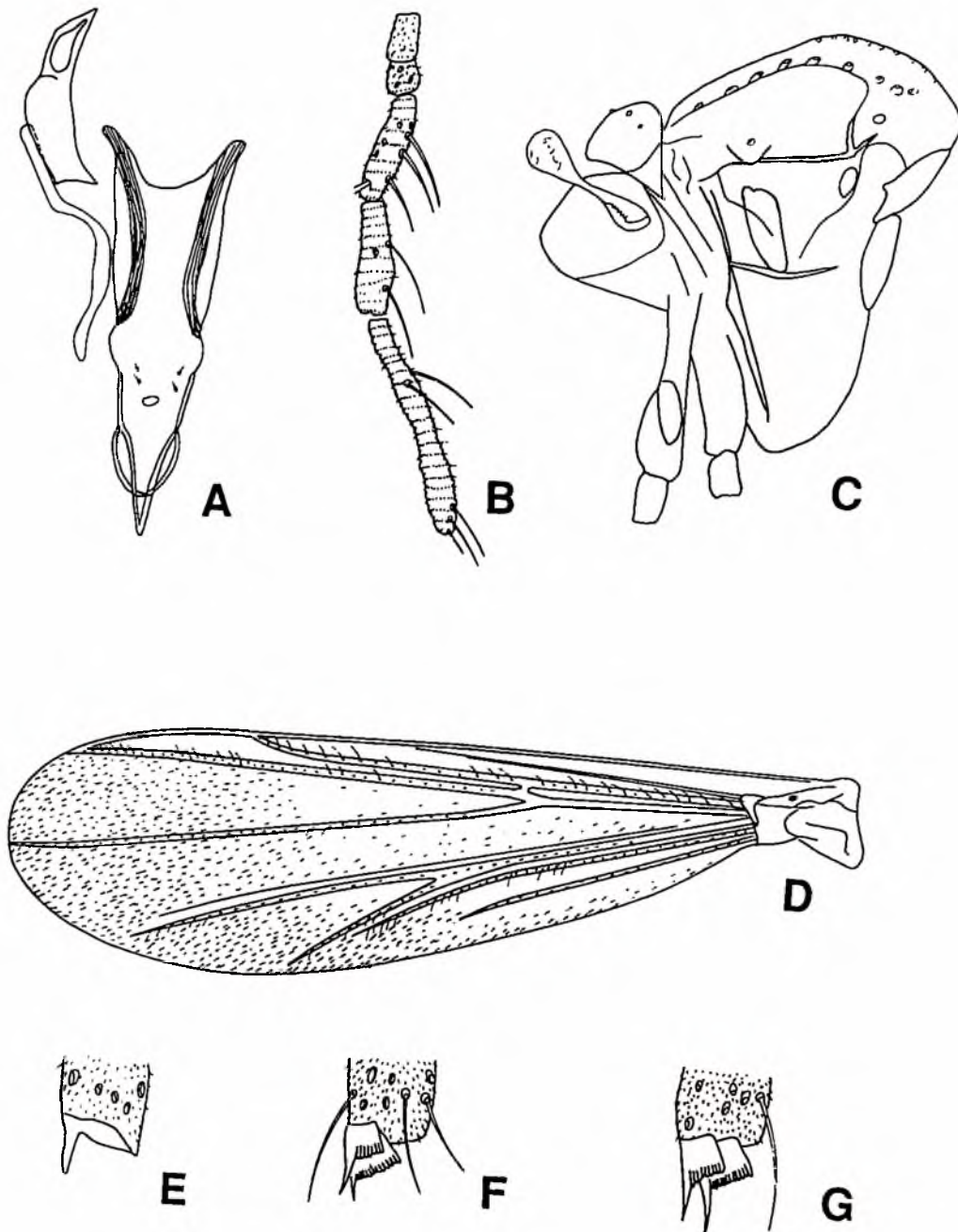


Fig. 17. *Rheotanytarsus kjaerandseni* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

20 (9); R₄₊₅ 40-52, 46 (9); Sc bare; RM with 1-2, 2 (9); M with 0-1, 0 (9); M₁₊₂ with 36-47, 41 (9); M₃₊₄ with 17-23, 21 (9); Cu with 13-17, 14 (9); Cu₁ with 12-16, 14 (9); PCu with 40-56, 44 (9); and An with 19-24, 21 (9) setae. Cells m with 13-25, 18 (9); r₄₊₅ with 130-365, 290 (9); m₁₊₂ with 250-345, 304 (9); m₃₊₄ with 93-116, 103 (9); and an with 21-58, 39 (9).

Legs (Fig. 17 E-G). Spurs of front tibia 15-22, 20 µm long; spurs of middle tibia 7-11, 9 and 11-15, 13 µm long; of hind tibia 13-18, 14 and 15-20, 16 µm long; all excluding comb. Comb of middle tibia 9- 13, 12 µm long; of hind tibia 11-13, 12 µm long. Width at apex of front tibia 31-38, 34 µm; of middle tibia 29-35, 31 µm; of hind tibia 31-44, 35 µm. Lengths and proportions of legs as in Table 6.

Table 6. Lengths (in µm) and proportions of legs of *Rheotanytarsus kjaerandseni* sp. n.

	fe	ti	ta ₁	
p1	464-653, 527	221-261, 242	578-693, 621 (4)	
p2	446-578, 496	336-418, 369	175-232, 198 (9)	
p3	482-586, 530	386-482, 422	236-314, 272 (8)	
	ta ₂	ta ₃	ta ₄	ta ₅
p1	286-357, 319 (4)	207-260, 228 (4)	171-207, 184 (4)	86-93 (3)
p2	75-107, 89 (9)	38-75, 62 (9)	36-46, 41 (9)	32-39, 35 (9)
p3	132-186, 158 (8)	125-157, 141 (8)	75-111, 90 (8)	46-57, 50 (8)
	LR	BV	SV	BR
p1	2.61-2.66, 2.63 (4)	1.66-1.69 (3)	1.18-1.32, 1.23 (4)	2.4-3.6 (3)
p2	0.50-0.57, 0.54 (9)	4.38-5.05, 4.60 (9)	4.17-4.72, 4.37 (9)	4.2-5.7, 5.0 (7)
p3	0.61-0.66, 0.64 (8)	2.63-2.86, 2.80 (8)	3.40-3.68, 3.52 (8)	5.6-6.5, 6.1 (5)

Hypopygium (Fig. 18 A-D). Tergite IX with 8-14, 10 setae. Anal point 35-69, 55 µm long; 18-24, 21 µm wide at base. Width at apex of anal point 4-11, 9 µm. Laterosternite IX with 1-2, 2 setae. Phallapodeme 35-62, 54 µm long;

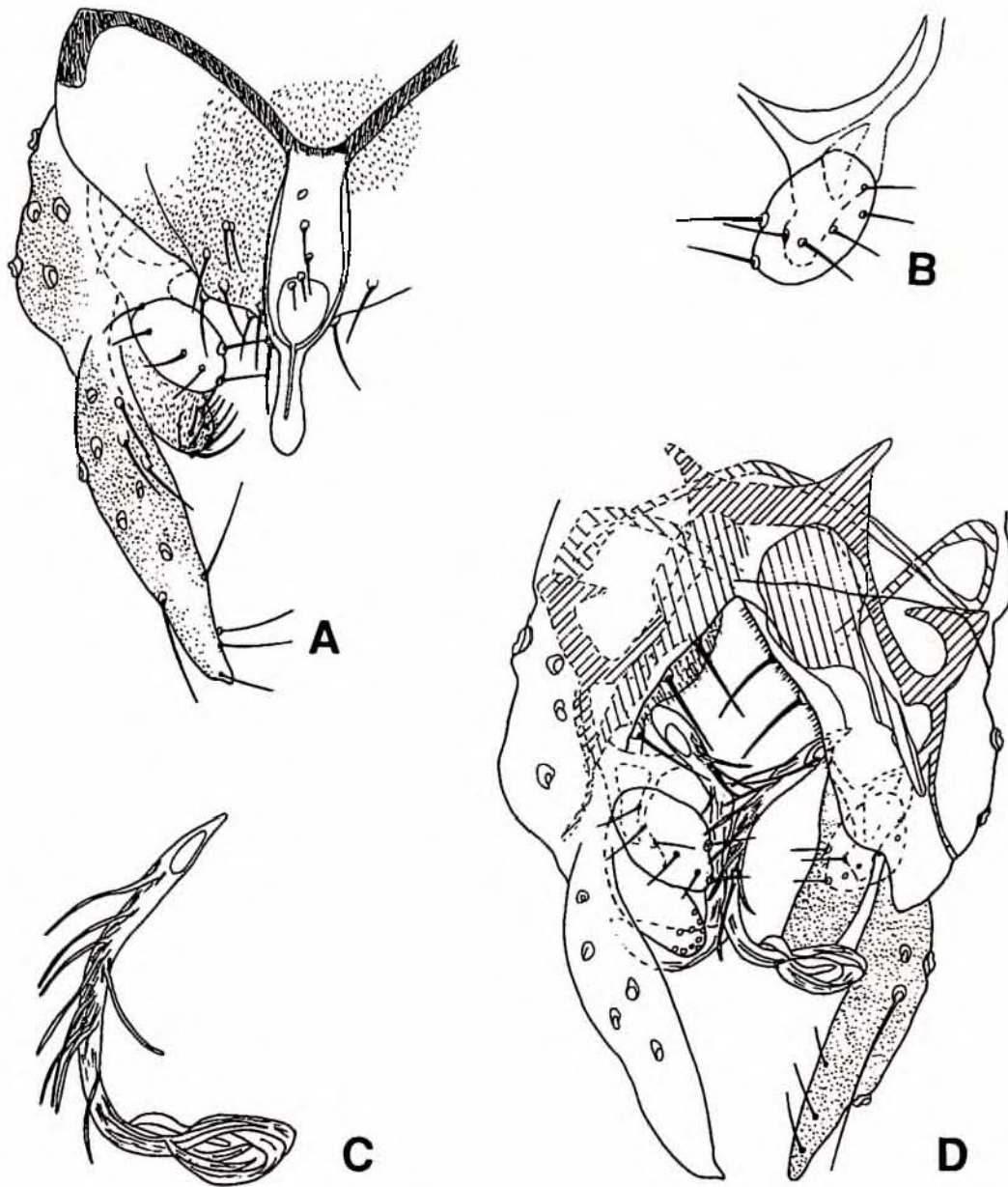


Fig. 18. *Rheotanytarsus kjaerandseni* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

transverse sternapodeme 31-49, 39 μm long. Gonocoxite 67-89, 80 μm long; gonostylus 64-87, 77 μm long. Superior volsella 24-35, 29 μm long; inferior volsella 44-62, 54 μm long; median volsella 55-69, 60 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella with narrow base, vestige of digitus conspicuous. Median volsellae very long, strongly curved and reaching apex of inferior volsella; apical plate pointed, turned outwards, without terminal points. HR 1.00-1.15, 1.04; HV 2.08-2.69, 2.38.

