

Photographic Guide

Freshwater Invertebrates of the Mambilla Plateau, Nigeria

Danladi M. Umar, Jon S. Harding & Michael J. Winterbourn



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First published in 2013 by
School of Biological Sciences
University of Canterbury
Private Bag 4800
Christchurch 8140
New Zealand
www.biol.canterbury.ac.nz

ISBN (Print) 978-0-473-25489-6
(PDF) 978-0-473-25490-2

Designed by Matt Walters, University of Canterbury, New Zealand
Printed by Canterbury Educational Printing Services, University of Canterbury, New Zealand

Preface

This photographic guide is an attempt to assist students and researchers in the field to identify some of the common freshwater benthic invertebrates of Mambilla Plateau. It is generally a guide to the juveniles (larvae or nymphs) and includes only a few adults. It is not a comprehensive guide to all the animals you might collect. Due to the lack of any existing guide for freshwater invertebrates on the Plateau we anticipate that this will become an essential field tool for students and researchers. Detailed taxonomic identifications of fauna will require more comprehensive sample collection protocols and identification keys, which are beyond the scope of this publication.

Acknowledgements

We wish to thank Stephen Moore (Manaaki Whenua Landcare Research, New Zealand) who took many of the invertebrate photos used in this guide. Other images were provided by Matt Walters, Trent Hoover and the authors. Many thanks to Linda Morris, Milen Marinov and Stephen Pohe (University of Canterbury) who helped at various stages. We thank Misa Zubairu, Hamadu and Mairiga who assisted in the field. We also thank Prof. Abdullahi Mahadi, Vice Chancellor, Gombe State University for logistical support. Finally, we thank Matt Walters for designing, formatting and arranging publication of the final document. Support came from Gombe State University, Nigeria, and the University of Canterbury, New Zealand.

This book was developed in collaboration with the Nigerian Montane Forest Project, University of Canterbury, who maintain a research field station at Ngel Nyaki on the Mambilla Plateau.

The aims of the Nigerian Montane Forest Project are:

1. To combine scientific research with education at both tertiary and local community level in order to develop long term sustainable management of Nigeria's montane forests.
2. To facilitate the involvement of national and international researchers in Nigerian montane forest research
3. To involve the community in the management of montane forest ecosystems
4. To work with the community in other ways, such as developing small businesses and working with schools to develop conservation awareness.

The major funders of the NMFP are the A. G. Leventis Foundation; North of England Zoological Society (Chester Zoo); Gombe State University; Nexen Inc. and Nexen Nigeria.

THIS BOOK IS DEDICATED IN MEMORY OF THE LATE STEPHEN MOORE
(MANAAKI WHENUA LANDCARE RESEARCH, NEW ZEALAND) WHO TOOK
MANY OF THE EXCELLENT 3D INVERTEBRATE PHOTOS USED IN THIS GUIDE.

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INTRODUCTION

In Nigeria, apart from a review of the diversity of aquatic faunal resources (Egborges, 1993), studies on the ecology of stream benthic invertebrate communities are limited. Faunistic works include keys for the identification of tropical freshwater fauna by Miles and Graham (1970), a checklist of macroinvertebrates of the Ikpoba River (Ogbeibu and Oribhabor, 2002), and a study of macroinvertebrate fauna from pools in the flood plain of the Anambra River (Eyo and Ekwonye, 1995).

Several studies have investigated benthic invertebrate communities in specific rivers; Anambra River (Eyo and Ekwonye, 1995), (Ogbeibu and Egborge, 1995) and Ogba River (Olomukoro and Okologume, 2008), while others have documented the impact of pollution by domestic waste, sewage and heavy metals on benthic invertebrate communities (Ofojekwu et al., 1996). Omeozor (1995) described benthic communities influenced by substrate conditions. Variation in the distribution of species as a result of difference in pH, salinity and dissolved oxygen has also been studied by Zabbey and Hart (2005). In most of these studies invertebrates have been identified to family, and occasionally genus. However, most identifications have had to be made using general texts and keys that deal largely with European and North American faunas rather than the Nigerian fauna, or even African freshwater invertebrates. Therefore, previous identifications should be treated with caution, as a number may be shown to be incorrect when more detailed taxonomic studies have been made of the local fauna. Many aquatic insect larvae have not been associated with adults, and consequently their accurate identification to species is not possible (Boulton et al., 2008; Pearson and Boyero, 2009; Solomon et al., 2009).

In this book we present an illustrated guide to the most common benthic stream invertebrates found in tropical highland streams on the Mambilla Plateau in Nigeria. They include Crustacea and insects in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Odonata (dragonflies), Coleoptera (beetles), Hemiptera (true bugs) and Diptera (true flies).

The Mambilla Plateau



MAP 1.
Location of the Mambilla Plateau in Taraba State. The Plateau lies on the Cameroon Highlands, and is near the border of Nigeria and Cameroon.

This tropical montane plateau is composed of volcanic rock with an area of approximately 3000 square kilometres in the south east corner of Taraba State, Nigeria, between 6–11° East and 6–7° North (Map 1). The altitude ranges from 1066 to 1900 metres above sea level, with an average elevation of 1500masl. The underlying geology varies from areas of dissected lava upland to granitic basement complex (Tuley and Bawden, 1966). The Plateau is within the Cameroon Highlands, a region considered to be a biodiversity hotspot.

The Plateau has an average annual rainfall of around 1800 millimetres, which falls during the rainy season from late March until late October (Chapman and Chapman, 2001). During the dry season, a dry cold northerly wind, known as the Harmatan, blows over the region. Due to this wind and the high elevation, mean daily temperatures rarely exceed 30 °C.

Many small streams originate on the Plateau, forming the headwaters of larger rivers, including the Donga and Mayo-Jigawal which flow into the Benue and into the Niger.

The vegetation comprises mainly undulating grassland with degraded and fragmented river valley forest (Fig. 1) (Chapman and Chapman, 2001). The largest continuous forest on the Plateau is within Ngel Nyaki Forest Reserve and covers an area of 7.5 square kilometres.

The majority of the Plateau is covered by grassland and agricultural fields, including tea, maize and cabbage. Grassland fires during the dry season are used to encourage new growth to feed livestock. These fires often encroach into the forested areas, slowly reducing their area and causing stream degradation.



FIGURE 1.
Streams within river valley forests are vulnerable to degradation from livestock and grassland fire.

What are freshwater invertebrates?