Female imago (n = 1).

Total length 1.84 mm. Wing not measurable (broken). Colouration: thorax dark around, postnotum and preepisternum; vittae dark. Legs and abdomen pale.

Head (Fig. 19 A-B). AR 0.29 Lengths of flagellomeres (in μm): 61, 37, 37, 41, 51. Temporal setae 7; including 3 inner verticals, 2 outer verticals, and 2 postorbitals. Clypeus with 24 setae. Tentorium 57 μm long, 14 μm wide at sieve pore and 10 μm wide at posterior tentorial pit. Stipes 88 μm long, 8 μm wide. Palp segment lengths (in μm): 27, 27, 66, 70, 119. Fifth palpal segment / third palpal segment 1.81.

Thorax (Fig. 19 C). Dorsocentrals 16, acrostichals 24. Scutellum with 8 setae. Wings not measurable (broken).

Legs. Spur of front tibia 20 μm long, spurs of middle tibia 10 and 14 μm long, of hind tibia 14 and 16 μm long, all excluding comb. Comb of middle tibia 8 μm long, of hind tibia 16 μm long. Width at apex of front tibia 37 μm , of middle tibia 35 μm , of hind tibia 41 μm . Lengths and proportions of legs as in Table 7.

Table 7. Lengths (in μm) and proportions of legs of female of *Rheotanytarsus kjaerandseni* sp. n.

	fe	ti	ta1	ta2	ta3	ta4	ta5	LR	BV	SV	BR
p1	480	208	500	28	200	180	96	2.40	1.57	1.38	-
p2	472	280	200	100	68	48	40	0.71	3.72	3.76	
p3	500	440	240	160	144	96	68	0.54	2.52	3.92	

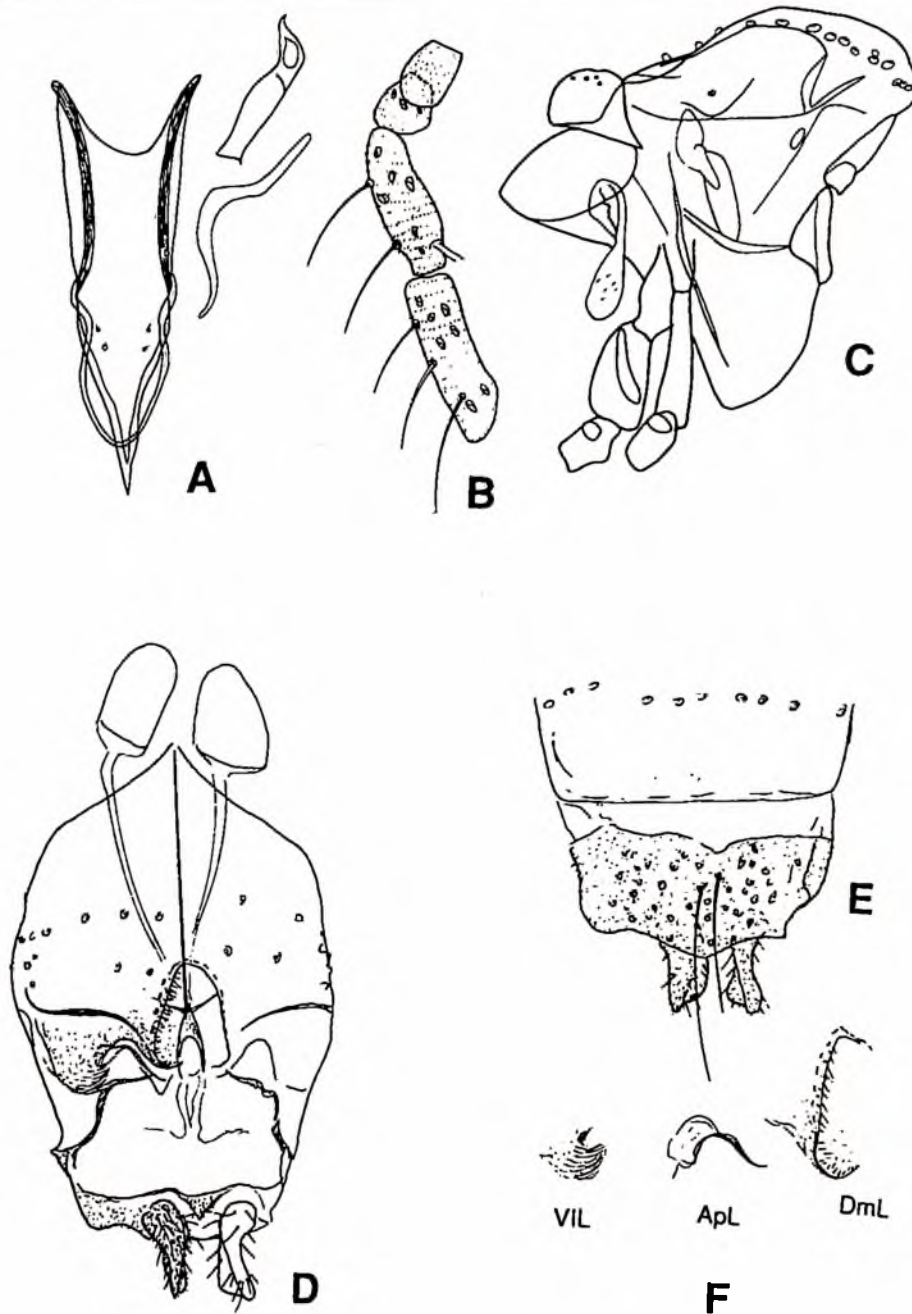


Fig. 19. *Rheotanytarsus kjaerandseni* sp. n., female imago. - A. Cibarial pump, tentorium and stipes. - B. Palps. - C. Thorax. - D. Genitalia, ventral view. - E. Genitalia, dorsal view. - F. Gonapophysis VIII (VIL, ventrolateral lobe; DmL, dorsomesal lobe) and apodeme lobe (ApL).

Abdomen. Number of setae on tergites I-VIII as (both sides counted): 6-9, 6-8, 7-9, 6-10, 6-10, 6-9, 6-9, 5-10. Number of setae on sternites I-VII as (both sides counted): 0, 2-3, 2-4, 2-6, 2-4, 3-4, 3-4. On sternite VIII 10-15 setae; 3-6 on each side of the genital fissure and 1-3 along lateral margin.

Genitalia (Fig. 19 D-F). Gonocoxite without setae. Tergite IX not divided, with 41 setae. Cercus 55 μm long, 6 μm wide at apex. Seminal capsule 55 μm long including a 14 μm long neck; seminal capsule not sclerotized. Notum 76 μm long.

Pupa (n = 10 except when otherwise stated).

Total length 1.88-2.42, 2.26 mm. Exuviae pale with outer edges of cephalothorax dark.

Cephalothorax. Frontal apotome (Fig. 20 B) slightly granulose anteriorly. Frontal setae 18-43, 27 μm long. Frontal apotome rugulose anteriorly. Median anteprenotals 82-143, 110 μm long; lateral anteprenotals 31-61, 45 μm long; both median and lateral anteprenotals taeniate. Precorneals close together; anterior precorneals 16-49, 34 μm long and taeniate; median precorneals 25-72, 38, μm long; posterior precorneals 113- 184, 149 μm long, both taeniate. Anterior dorsocentrals Dc_1 . 10-25, 15 μm long; Dc_2 10-29, 15 μm long; Dc_3 10-20, 14 μm long; Dc_4 10-16, 13 mm long. Dc_1 1-2, 2 μm in front of Dc_2 ; Dc_2 78-96, 84 μm in front of Dc_3 ; and Dc_3 1-3, 2 μm in front of Dc_4 . Thoracic horn (Fig. 20 D) 340-444, 392 μm long; 28-44, 37 μm wide; with fine spinules for most of its length. Nose of wing sheath (Fig. 20 E) 22-39, 27 μm long.

Abdomen (Fig. 20 A). Tergite I bare; spines on tergites II-V arranged in circular patches. Tergite II (Fig. 20 C) with additional pair of posterior patches of very fine spinules. Median shagreen essentially absent, weak and sparse shagreen present caudolaterally on tergites IV and V. Number of spines on T II-V: 50-70, 60; 50-70, 57; 40-60, 50; 27-50, 39. Caudal hooklets occupying approximately median 1 / 7 of tergite II, about 30 hooklets. Caudal spur (Fig. 20 F) 18-31, 23 μm long. L-setae on segments II-VIII as 3, 3, 3, 4, 4, 4, 4; all taeniate. Lengths (in μm) of L_3 and L_4 on segment VIII 72-240, 107; 82-225, 106.

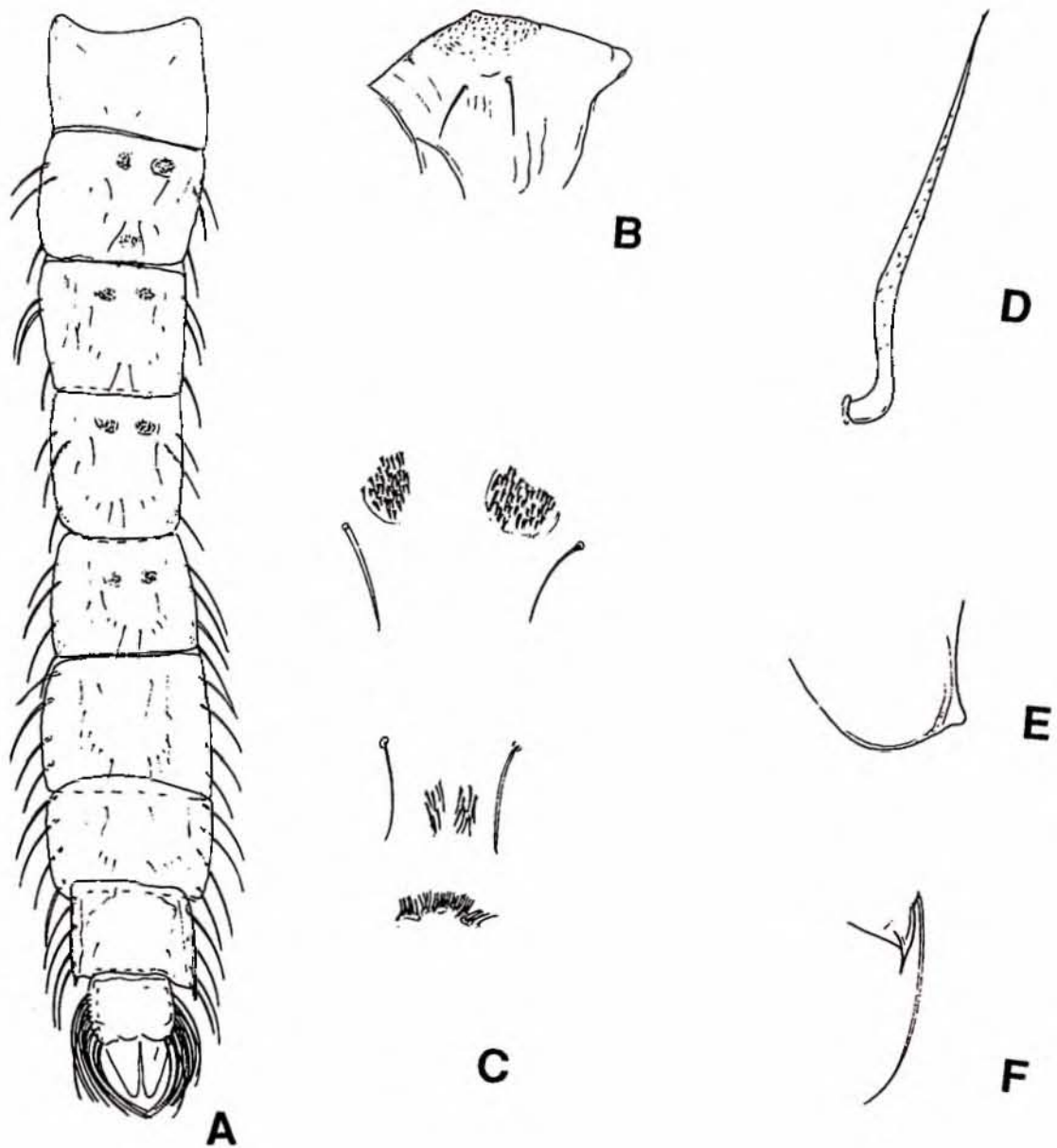


Fig. 20. *Rheantomyia kjuenankuani* sp. n., pupa. - A. Tergites. - B. Frontal apertome. - C. Tergite II, showing patch of spinules and caudal hooklets. - D. Thoracic horn. - E. Nose of wing sheath. - F. Caudal spur.

Anal lobe with 1 weak dorsolateral seta not always apparent; 15-17, 16 taeniae in fringe; longest taeniae 340-520, 442 μm long. Male genital sac overreaches anal lobe by 82-127, 94 μm .

Fourth instar larva (n = 10 except where otherwise stated).

Total length 2.20-3.14, 2.72 mm. Head capsule length 0.22-0.26, 0.24 mm.

Head. Antenna as in Fig. 21 A. Length of antennal segments (in μm): 72-84, 78; 16-22, 18; 6-10, 7; 4; 2-4, 3. AR 1.85-2.73, 2.36. Basal antennal segment 12-14, 13 μm wide, distance from base to ring organ 3-7, 5 μm ; to basal mark of seta 35-47, 42 μm . Blade 14-20, 18 μm long; accessory blade 6-10, 8 μm long. Apical style of second segment 4-5, 4 μm long; Lauterborn organ 3-7, 5 μm long, pedicel 5-11, 8 μm long. Pecten epipharyngis (Fig. 21 D) a simple broad comb without indication of division into parts. Posterior chaetulae laterales with conspicuously long branches. Premandible 39-45, 42 μm long. Mandible (Fig. 21 B) 72-88, 78 μm long. Mentum (Fig. 21 C) 51-61, 57 μm wide; with median tooth 8-14, 10 μm wide, with lateral notches which may be more or less worn down; ventromental plate width / length 3.11-4.50, 3.56; number of ventromental plate striations 21-24, 22. Postmentum 90-96, 93 μm long.

Abdomen. Procercus 16-25, 20 μm long; 12-18, 15 μm wide; anal setae 260-340, 299 μm long. Supraanal seta 60-100, 75 μm long; length of supraanal setae / length of anal setae 0.21-0.29, 0.25. Posterior parapods (Fig. 21 G) 102-164, 131 μm long. Anal tubuli 66-154, 97 μm long; 16-41, 29 μm wide at base; 20-55, 37 μm wide at middle; 14-31, 20 μm wide at apex.

Third instar larvae (n = 3, except where otherwise stated).

Total length 1.81-2.00 mm. Head capsule length 0.16-0.20 mm.

Head. Antenna as in Fig. 31 A. Length of antennal segments (in μm): 45-47, 12-16, 4-6, 4, 2. AR 1.57-1.92. Basal antennal segment 8-10 μm wide, distance from base to ring organ 3-4 μm ; to base mark of seta 16-20 μm . Blade 14-17 μm long; accessory blade 5-8 μm long. Apical style of second segment 3-4 μm long;

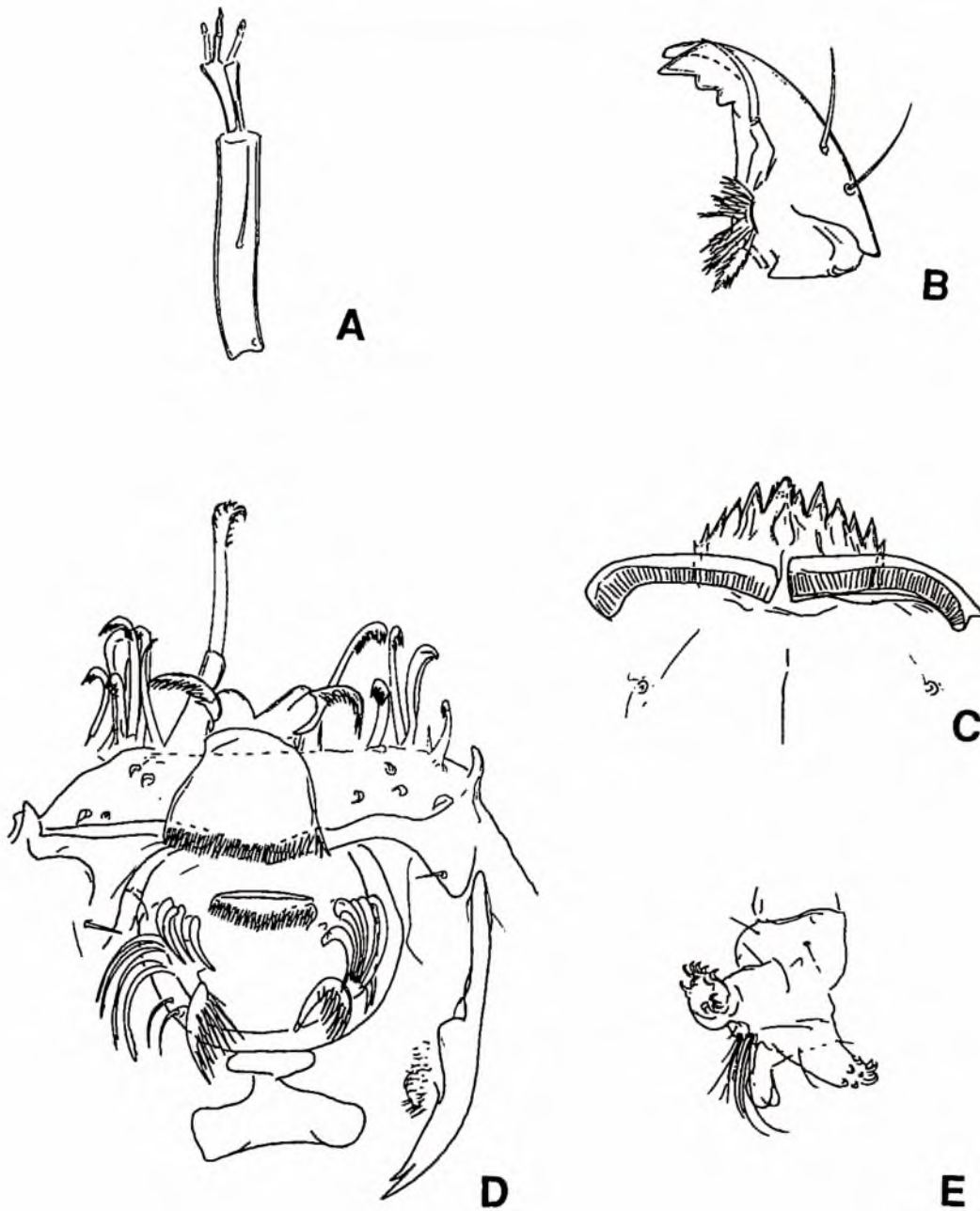


Fig. 21. *Rheotanytarsus kjaerandseni* sp. n., larva. - A. Antenna. - B. Mandible. - C. Mentum. - D. Labrum and epipharyngeal area. - E. Posterior area.

Lauterborn organ 4-5 μm long, pedicel 4-7 μm long. Premandible 29-33 μm long. Mandible (Fig. 21 B) 53-61 μm long. Mentum (Fig. 21 C) 35-43 μm wide, with median teeth 6-8 μm wide; ventromental plate width / length 3.50-3.80; number of ventromental plate striations 17-18 (2) postmentum 67-76 μm long.

Abdomen. Anterior parapods as in Fig. 21 E. Procercus 14-18 μm long, 8-10 μm wide; anal setae 140-240 μm long. Supraanal seta 44-72 μm long; length of supraanal setae / length of anal setae 0.27-0.31. Posterior parapods (Fig. 21 E) 76-82 μm long. Anal tubuli 49-72 μm long; 16-20 μm wide at base, 25-31 μm wide at middle, 12-20 μm wide at apex.

Remarks. - *R. kjaerandseni* sp. n. is very close to *R. ororus*, but can be easily separated by the long median volsella with the outwardly directed apical plate and the slightly lower antennal ratio. The pupae of the two species are essentially inseparable except that all L setae on segments II-VIII are taeniate in *R. kjaerandseni*.

Distribution. - The species is known from smaller rivers in southern Ghana.