Freshwater benthic invertebrates are small animals (ranging in size from microscopic to several centimetres) which do not have back-bones. They are diverse and include worms, leeches, crustaceans, insects and snails. This guide focuses on macroinvertebrates (i.e., $>500\ \mu\text{m}$) which can usually be seen with the naked eye. Benthic invertebrates have many reproductive strategies and life cycles, with some groups (e.g., snails and worms) spending their entire lives in water, while others, for example some insect larvae or nymphs, only spend part of their life in the water, their winged adults live in terrestrial environments. Benthic invertebrates can be abundant in freshwater and can be used as indicators of changes in water quality; they also form an important part of aquatic food webs. Because of their ability to respond to physical (i.e., temperature) and chemical (i.e., pH) changes in freshwater conditions, benthic invertebrates are often used for biomonitoring and can provide useful information on natural and anthropogenic disturbance gradients.

Taxonomic classification used in this guide

Living organisms are classified into a series of hierarchical groups, based to a large extent on consistent morphological features. In this guide the standard international classification scheme has been used as shown below.

Kingdom (e.g., Animalia)

Phylum (e.g., Arthropoda)

Class (e.g., Insecta)

Order (e.g., Diptera)

Family (e.g., Tipulidae)

Subfamily (e.g., Limoniinae)

Tribe (e.g., Hexatomini)

Genus (e.g., *Paralimnophila*)

Species (e.g., *Paralimnophila skusei*)

Functional feeding groups used in this guide

Invertebrate species can eat by a number of different methods, these are called functional feeding groups (FFG). The relative abundance of functional feeding groups can reflect the types of food available in a stream. For example, a forested stream full of leaves may have invertebrates which are shredders, i.e. they shred the leaves. Dominance of, or loss of, a particular group may indicate a change in the ecological status of the waterway. The ideal “healthy” aquatic habitat would have representative of several functional feeding groups. The functional feeding groups listed below are adapted from Merrit and Cummins (1996).

TABLE 1.
Functional feeding groups
used in this guide.

FFG	Food
Shredders	Decomposing plant tissue, e.g., leaves and wood.
Filter feeders	Suspended fine particulate organic matter (FPOM), e.g., small particles of leaves or algae that are in the water column.
Collector-gatherers	Deposited decomposing fine particulate organic matter (FPOM), e.g., particles on the stream bed.
Scrapers (or grazers)	Biofilm, i.e. periphyton, bacteria, fungi.
Predators (and scavengers)	Living animals. Scavengers feeding on dead animals are generally rare.
Macrophyte piercers	Living vascular plants and algal fluid.

Water quality of the streams

There are streams of varying quality on the Plateau, from high quality with a diverse invertebrate communities to very low quality stagnant pools with a very limited invertebrate fauna.

Streams within the forest are generally fast flowing and have water of high quality (Fig. 2). The streambeds are composed of rocky substrates and large quantities of organic matter collect in the streams providing food and shelter for many invertebrates. Shade from the forest canopy keeps the water cool, around 16 °C. Dissolved oxygen saturation is relatively high, over 75%, and the pH neutral. There is limited livestock access to these streams. Thus 20 or more taxa can be found in these streams.

The fragmented river valley forests have fast flowing streams with water of high to medium quality (Fig. 3). The substrate is often cobbles and sand; the channels are deep. The surrounding open forest habitat offers partial shade resulting in a water temperature of 18–20 °C. Dissolved oxygen is around 50–75% and the pH is neutral. There is easy livestock access to these streams along their length. Up to 15 taxa may be present.

Pasture streams occur in flatter areas resulting in a slow flow rate and have water of medium to low quality. The streambed is usually composed of sand and the channel depth is moderate. The surrounding pasture offers very little shade resulting in a water temperature of 21 °C or higher. Dissolved oxygen saturation is around 30–50% and the pH is low. Livestock are often present in these streams, fouling the water and damaging the stream banks causing erosion.

The lowest quality water is found in the streams surrounded by agricultural crops such as maize, where the flow rate is low and stagnant pools often form (Fig. 4). The streambed is generally composed of mud and organic matter; the channels are shallow. These streams are fully exposed to sunlight and livestock are often present resulting in a high water temperature of 25–28 °C and very low dissolved oxygen saturation, often below 30%. The invertebrate fauna in these streams is often limited, and may be dominated by only a few taxa such as Chironomidae.

FIGURE 2.
Shaded forest streams
have a high water quality
and diverse invertebrate
communities.

.....



FIGURE 3.
An exposed section of a
stream through a river
valley forest. The water
quality is degraded due
to human and animal
activities which add
sediment and nutrients,
as well as reduce dissolved
oxygen levels and increase
water temperature.

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FIGURE 4.
Stagnant pools in
agricultural areas contain
water of low quality and
support a limited diversity
of invertebrates.

.....



How to collect freshwater invertebrates

Field sampling methods

Benthic invertebrates can be picked directly from pieces of substrate, such as stones and submerged wood or leaves (Fig. 5A & 5B). However, in deeper waterways or faster water, alternative methods such as nets need to be used. In order to get a more extensive species list, a kick-net sample can be taken from a range of different micro-habitats (run, riffle and pool) (Fig. 5C). Where they occur, leaf packs, wood jams and mosses can be included in kick-net samples. Quantitative samples can be collected in streams using a Surber sampler (0.1m², 250µm mesh Fig. 5D). This is a net with a frame which allows the user to sample a known area of stream bed. This is useful if you want to work out the density of invertebrates. All samples collected should be clearly labelled, both when collected in the field and after processing in the laboratory, before storage. Labels are best written in pencil on waterproof paper as ink will bleed out in ethanol. A label should include the site name (and code), date, collection method (e.g., Surber) and collector's name.

Preservation

Samples collected should be preserved in 70% ethanol and later identified in the laboratory using a stereo dissecting microscope. Identifications can be made using a key or combination of keys (e.g., Stehr, 1987, Thorp and Covich, 1991, Merrit and Cummins, 1996, Yule and Yong, 2004, Blakely et al., 2010 and the series of guides to the aquatic invertebrates of South Africa).