***Rheotanytarsus plerunguisus* sp. n.**

(Figs 22-24)

Tanytarsus (Rheotanytarsus) fuscus Freeman, 1958: 348, pro parte; nec Freeman 1954.

Type locality. - Tanzania: Tanga Region, West Usambara Mts., Mazumbai.

Type material. - Holotype j , Tanzania: Tanga Region, West Usambara Mts., Mazumbai, 28. x. 1990, light trap, ZMBN's Tanzania expedition (ZMBN). Paratype: j , as holotype. 2 m , Zimbabwe (S. Rhodesia): Salisbury, E. T. M. Reid (B. M. 1956-317) (BMNH).

Diagnostic characters. - Large oblong superior volsella; median volsella strongly S-shaped with many curved claw-like apical points on apical plate.

Etymology. - From the Latin *plerus*, very many and *unguis*, claws; referring to the many curved claw-like setae on the median volsella.

Description

Male imago (n = 1-2).

Total length 3.00 mm. Wing length 1.91-1.95 mm. Total length / wing length 1.53. Wing length / length of profemur 2.23-2.27. Colouration: thorax pale, abdomen pale, legs pale with forelegs darker.

Head (Fig. 22 A-B). AR 0.85-0.87. Thirteenth flagellomere 443-468 μm long. Temporal setae 9; including 4 inner verticals, 2 outer verticals, and 3 postorbitals. Clypeus with 13-14 setae. Tentorium 84-121 μm long, 32 μm wide at sieve pore and 18 μm wide at posterior tentorial pit. Stipes 132-150 μm long, 7-14 μm wide. Lengths of palp segment 1 to 4 (in μm): 32-36, 39, 139-143, 132; segment 5 lacking.

Thorax (Fig. 22 C). Dorsocentrals 8-9, acrostichals 22-24. Scutellum with 5 setae.

Wing (Fig. 22 D). VR 1.31-1.33. Membrane with about 1500 setae in all. Brachiolum with 1 seta, R with 26 setae, R_1 with 39-42, R_{4+5} with 77-78 setae, Sc, RM and M bare; M_{1+2} with 87-80, M_{3+4} with 43-52, Cu with 21-29, Cu_1 with 26-27, PCu with 61, and An with 41-46 setae. Cells m with 29-34 setae, r_{4+5} with about 350, m_{1+2} with about 300, m_{3+4} with about 200, cu with about 200, and an with 77-85 setae.

Legs (Fig. 22 E-G). Spur of front tibia 27-35 μm long, spurs of middle tibia 13 and 15-18 μm long, of hind tibia 13-20 and 20 μm long, all excluding comb. Comb of middle tibia 13-15 μm long, of hind tibia 15-18 μm long. Width at apex of front tibia 49-51 μm , of middle tibia 42-44 μm , of hind tibia 49 μm . Lengths and proportions of legs as in Table 8.

Hypopygium (Fig. 23 A-D). Tergite IX with 10-12 setae. Anal point 60-67 μm long, 24-31 μm wide at base. Width at apex of anal point 9-11 μm . Laterosternite IX with 1 setae. Phallapodeme 67-69 μm long, transverse sternapodeme 40-44 μm long. Gonocoxite 104-118 μm long, gonostylus 95-113 μm long. Superior volsella 33-38 μm long, inferior volsella 67-75 μm long, median volsella 60-67 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella oblong in shape. Median volsellae strongly S-shaped with distal lamellae fused into a single plate with claw-like terminal points. HR 1.04-1.09, HV 2.65 (1).

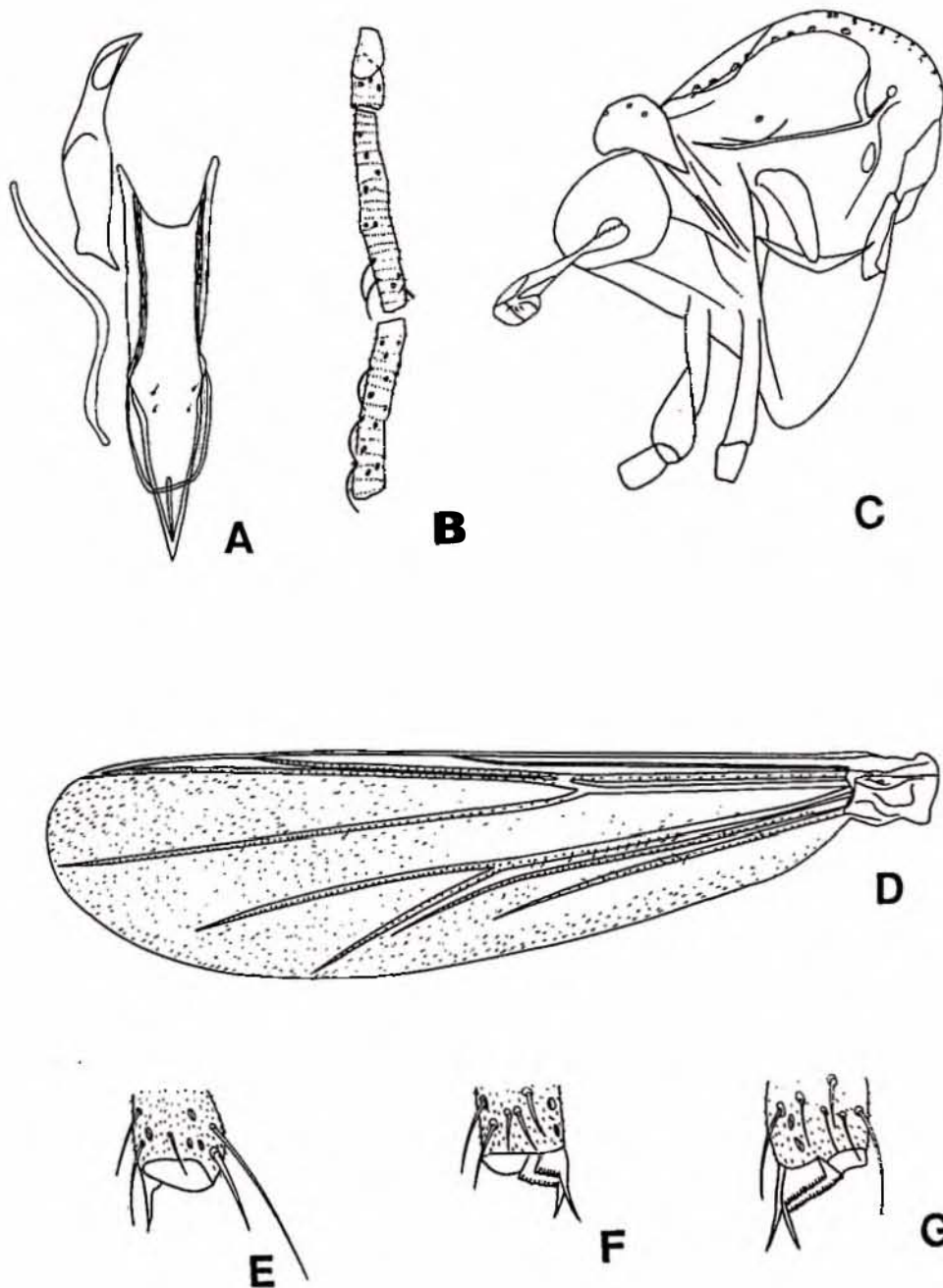


Fig. 22. *Rheotamytansus plerusinguisus* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

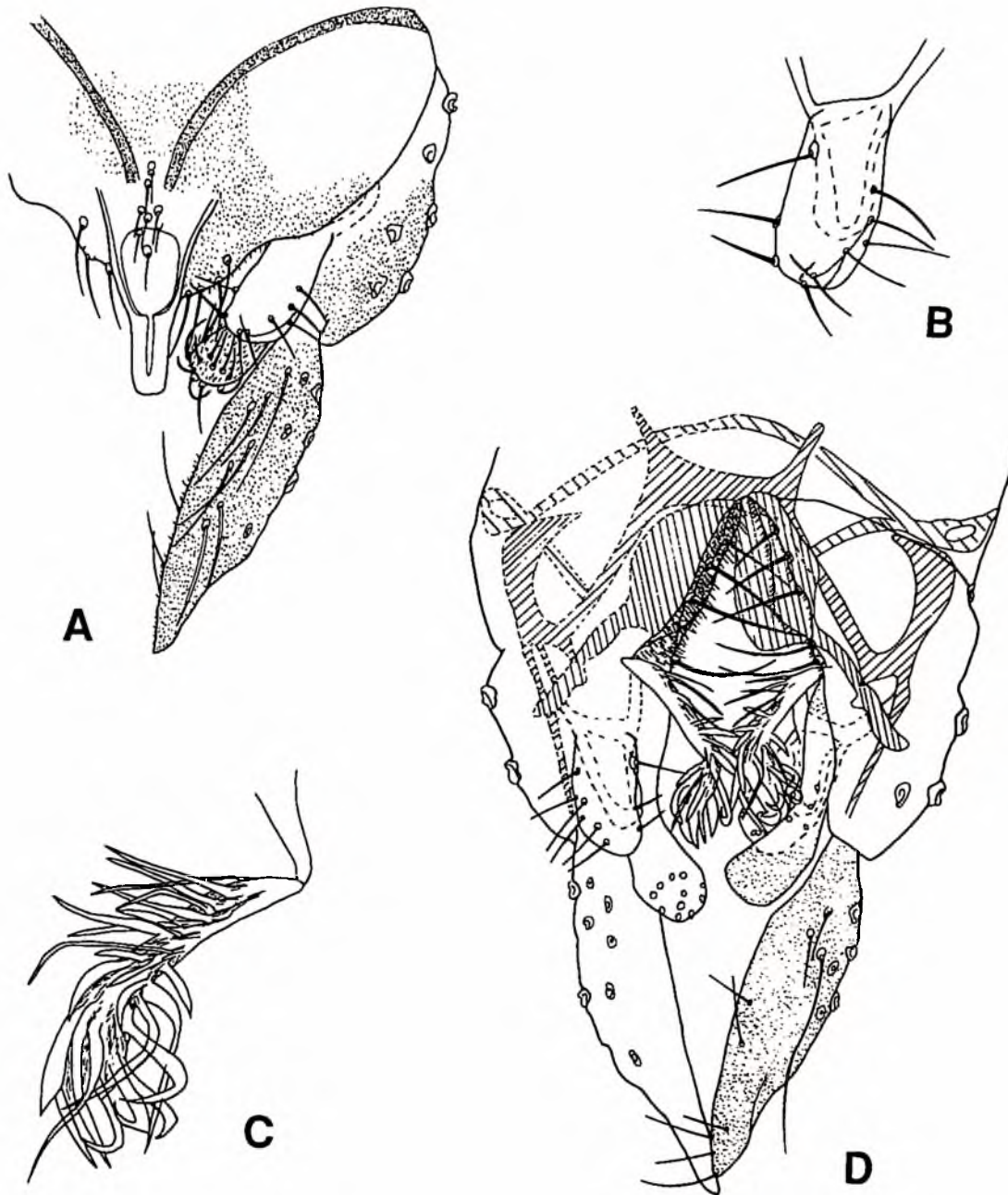


Fig. 23. *Rhetantarsus plerunguisus* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

Table 8. Lengths (in μm) and proportions of legs of *Rheotanytarsus plerunguisus* sp. n.