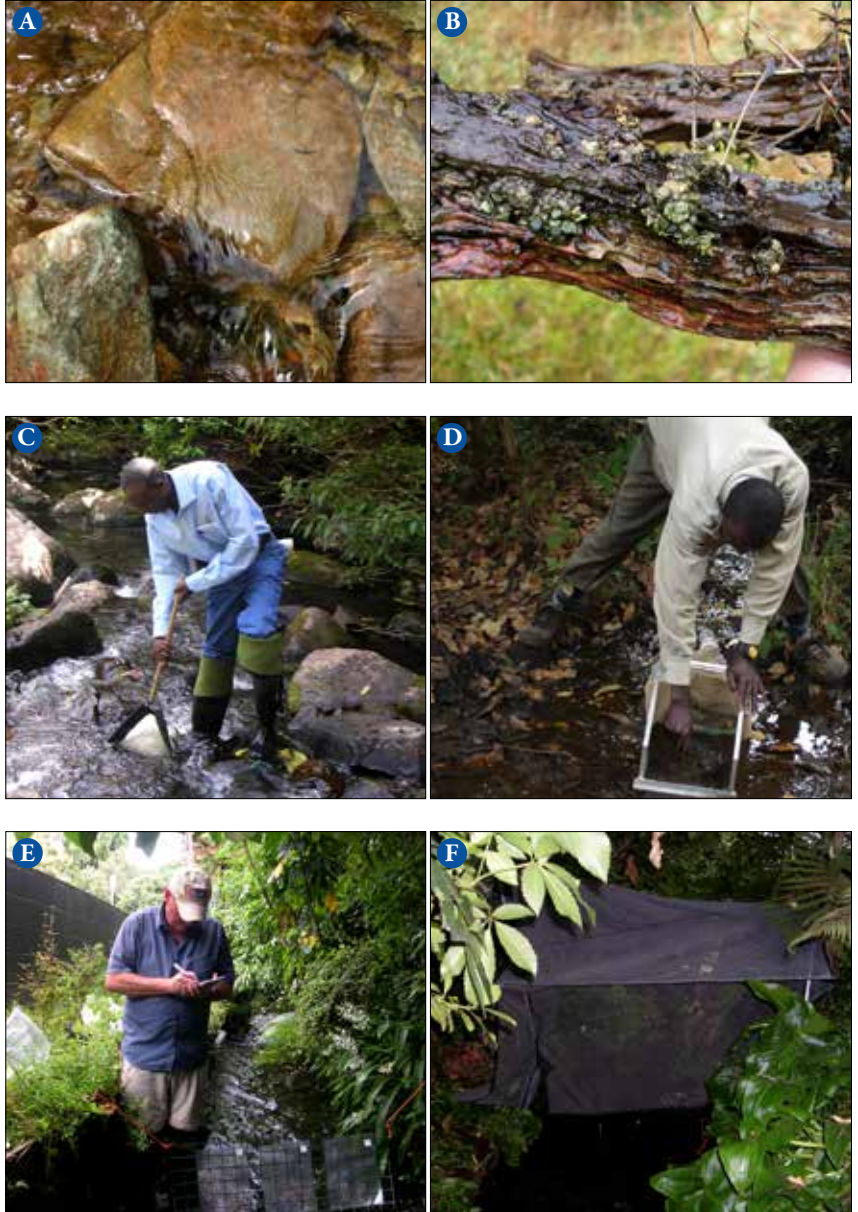


FIGURE 5. Different techniques of sampling stream invertebrates, (A) picking invertebrates from stone, (B) removing from wood, (C) kick or hand net (D) Surber sampling. Adult insects are usually collected by other methods; E) sticky trap and (F) malaise trap.
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Laboratory methods

Sample sorting and identification

Samples collected should be rinsed to remove debris and sediments by washing through a 500 μm mesh sieve. This process should be repeated until the contents of the sieve are washed into a white tray. It is advisable that sample processing and identification be done in a well illuminated laboratory using a low-power microscope (e.g., x 50). All invertebrates in the sample should be identified to the appropriate taxonomic level (either family level or lowest possible taxonomic level – generally genus or species) counted, and recorded in a laboratory book. When working with very large samples, for example 1000s of invertebrates, sub-samples of half or a quarter of the whole sample can be taken.



FIGURE 6. Benthic invertebrate sample being identified (A) under stereo light microscope (B) an invertebrate sample in a gridded tray.

PHYLUM: ARTHROPODA

CLASS: INSECTA

The Insecta have a number of orders which live in freshwater. Frequently insect larvae and nymphs dominate stream communities. Insects are characterised by having an exoskeleton and three pairs of legs. The adults usually have wings.

ORDER

EPHEMEROPTERA

COMMON NAME

MAYFLIES

Mayflies are hemimetabolous insects, meaning they do not have a pupal stage in the life cycle. In older nymphs, wing pads can be seen developing dorsally on the thorax. Mayflies have 3 “tails” or filaments (occasionally two) and dorsal or lateral gills on most abdominal segments. Each leg has a single tarsal claw. At least six families of Ephemeroptera have been found on the Mambilla Plateau. This section only included photos of nymphs. No adults are covered.

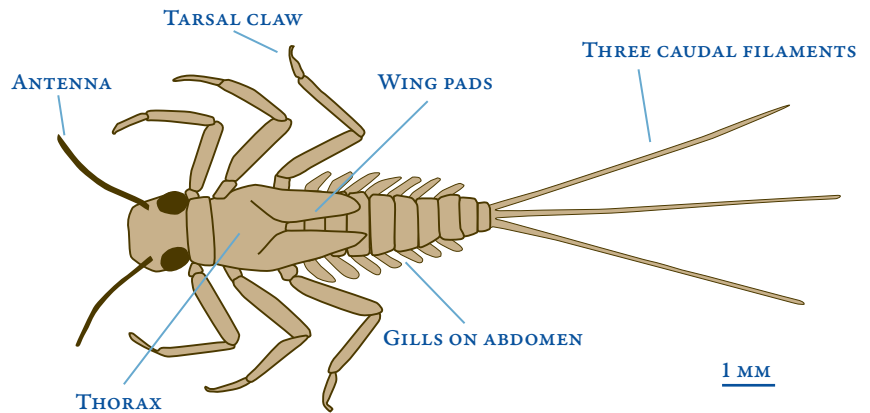
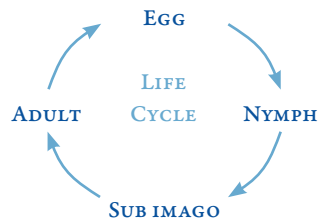


FIGURE 7.

A generalised mayfly and life cycle. The mayfly subimargo is an immature adult



FAMILY **Oligoneuriidae**

A single species which may be *Elassoneuria* Eaton 1881 (Gillies, 1974) is common in some streams. A species of this genus (*E. candida*) was described from Nigeria by Eaton in 1913. It has a streamlined, fish-like, nymph with a body length of up to 20 mm. This mayfly has abundant gills, including leaf-like structures on abdominal segments and a prominent tuft of maxillary gills beneath the head; thoracic gills are also present (Fig.8). Initially, it looks like a small fish as it darts around the stream.

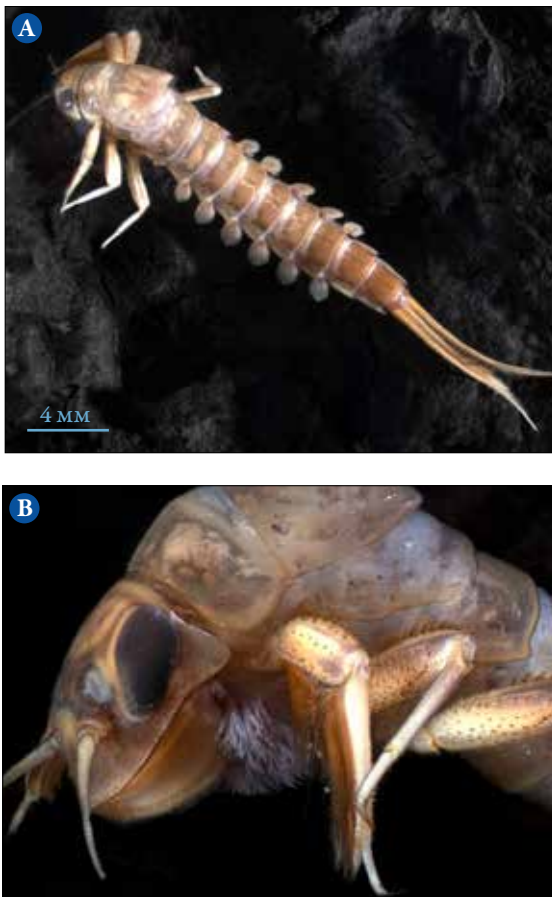


FIGURE 8.
(A) Oligoneuriidae:
Elassoneuria, with leaf-like
abdominal gills and (B)
maxillary gills beneath the
head.
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Ecological notes

This species can be abundant in forested streams or those with very good water quality. Nymphs are believed to be filter feeders that trap particles with a double row of long setae on the forelegs. Nymphs may have a phoretic association with *Simulium* (Gillies, 2009).

FAMILY Baetidae

Baetidae have small, fish-like nymphs with a cylindrical to flat body. The length of their antennae is about twice the width of the head. The lateral corners of the posterior abdominal segments are rounded and have no sharp points. Several genera of Baetidae are known from Nigeria, including *Baetis* and *Cloeon* but their nymphs have not been distinguished (Fig. 9). These are generally very small mayflies less than 10 mm long.



FIGURE 9.
(A & B) Baetidae larvae,
dorsal view.

Ecological notes

Nymphs are fast swimmers, and their guts primarily contain algae. Baetids were found in the continuous forest and river valley forest streams and seem to prefer larger cobble substrate.

FAMILY **Heptageniidae**

Nymphs are strongly flattened with large plate-like gills. When viewed from above the mandibles are hidden beneath the flattened head. There are two slender tail filaments (though they are easily broken). Nymphs usually attach closely to stream substrates and can swim awkwardly; body length up to 20 mm.

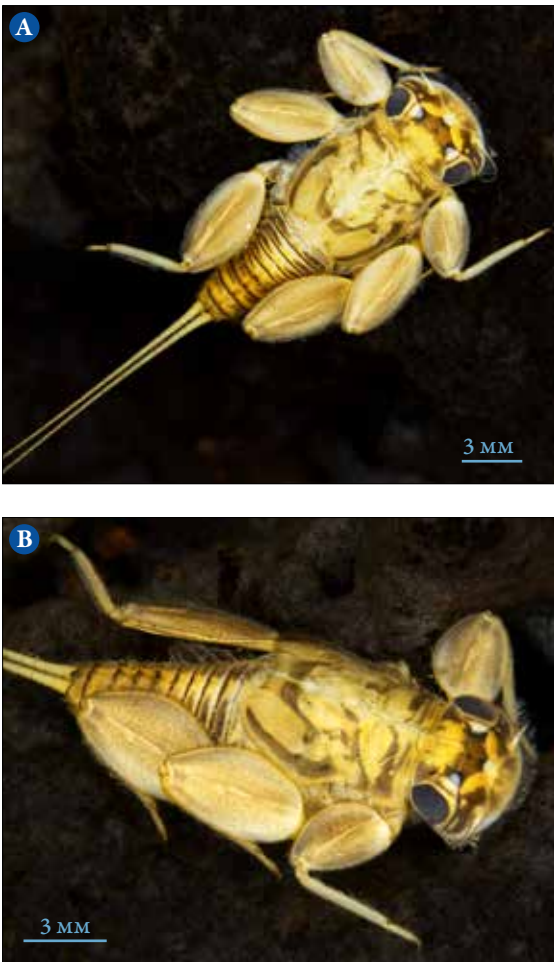


FIGURE 10.
(A & B) Heptageniidae nymphs with very short antennae.

Ecological notes

Heptageniidae can be common in high quality streams, and were found mostly in the forest and river valley forest streams. The genus *Heptagenia* has been reported from Opa River catchment basin, Nigeria (Ogbogu and Oyewole, 2007).

FAMILY Caenidae

Caenids are commonly known as small, square gill mayflies. Their gills are not found in rows along the sides of the abdomen as in most mayfly nymphs, but hidden beneath a pair of covering flaps (opercula) on abdominal segment 2. The flaps are not fused in the midline but overlap slightly so they look rather like a skirt (Fig. 11). These are very small mayflies, generally less than 10 mm long.



FIGURE 11.

Caenidae nymphs with (A) the operculum, covering and partially protecting the gills, and (B) gills projecting behind the operculum.

Ecological notes

Nymphs are found in mud and amongst leaf litter, and are tolerant of mild pollution. On the Mambilla Plateau nymphs of Caenidae were found in river valley forest and open pasture streams.