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄
p1	893-911	528-553	1018-1036	571-578	386	307
p2	832-839	678-682	378	189	139	
p3	968-982	846-853	553	364	300	193
	ta ₅	LR	BV	SV	BR	
p1	171	1.87-1.93	1.73	1.40-1.41	4.5	
p2		0.55		4.02	5.5	
p3	96	0.65	2.50	3.30	7.5	

Female imago (n = 1-2).

Total length 1.68-1.87 mm. Wing length 1.66-1.68 mm. Total length / wing length 1.00-1.13. Wing length / length of prefemur 2.26-2.37. Colouration: thorax, abdomen and legs pale.

Head (Fig. 24 A-B). AR 0.31 (1). Lengths of flagellomeres (in μm): 84, 56-60, 60-64, 60, 84. Temporal setae 7, including 3-4 inner verticals, 2 outer verticals, and 1-2 postorbitals. Clypeus with 15-17 setae. Tentorium 113-119 μm long, 16-22 μm wide at sieve pore and 8 μm wide at posterior tentorial pit. Stipes 123-133 μm long, 20-27 μm wide. Palp segment lengths (in μm): 32-36, 32-40, 104-112, 104-120, 162-172. Fifth palpal segment / third palpal segment 1.54-1.61.

Thorax (Fig. 24 C). Dorsocentrals 11-14, acrostichals 16-24. Scutellum with 7 setae.

Wing. VR 1.30-1.33. Membrane with about 1500 setae in all. R with 17 seta, R₁ with 30 setae, R₄₊₅ with 65, Sc, RM and M bare, M₁₊₂ with 80, M₃₊₄ with 39-43, Cu with 22-24, Cu₁ with 23-25, PCu with 67, and An with 41 setae. Cells m with about 30 setae, r₄₊₅ with about 450, m₁₊₂ with about 400, m₃₊₄ with about 150, cu with about 150, and an with 108 setae.

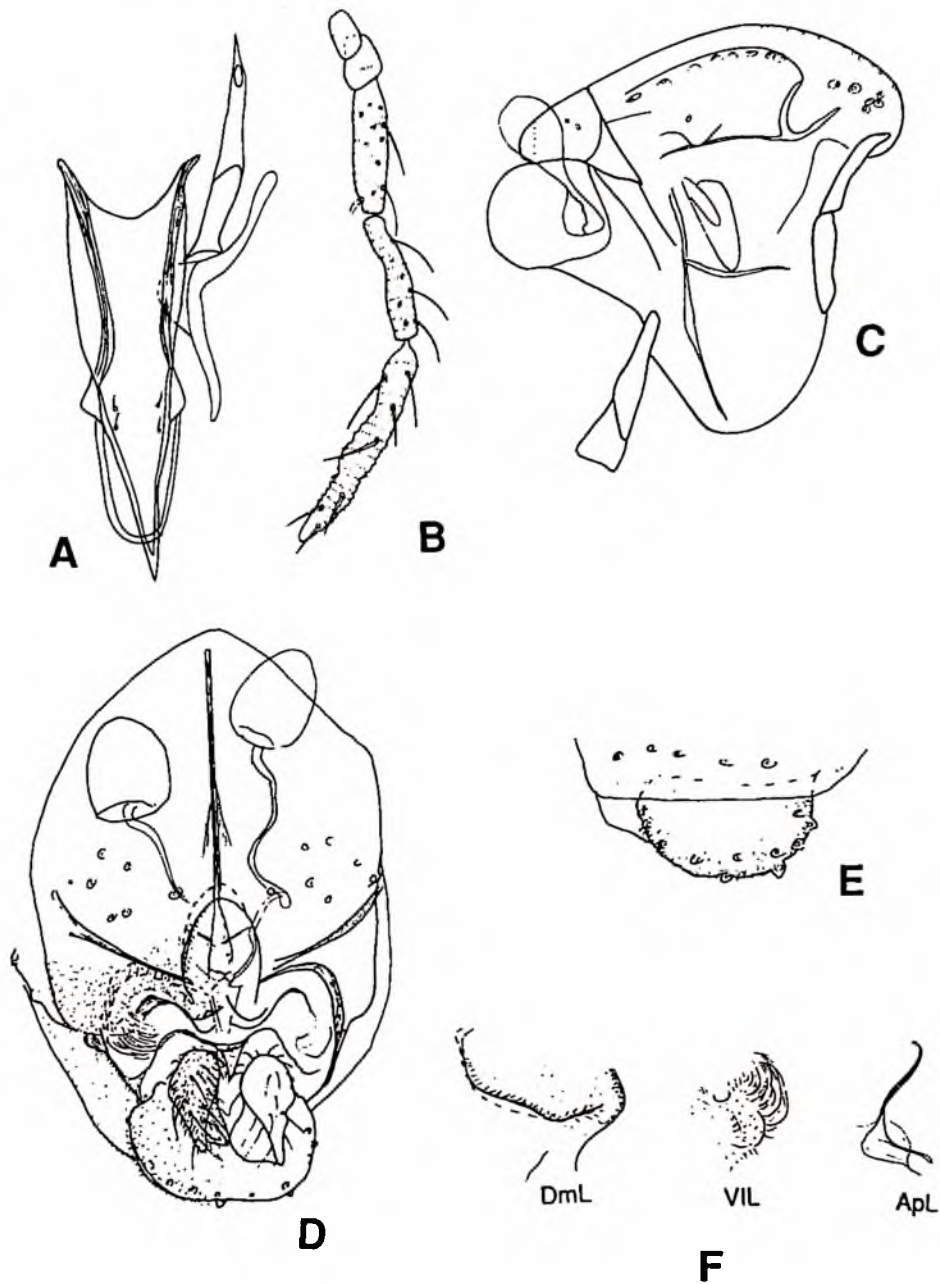


Fig. 24. *Rheotanytarsus plerusinguisus* sp. n., female imago. - A. Cibarial pump, tentorium and stipes. - B. Palps. - C. Thorax. - D. Genitalia, ventral view. - E. Genitalia, dorsal view. - F. Gonapophysis VIII (VIL, ventrolateral lobe; DmL, dorsomesal lobe) and apodeme lobe (ApL).

Legs. Spur of front tibia 29-31 μm long, spurs of middle tibia 8-14 and 10-16 μm long, of hind tibia 12-14 and 16 μm long, all excluding comb. Comb of middle tibia 12 μm long, of hind tibia 12-16 μm long. Width at apex of front tibia 45-51 μm long, of middle tibia 49 μm , of hind tibia not measurable. Lengths and proportions of legs as in Table 9.

Table 9. Lengths (in μm) and proportions of legs of female of *Rheotanytarsus plerusinguisus* sp. n.

	fe	ti	ta ₁	ta ₂	ta ₃	
p1	711-735	417-425	899	474	327	
p2	694-711	547-563	327	163	122	
p3	760-817	678-694	457-474	270-284	229	
	ta ₄	ta ₅	LR	BV	SV	BR
p1	261	122	2.11	1.74	1.29	
p2	73-82	57-65	0.58-0.60	3.70-3.76	3.80-3.90	3.0-5.0
p3	131-139	65-82	0.67-0.68	2.18-2.81	3.07-3.27	3.1

Abdomen. Number of setae on tergites could not be counted due to folding of parts of the abdomen. Likewise number of setae on sternites could not be counted.

Genitalia (Fig. 24 D-F). Gonocoxite with 0-1 seta. Tergite IX not divided, with 18-23 setae. Cercus 51-57 μm long, 10-14 μm wide at apex. Seminal capsule 61 μm long including a 29-37 μm long neck; seminal capsule not sclerotized. Notum 76-86 μm long.

Remarks. - *R. plerusinguisus* sp. n. can be separated from all other species of the genus by its large oblong superior volsella and the many curved claw-like apical points on the apical plate.

Distribution. - The species is known only from a rain forest area in the West Usambara Mts. in North-East Tanzania.

***Rheotanytarsus saetheri* sp. n.**

(Figs 25-26)

Type locality. - Ghana: Eastern Region, Kibi, Subri Stream.

Type material. - Holotype ♂, Ghana: Eastern Region, Kibi, Subri Stream, 6. xi. 1993, light trap, NUFU project (ZMBN). Paratypes: 2 ♂, as holotype; 2 ♂, as holotype except 4. ii. 1993; Ghana: Central Region, Kakum National Park, Abrafo, 2 ♂, 8-18. xi. 1994, Malaise trap, NUFU project.

Diagnostic characters. - Median volsella long reaching beyond tip of inferior volsella with many long finger-like apical points.

Etymology. - Named after professor Ole A. Sæther, one of my supervisors. He introduced me to phylogenetic systematics and was of immense help to me during the writing of this dissertation.

Description

Male imago (n = 7, except when otherwise stated).

Total length 1.64-2.00, 1.77 (6) mm. Wing length 1.01-1.20, 1.06 (6) mm. Total length / wing length 1.62-1.75, 1.65 (5). Wing length / length of profemur 1.82-2.11, 1.94 (6). Colouration: thorax pale brown vittae and postnotum, abdomen pale, legs pale with apical part of femur darker.

Head (Fig. 25 A-B). AR 0.37-0.38, 0.38 (5). Thirteenth flagellomere 182-196, 186 (5) μ m long. Temporal setae 4-7, 5 (6); including 3 (6) inner verticals; 1-2, 2 (6) outer verticals; and 1-2, 1 (4) postorbitals. Clypeus with 14-17, 15 setae. Tentorium 47-78, 58 μ m long; 11-15, 13 μ m wide at sieve pore; and 7-9, 8 μ m wide at posterior tentorial pit. Stipes 71-93, 82 μ m long, 7-11, 8 μ m wide. Palp segment lengths (in μ m): 22-29, 25; 27-29, 28; 53-84, 63; 60-75, 66 (6); 113-133, 125 (4). Fifth palpal segment / third palpal segment 1.70-2.50, 2.07 (4).