FAMILY **Leptophlebiidae**

Nymphs often have flattened bodies (dorso-ventrally flattened) and may have large flattened heads. However, unlike heptageniids the edges of the mandibles can be seen from above at the front sides of the head. On the under sides of the head a pair of prominent, comb-like maxillary brushes is a characteristic feature of leptophlebiid nymphs. A variety of gill shapes are found. Many gills are pointed and they are often bifid (V-shaped), however, gills are easily lost. The posterior-lateral corners of the posterior abdominal segments typically have sharp points. “Tails” are long thin filaments, which also get broken easily. Some nymphs collected on the Mambilla Plateau resemble those of *Adenophlebioides*. The body of nymphs can be 3–10 mm long.

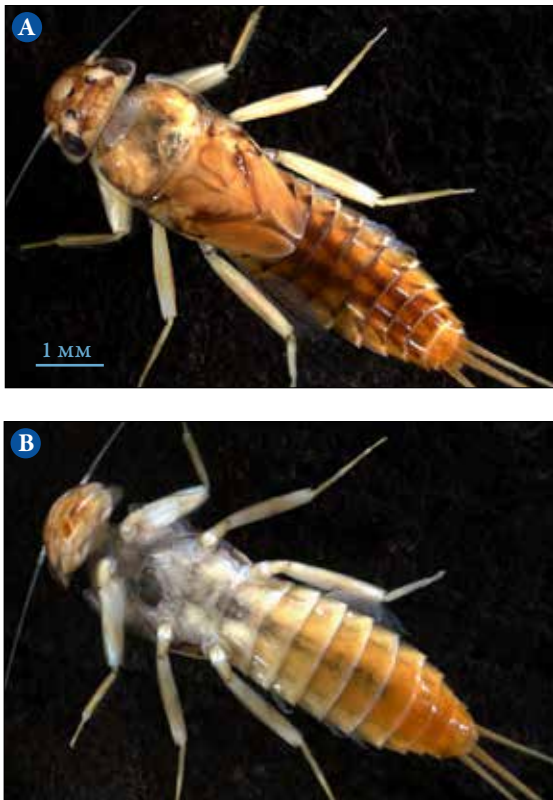


FIGURE 11.
Leptophlebiidae nymph
(A) dorsal view showing
flat head and (B) ventral
view with gill on display.

Ecological notes

Nymphs of Leptophlebiidae live under logs and boulders in streams with medium to high quality water. They are collector-browser or grazers feeding on algae, or deposited fine particulate organic matter and are mostly found in forested streams on the Mambilla Plateau.

FAMILY Polymitarcyidae

Members of this family have nymphs, which burrow into fine and soft sediments with modified legs and mandibles. The mandibles have prominent tusks that are digging structures. Gills of the nymphs lie over the abdomen (not at the sides) and have fringed edges. The genus *Povilla* has been recorded from Nigeria. Nymphs of another family, the Ephemeridae are very similar to those of Polymitarcyidae and may also occur in Nigeria.

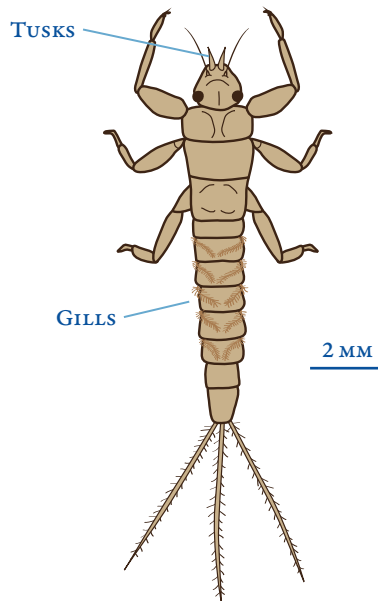


FIGURE 12.
Polymitarcyidae nymph
showing gills over the
abdomen.

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Ecological notes

Larvae were very rare but did occur in forested streams on the Mambilla Plateau.

ORDER

PLECOPTERA

COMMON NAME

STONEFLIES

Stoneflies are hemimetabolous insects with two tails, two tarsal claws on each leg, and long antennae.

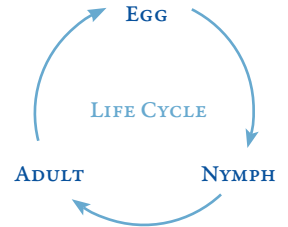
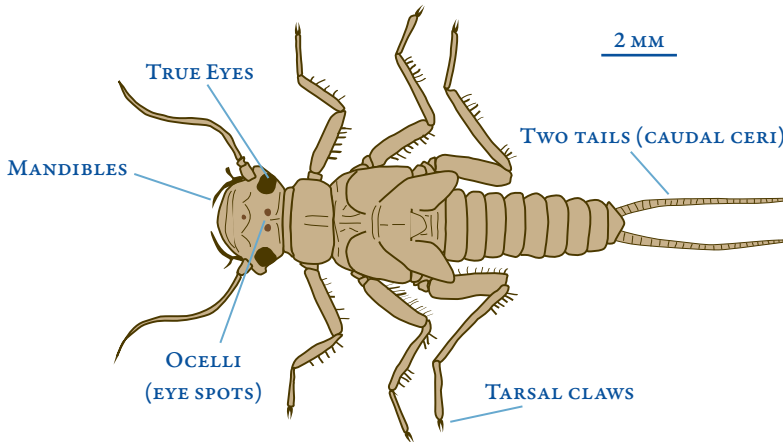


FIGURE 14.
A generalised stonefly nymph and life cycle.

FAMILY Perlidae

A single genus, *Neoperla*, has been found on the Mambilla Plateau but it may be represented by more than one species. Nymphs have branched filamentous gills at the bases of each leg, and at the bases of each caudal cercus ('tail'). The nymph (Fig. 15) resembles that of the unidentified *Neoperla* species reported in Nigeria by Ogbogu (2006).

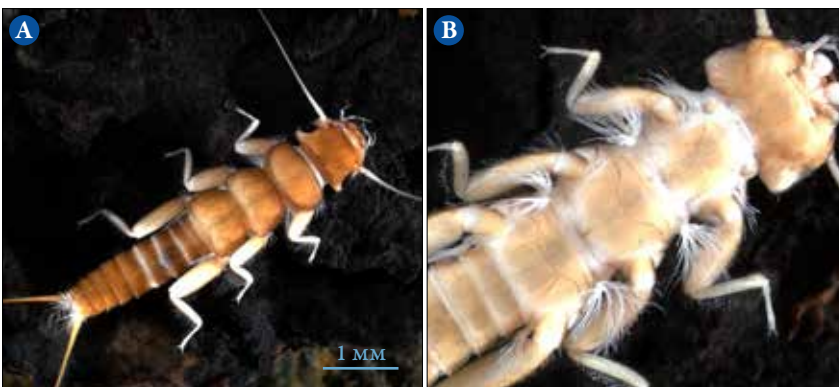


FIGURE 15.
Perlidae genus resembling *Neoperla* showing (A) the pair of ocelli on head (B) filamentous gills, at the base of each leg and between caudal cerci.