Thorax (Fig. 25 C). Dorsocentrals 8-9, 8 (5); acrostichals 12-14, 14 (5). Scutellum with 3-4, 4 (5) setae.

Wing (Fig. 25 D). VR 1.50-1.67, 1.59 (6). Membrane with 850-1100 setae in all. Brachiolum with 1 seta; R with 12-15, 13 (6) setae; R₁ with 15-34, 21 (6);

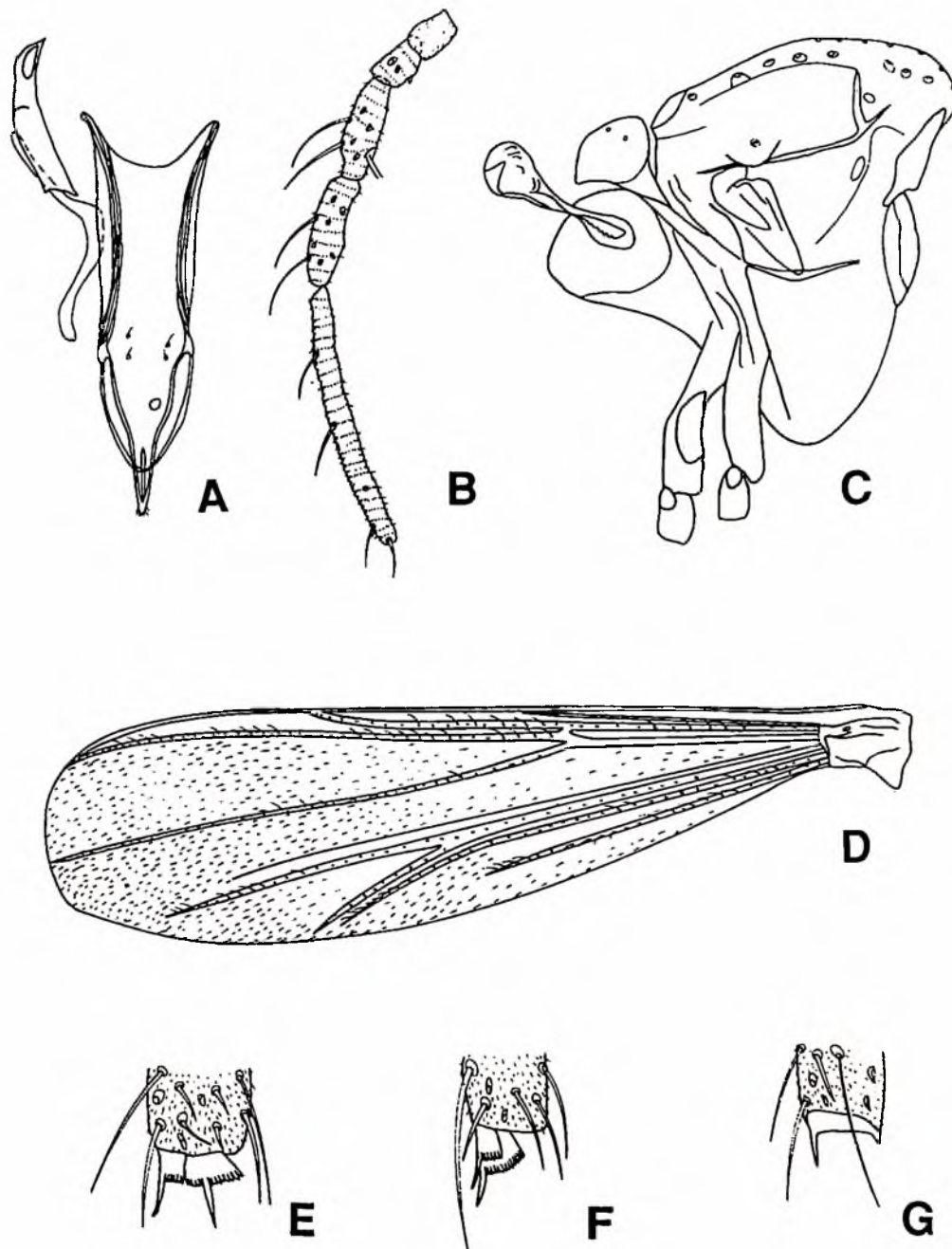


Fig. 25. *Rheotanytarsus saetheri* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

R₄₊₅ with 32-67, 45 (6); Sc and M bare; RM with 0-2, 1 (6); M₁₊₂ with 38-59, 45 (6); M₃₊₄ with 18-27, 21 (6); Cu with 12-15, 13 (6); Cu₁ with 10-16, 12 (6); PCu with 27-46, 37 (6); and An with 18-31, 23 setae (6). Cells m with 13-20, 17 (6) setae; r₄₊₅ with about 300 (6); m₁₊₂ with about 250 (6); m₃₊₄ with 49-104, 74 (6); cu with 55-166, 84 (6); and an with 8-65, 24 (6) setae.

Legs (Fig. 25 E-G). Spur of front tibia 15-29, 21 μ m long; spurs of middle tibia 4-13, 10 (4) and 13-15, 14 μ m long; of hind tibia 13-18, 15 (6) and 15-18, 17 μ m long, all excluding comb. Comb of middle tibia 11-13, 12 μ m long, of hind tibia 11-13, 12 μ m long. Width at apex of front tibia 33-40, 35 μ m; of middle tibia 29-40, 32 μ m; of hind tibia 33-38, 36 μ m. Lengths and proportions of legs, Table 10.

Table 10. Lengths (in μ m) and proportions of legs of *Rheotanytarsus saetheri* sp. n.

	fe	ti	ta ₁	
p1	500-643, 558	214-293, 248	625-796 (3)	
p2	482-625, 533	353-446, 380	207-246, 231 (6)	
p3	518-661, 565	411-536, 446	246-346, 253	
	ta ₂	ta ₃	ta ₄	ta ₅
p1	282-392 (3)	200-275 (3)	182-225 (3)	71-100 (3)
p2	93-121, 102 (6)	64-86, 72 (6)	36-50, 47 (6)	32-39, 37 (6)
p3	143-193, 166	132-193, 144	82-114, 98	39-57, 51
	LR	BV	SV	BR
p1	2.61-2.73 (3)	1.74-1.86 (3)	1.17-1.25 (3)	2.7-3.0 (3)
p2	0.55-0.65, 0.59 (6)	4.45-4.70, 4.56 (6)	3.70-4.40, 4.03 (6)	3.9-5.3, 4.5 (6)
p3	0.57-0.68, 0.64	2.73-2.89, 2.80	3.32-3.88, 3.55	4.4-6.1, 5.3 (5)

Hypopygium (Fig. 26 A-D). Tergite IX with 10-17, 12 setae. Anal point 44-55, 51 μ m long; 13-22, 17 μ m wide at base. Width at apex of anal point 4-9 μ m.

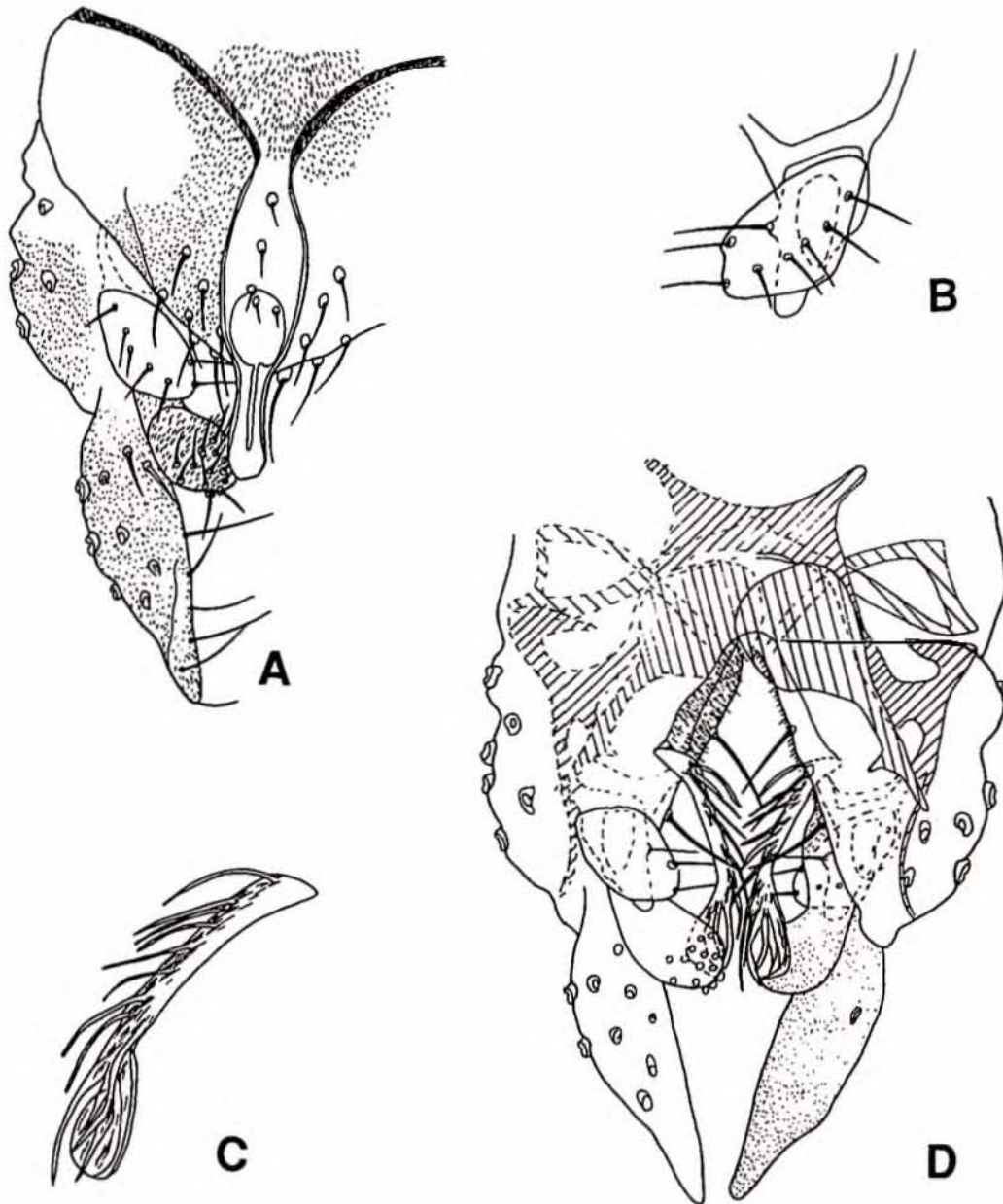


Fig. 26: *Rheotanytarsus saetheri* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

Laterosternite IX with 1-2, 1 setae. Phallapodeme 44-60, 56 μm long; transverse sternapodeme 35-44, 40 μm long. Gonocoxite 55-78, 74 μm long; gonostylus 51-73, 68 μm long. Superior volsella 24-35, 29 μm long; inferior volsella 47-55, 50 μm long; median volsella 40-53, 46 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella oval-shaped with vestige of digitus extending conspicuously beyond margin of superior volsella. Median volsellae slightly S-shaped with distal lamellae fused into single plate with finger-like terminal points. HR 1.06-1.13, 1.08; HV 2.25-2.82, 2.50.