Ecological notes

Nymphs are predatory, can be up to 30 mm long and common in high quality streams.

ORDER

TRICHOPTERA

COMMON NAME

CADDISFLIES

Caddisflies are holometabolous insects, meaning the life cycle includes a larva, a pupa and an adult. Larvae have biting mouthparts with well developed mandibles, very small antennae, and the abdomen lacks prolegs on its middle segments unlike the caterpillars of Lepidoptera. Many caddis larvae have portable cases made from sand grains, or fragments of leaves or other materials. Others have a fixed retreat, whereas still others have no case or retreat and are described as free-living.

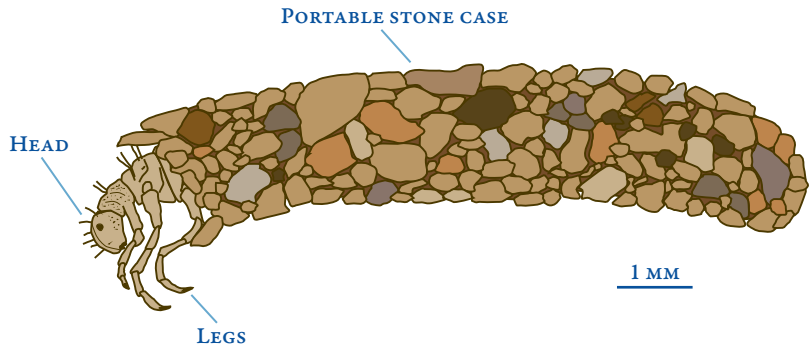
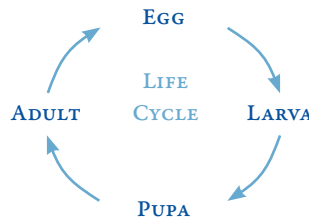


FIGURE 15. A generalised cased caddisfly nymph and life cycle.



FAMILY **Hydropsychidae** *net-spinning caddis*

Several species belonging to this family, and the subfamily Hydropsychinae, occur on the Plateau. They can be recognised by the presence of branched gills on the ventral surfaces of 7 or 8 abdominal segments, and the prominent brush extending from the base of each anal claw. Larvae live in retreats (small stone houses) attached to rocks and wood and spin a capture net at the retreat entrance. Larvae are poor swimmers and may be up to 15 mm long.



FIGURE 17. Hydropsychidae sp. A showing (A) pattern on the head, and (B) ventral view showing the branched gills.

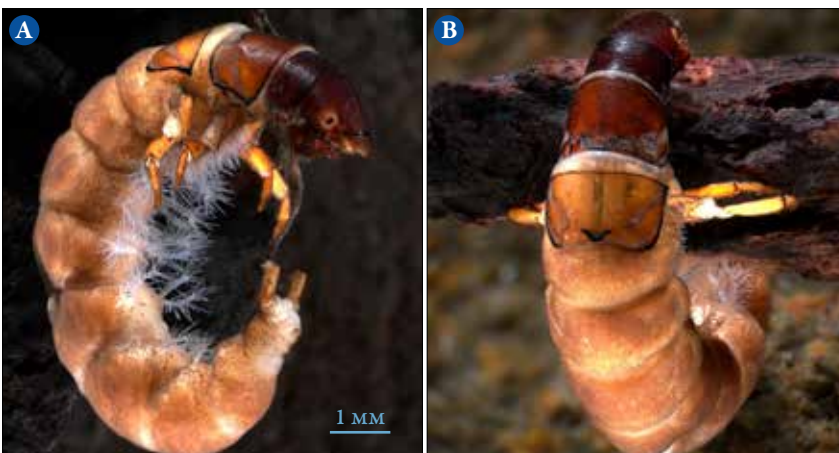


FIGURE 18. Hydropsychidae sp. B (A) has no pattern on the head (B) dorsal view.

Ecological notes

Hydropsychid sp. A (Fig. 17) has a distinct pattern on its head and is confined mainly to forest, while sp. B (Fig. 18) has no pattern on its head and is found in both forest and pasture streams on the Mambilla Plateau. Gut content analyses revealed the presence of filamentous algae, diatoms and fungi. This suggests they may be mainly herbivores and possibly scrapers as well as filter feeders.

FAMILY Philopotamidae

Most philopotamid larvae are predominantly white and live in fine-meshed stocking-like retreats. They have no gills and can be recognised by the “T-shaped” labrum at the front of the head. Larvae are normally found in flowing high quality water.



FIGURE 19.
Philopotamidae larva.

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Ecological notes

On the Mambilla Plateau larvae were found within a silken net retreat, and were mainly confined to the forest and river valley forest streams. Algae and fine particulate materials were found in the gut.

FAMILY Polycentropodidae

Larvae may be free-living or occupy tubular retreats. They do not have a T-shaped labrum but have a pointed trochantin close to the base of the foreleg (Fig. 20).



FIGURE 20.
Polycentropodidae larva.

Ecological notes

The member of this family found on the Plateau had retreats with silken catch nets. Larvae were found in forest and river valley forest streams.

FAMILY Psychomyiidae

Larvae live on stones and wood in silken retreats that incorporate fine sand grains and detritus. Psychomyiidae have a superficial resemblance to Polycentropodidae but the trochantin at the base of the foreleg is shaped like the head of an axe.



FIGURE 21.
Psychomyiidae larva.

Ecological notes

Psychomyiidae larvae were found in high quality flowing waters in the forest on the Mambilla Plateau.

FAMILY **Leptoceridae**

Larvae build a great variety of cases from pieces of wood, leaf fragments and mineral particles. The hind legs are very long. The family identity can be confirmed by examining the antennae, which although small are about 6 times as long as wide.



FIGURE 22.
(A & B) Leptoceridae larva
in portable leaf case.
.....

FIGURE 23.
Leptoceridae larva in a
“log cabin” case made from
wood.
.....



FIGURE 24.
Leptoceridae larva using
particles for its case.
.....



Ecological notes
found in all types of streams in different land use (e.g., forest and pasture).

FAMILY Glossosomatidae

Larvae build turtle-like cases out of sand grains and small stones. Larvae are usually found on the upper sides of stones where they scrape algae from the surface. Case length is up to 15 mm. Glossosomatid larvae can be common in medium to high quality streams.



FIGURE 25.
Glossosomatidae (A) stony case, (B) case and larva.
.....

Ecological notes

On the Plateau glossosomatid larvae are found in both forest and pasture streams.

FAMILY Brachycentridae

The larva has a distinctive case constructed from two large pieces of leaf (Fig. 26). Its identity as a brachycentrid is indicated by the long setae on the middle and hind legs and the lack of any dorsal or lateral humps on the first abdominal segment. This larva also has a distinct medially divided pronotum. The setae on the legs are used for filtering food materials from the water current, a habit possessed by many brachycentrid larvae world-wide. Larvae are common in high quality streams and may have cases 12–25 mm long.



FIGURE 26.
Brachycentridae larva (A)
dorsal view and (B) ventral
view.

.....

Ecological notes

On the Mambilla Plateau brachycentrid larvae are found mostly in shaded forest streams with high quality running water and an abundance of wood and leaf packs.

FAMILY **Hydroptilidae**

Hydroptilids are some of the smallest caddisflies and are called micro caddis. They have secreted cases that may be transparent, or incorporate plant material. Like hydropsychids, all their thoracic segments have well developed dorsal plates, which can be seen easily through the case if it is transparent. A hydroptilid found on the Mambilla Plateau is the very distinctive *Bibusa*, which incorporates filaments of red algae into the case.

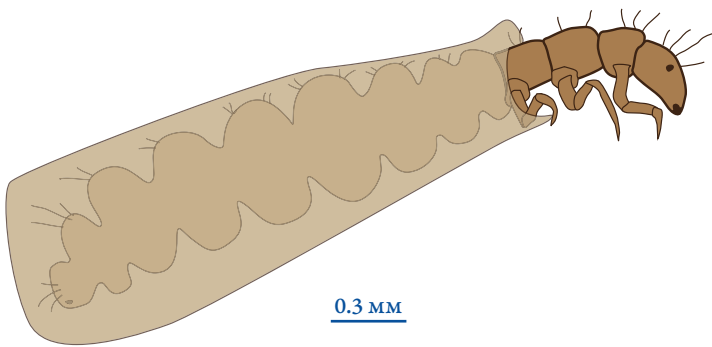


FIGURE 27.
Generalised Hydroptilidae
larva showing transparent
case.

Dragonflies (Anisoptera) are hemimetabolous insects and include some of the largest freshwater insects. They have an elongated, hinged labium (the mask), which is held beneath the head and over the face when at rest. The labium is shot out to capture prey. Damselflies (Zygoptera) have a long, narrow abdomen terminating in three “tails”, caudal lamellae, which are actually gills. In contrast, the abdomens of dragonflies (Anisoptera) are much broader and there are no caudal lamellae. Dragonflies gills are internal. On the Mambilla Plateau odonate larvae may have a body length up to 30 mm, and are most common in wetlands and pools.

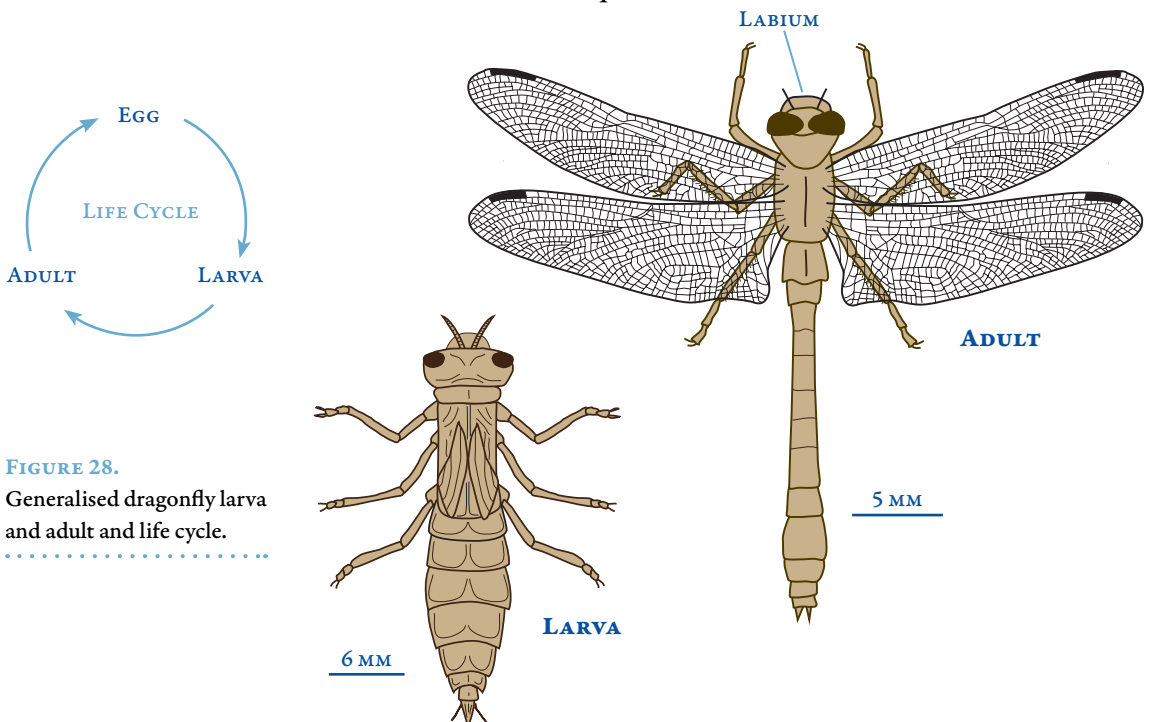


FIGURE 28.
Generalised dragonfly larva
and adult and life cycle.

Anisoptera *dragonflies*

FAMILY Gomphidae

The mask of gomphid larvae is almost flat and the abdomen is short and broad. Features that can be used to identify gomphids are the 4-segmented antennae (the third segment is much longer than the others), and the 2-segmented tarsi of the middle legs.



FIGURE 29. Gomphidae (A) Dorsal view and (B) Anterior view showing the labial mask and 4 segment antennae.