Remarks. - *R. saetheri* sp. n. is close to *R. abonae* sp. n., but can be easily separated by having the vestige of the digitus extending conspicuously beyond the margin of the superior volsella and by the short closed, rounded crest.

Distribution. The species is known only from streams and small rivers in southern Ghana.

***Rheotanytarsus weijensis* sp. n.**

(Figs 27-28)

Type locality. - Ghana: Greater Accra Region, Weija.

Type material. - Holotype i , Ghana: Greater Accra Region, Weija, 29. i. 1993, light trap, NUFU project (ZMBN). Paratype: i , as holotype.

Diagnostic characters. - Abdomen strongly banded and superior volsella oblong in shape. Most of the lamelliform setae on the median volsella fused into one single plate to form a fan-like structure.

Etymology. - Named after Weija water works near Accra, Ghana, and the Latin suffix-*ensis*, denoting place, locality.

Description

Male imago (n = 2).

Total length 1.98-2.17 mm. Wing length 1.07-1.12 mm. Total length / wing length 1.85-1.93. Wing length / length of profemur 2.01-2.06. Colouration: thorax dark brown around vittae and postnotum; abdomen pale with dark bands around

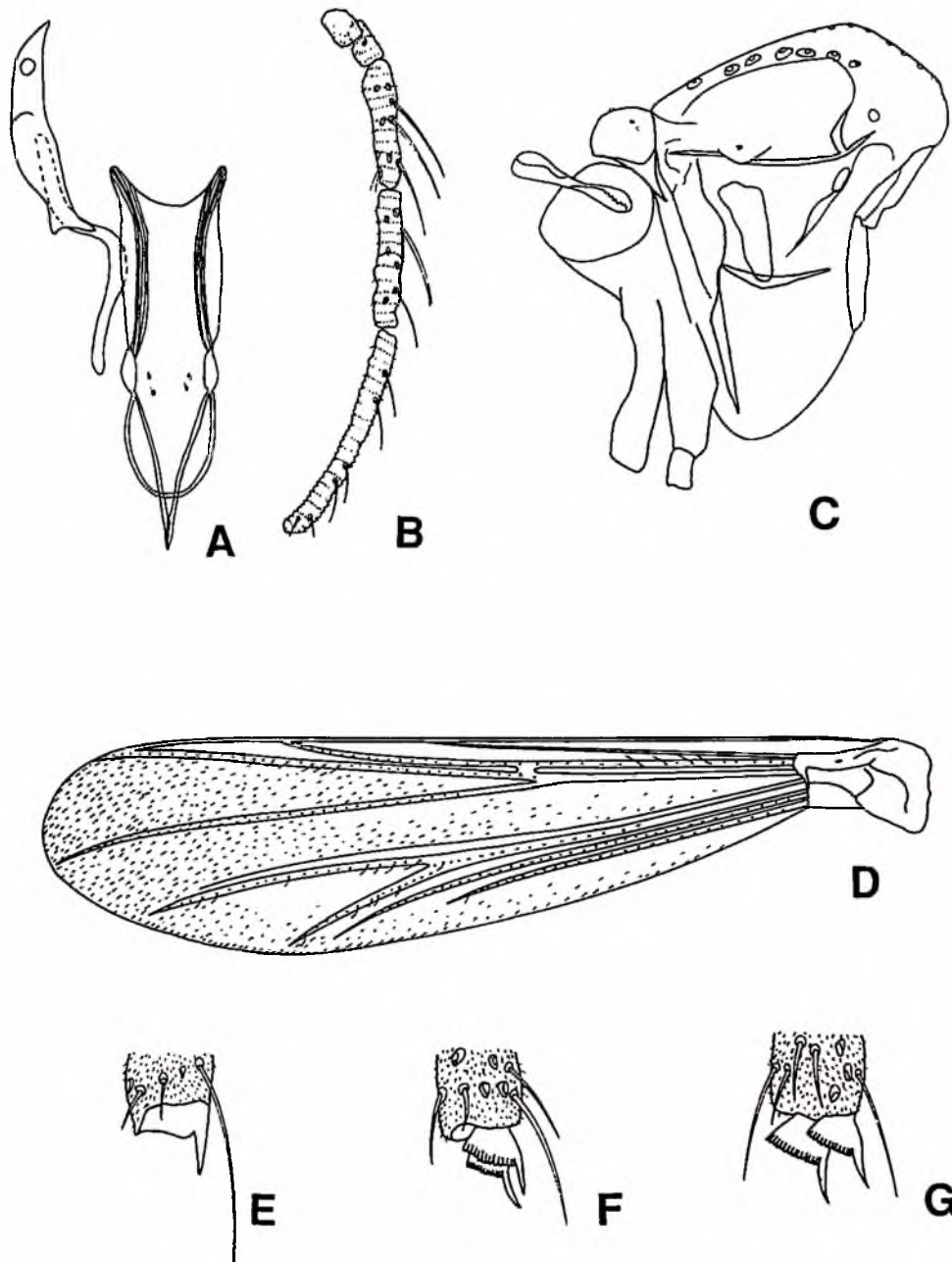


Fig. 27. *Rheotanytarsus weijensis* sp. n., male imago. - A. Cibarial pump, tentorium and stipes. - B. Palp. - C. Thorax. - D. Wing. - E-G. Spurs of fore, mid and hind tibia.

end of tergites; legs pale with apical 1 / 4 of femur darker. Head (Fig. 27 A-B). AR 0.57-0.59. Thirteenth flagellomere 253-278 μm long. Temporal setae 7; including 3 inner verticals, 2 outer verticals and 2 postorbital. Clypeus with 12-19 setae. Tentorium 78 μm long, 18-20 μm wide at sieve pore and 11-13 μm wide at posterior tentorial pit. Stipes 89-93 μm long, 7-9 μm wide. Palp segment lengths (in μm): 24, 27-29, 69-75, 67-87, 131-147. Fifth palpal segment / third palpal segment 1.90-1.94.

Thorax (Fig. 27 C). Dorsocentrals 7-8, acrostichals 18-22. Scutellum with 4-5 setae.

Wing (Fig. 27 D). VR 1.41-1.42. Membrane with 717-764 setae in all. Brachiolum with 1 seta, R with 16 setae, R_1 with 20-22, R_{4+5} with 39-44 setae, Sc bare, M with 2, RM with 1-2, M_{1+2} with 36-46, M_{3+4} with 21-24, Cu with 17-18, Cu_1 with 14-15, PCu with 40-42, and An with 27-29 setae. Cells m with 15-20 setae, r_{4+5} with about 200, m_{1+2} with about 200, m_{3+4} with 38-49, cu with 53-65, and an with 15-17 setae.

Legs (Fig. 27 E-G). Spur of front tibia 24 μm long, spurs of middle tibia 11-13 and 13-15 μm long, of hind tibia 11 and 15 μm long, all excluding comb. Comb of middle tibia 13-15 μm long, of hind tibia 13-15 μm long. Width at apex of front tibia 33 μm , of middle tibia 27-29 μm , of hind tibia 35 μm . Lengths and proportions of legs as in Table 11.

Table 11. Lengths (in μm) and proportions of legs of *Rheotanytarsus weijensis* sp. n.

	fe	ti	ta ₁	ta ₂	ta ₃	ta ₄
p1	543-553	293-300	593-600	289-303	218	153
p2	521-528	411-425	236-243	118-121	82	57-61
p3	546-571	518-553	336-343	189-200	157-161	82-104
	ta ₅	LR	BV	SV	BR	
p1	82	2.00-2.02	1.91-1.92	1.41-1.42	3.4-3.6	
p2	46	0.57	3.80-3.89	3.93-3.95	5.1-5.2	
p3	61-64	0.62-0.65	2.78-2.85	3.17-3.28	5.3-6.3	

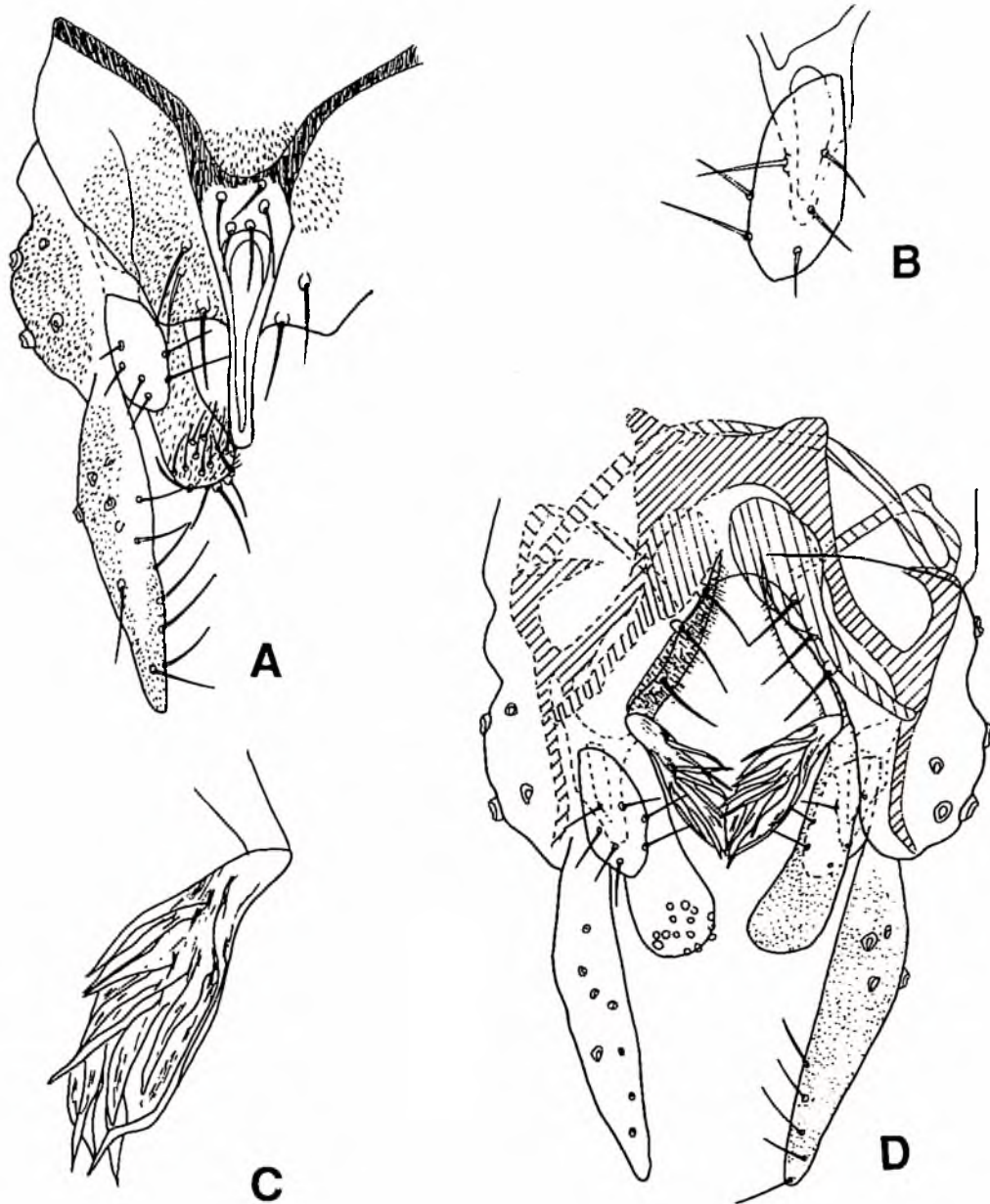


Fig. 28. *Rheotanytarsus weijensis* sp. n., male imago. - A. Hypopygium, dorsal view. - B. Superior volsella. - C. Median volsella. - D. Hypopygium, ventral view.

Hypopygium (Fig. 28 A-D). Tergite IX with 6-7 setae. Anal point 58-64 μm long, 18-24 μm wide at base. Width at apex of anal point 7-9 μm . Latero-sternite IX with 1 setae. Phallapodeme 44-51 μm long, transverse sternapodeme 42-44 μm long. Gonocoxite 87-89 μm long, gonostylus 75-80 μm long. Superior volsella 38-40 μm long, inferior volsella 53-55 μm long, median volsella 44 μm long. Inferior volsella with microtrichia, superior and median volsellae without microtrichia. Superior volsella oblong in shape. Almost all setae on median volsella fused to form a fan-like plate with apical terminal points. HR 1.11-1.152; HV 2.64-2.72.

Remarks. - *R. weijensis* sp. n. is close to *R. curtistylus*, but can be easily separated on its smaller size and antennal ratio.

Distribution. - The species is known only from a water reservoir in southern Ghana.

Chapter 8

DISCUSSION

ADAPTATION OF CHIRONOMIDS TO TROPICAL AREAS

Generally, the Ghanaian species of *Rheotanytarsus* are smaller with lower antennal ratios and chaetotaxy than the species from Eastern and Southern Africa. This might be an adaptation to the warm, humid climate in the rainforests of Ghana, whereas the species from Eastern and Southern Africa come from either montane habitats or from localities with a much cooler climate (Sæther, 1980b).

A comparison of certain body measurements, ratios and wing chaetotaxy was made to determine whether there were any marked differences between the tropical and temperate species but the results were not very significant, (Table 12). The tropical species were much smaller than the temperate species. This is probably to reduce excessive loss of water due to the high temperature. Though the range of the AR of the tropical species is quite wide, a larger number have AR of less than 0.60. Those with much higher AR are generally from areas with much cooler climates comparatively or from areas with higher elevations like montane areas. With the exception of just a few species, most of the temperate species on the other hand have AR more than 0.60. The LR of the tropical species is slightly higher than those of the temperate species. With the exception of just a few species the VR of the tropical species are also slightly higher than those of the temperate areas. Generally, the tropical species are darker in colour than the temperate species. Table 12, below shows a comparison of certain body proportions, parts

and ratios of some tropical species and their temperate sister species, or closely related species. Sæther (1981) found from his studies that tropical species tend to be much smaller than their temperate counterparts with a general reduction in body parts especially the volsellae but this is not so for this genus. The tropical species of this genus seem to have developed much larger volsellae especially the median volsellae which is also much more complicated in structure. The reason for this is not very clear. The tropical species also have lower chaetotaxy than the temperate species with the exception of the species from cooler regions and montane localities.

Table 12. Comparison between wing lengths, selected ratios and counts of setae on wing membrane of some tropical members of the *Rheotanytarsus curtistylus* group and their temperate sister species or closest relatives.

Name	Area	WI	VR	AR	LR ₁	No. of setae on wing membrane
<i>R. weijensis</i>	Trop.	1.07-1.12	1.41-1.42	0.57-0.59	2.00-2.02	717-764
<i>R. curtistylus</i>	Temp.	1.50-1.70	1.45-1.56	0.70	1.50-1.60	1600
<i>R. atrius</i>	Trop.	0.85-0.97	1.60-1.69	0.20-0.25	2.75-3.05	817-893
<i>R. muscicola</i>	Temp.	1.60-2.10	1.38	0.70-0.80	1.80-1.90	2000
<i>R. saetheri</i>	Trop.	1.01-1.20	1.50-1.67	0.37-0.38	2.61-2.73	850-1100
<i>R. photophilus</i>	Temp.	2.20-2.30	1.38-1.47	1.0	1.90	2000

ZOOGEOGRAPHICAL REMARKS

The genus *Rheotanytarsus* is more or less cosmopolitan with species found in almost every part of the world. Most of the seven groups under this genus have species from variable geographical regions. A complete zoogeographical analysis of the genus cannot be made in this study since in order to do that all the described species have to be re-examined. However, the preliminary placement of some species in the species groups outlined here gives some interesting zoogeographical indications.

The genus as a whole apparently is of Pangaeic origin since it occurs in all zoogeographical regions and there appears to be a multiple sister group relationships between at least some of the species and species groups. The *ceratophylli* group has one Afrotropical and possibly two Japanese representatives. A Gondwanian origin thus is indicated.

Included in the *distinctissimus* group is one undescribed Afrotropical species, one Australasian and Oceanic, two Oriental and two Palaearctic species.

The *globosus* group is made up of the Neotropical *R. globosus* and possibly the Nearctic *R. magnini*. The group might be of Neotropical origin with later dispersal to the Nearctic region.

There is so far only one species belonging to the *pentapoda* group, the Palaearctic *R. pentapoda*.

Included in the *curtistylus* group are nine Afrotropical, one Australasian and Oceanic, one Oriental and three Palaearctic species. This group has a wide distribution stretching from Ghana in W. Africa, through Europe to Asia and Australia. This distribution supports the view that all the continents used to be one large landmass known as Pangaea. *R. curtistylus* and *R. weijensis* are sister species, *R. saetheri* and *R. abonae* might also be sister species and seem to be closely related to *R. ororus*, *R. kjaerandseni*, *R. fuscus*, *R. photophilus* and *R. atrius*. *R. christinae*, *R. hamatus* and *R. tobaseptedecimus* also seem to be closely related. *R. plerunguisus*, *R. muscicola* and *R. aquilus* do not seem to be related to any other known species. Some of the species in the *curtistylus* group appear to be of relatively recent origin, especially the Afrotropical species which seem to have



Fig. 29. The distribution of the *curtistylus* group in Africa. ◆ *R. abonae* sp. n., ■ *R. aquilus* sp. n., ○ *R. atrius* sp. n., △ *R. fuscus* Freeman, + *R. kjaerandseni* sp. n., ◇ *R. ororus* Lehmann, ▲ *R. plerusinguisus* sp. n., □ *R. saetheri* sp. n., and × *R. weijensis* sp. n.

been divided into two groups by the Dahomey Gap. This is a discontinuity in the forest belt stretching from the Atlantic to the Nile. (Kingdon, 1989). The geological history of Africa was later overlaid by climatic changes during the Quaternary period.

The effects of drought and orogenic increases in altitude according to the refugie theory, led to refuges of forest which persisted during the dry and cold periods. This eventually led to the formation of centres of biotic diversity (core areas) and intervening gradients of declining numbers of species. The two principal core areas are in Cameroon / Gabon and eastern Zaïre, with other areas in West Africa and near the East African coast. It is believed that the core areas were the main centres of forest survival during the severe arid period around 18.000 BP. Also later events such as the creation of the Dahomey gap may have played a significant role in speciation at least in the *curtistylus* group. Just about 8.000 years ago, the rain forests of Africa stretched from Western to Eastern Africa, but the Dahomey Gap, brought about isolation of the western block of the forest (Kingdon, 1989m).

The *nigricauda* group consists of two exclusively Palaeartic species.

The *reissi* group consists of seven Afrotropical, including several species to be described, one Neotropical and four Palaeartic species. The group appears to be of Gondwanian origin with later speciation taking place during the last 18.000 years as for the *curtistylus* group. However, in both of these groups the bulk of the species are only tentatively placed. Only when the immatures, particularly the pupae, are known, can a more reliable zoogeographical analysis be performed.

FUTURE PLANS

The present thesis describes seven new Afrotropical species of the *Rheotanytarsus curtistylus* group and redescribes one. However, *R. ororus* has not been redescribed. Furthermore, very few immatures presently are known; and there certainly are several more species to be found in material from the Afrotropical region. The genus *Rheotanytarsus* is among the more common and abundant genera in the Ghanaian streams investigated so far. It thus should be possible to obtain a much higher number of rearings. In order to do a more finalized phylogenetic treatment both rearings and complete treatment of a group on a worldwide scale is indispensable.

The genus *Rheotanytarsus* as a whole and its different species certainly are of indicator value. The filter-feeding behaviour of the larvae, for instance, will exclude them from turbid streams and rivers.

It is my intention in future studies to redescribe the remaining Afrotropical species of the genus, to study new material, and to attempt to rear as many species as possible.

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