Ecological notes

On the Mambilla Plateau larvae of gomphids are common in both forest and pasture streams. They inhabit pools, in mud, underneath wood, stones or leaf packs. The mouth parts in addition to the mask are robust and well adapted for predation. Food items found in larvae were mostly animal parts.

FAMILY Aeshnidae

Aeshnid larvae also have a flattened mask but the abdomen is elongate, the antennae have 6 or 7 segments and the tarsi of the middle legs have three segments.



FIGURE 30.

Aeshnidae (A) Dorsal view and (B) Ventral view showing large eyes and flat labial mask.

.....

Ecological notes

Aeshnids are common in medium to high quality flowing streams and pools which have a muddy bottom. Gut contents analysis revealed the presence of animal parts like chironomids, consistent with them being predators.

FAMILY Libellulidae & Macromiidae

Larvae are short and broad with a spoon-shaped labial mask. The macromiids found on the Plateau had a distinctly patterned abdomen and thin striped legs (Fig. 33). Six species of Libellulidae in 3 genera were collected in light traps on the Mambilla Plateau (Umar et al., 2012) indicating it is a diverse family.



FIGURE 31.
Libellulidae (A) dorsal view
and (B) Anterior view.
.....



FIGURE 32.
Red dragonfly resting
beside a pool of water.
Body length is around 50
mm
.....

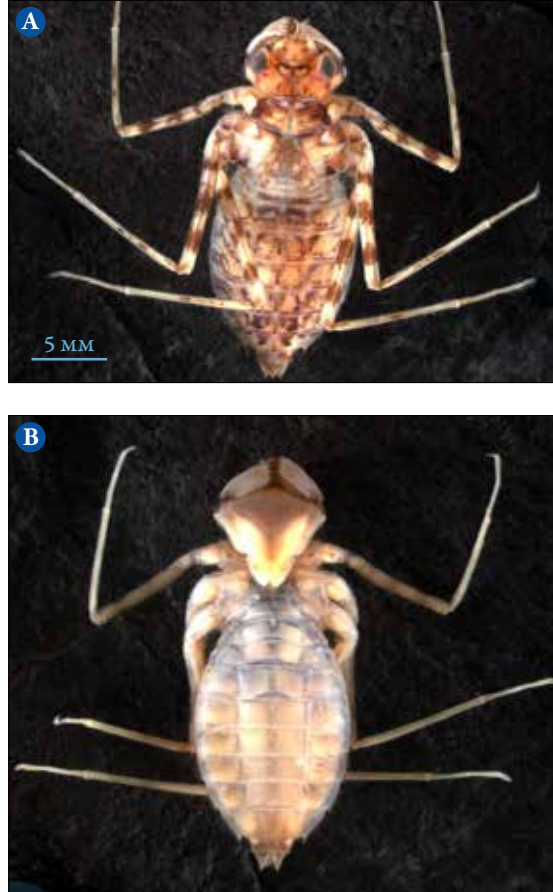


FIGURE 33.
Macromiidae (A) Dorsal
view and (B) Ventral view.

.....

Ecological notes

On the Mambilla Plateau the larvae of Libellulidae were most common in pasture streams which are muddy and have abundant macrophytes. Members of the family Macromiidae tended to be more common in pasture streams, and were associated with very low quality water. They are found in burrows in mud or live beneath leaf packs and woody substrates.

Zygoptera *damsselflies*

FAMILY Calopterygidae

Larvae are long and slender and the long first segment of each antenna is longer than all other segments together.



FIGURE 34. Adult zygopterans resting. (A) female, (B) male. Their body length is around 50 mm.
.....

Ecological notes

Damsselflies are very abundant in the pasture on the plateau, especially in grassland, where many pools and stagnant water bodies are quite common.

ORDER

COLEOPTERA

COMMON NAME

BETLES

Beetles are holometabolous insects whose larvae and adults can be aquatic. However, pupation is usually on land. Most adult beetles have chewing mouthparts and hard wing covers (elytra) which meet in a straight line over the thorax and abdomen. Larvae show a wide variety of forms and typically have 3 pairs of jointed thoracic legs but no prolegs on the abdomen.

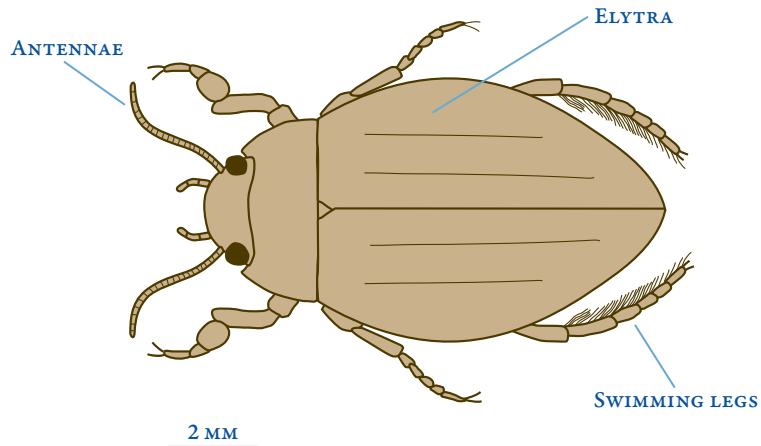
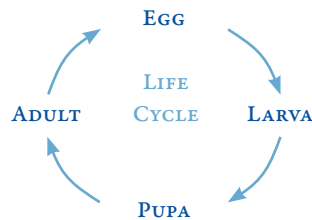


FIGURE 35.
Generalised beetle adult
and life cycle.



FAMILY *Dytiscidae* *diving beetles*

Both adults and larvae of dytiscids are aquatic. Adults have streamlined bodies and their legs may have long fringes of swimming hairs. The metasternum in front of the hind legs is covered by large plates often described as ‘wings’, and are characteristics of the family. Several species have been found on the Mambilla Plateau including the large black *Dytiscus* which is about 12 mm long. Other species are less than 10 mm long and one has longitudinally striped elytra.



FIGURE 36.
Dytiscidae adult (A) dorsal view and (B) ventral view.
.....

Ecological notes

On the Mambilla Plateau diving beetles are very common in ponds and streams. Food items found in their gut were mostly of animal origin, suggesting they are predators.

FAMILY Hydrophilidae

Hydrophilids are superficially like dytiscids and both adult beetles and larvae are aquatic. They can be fairly streamlined and may have swimming fringes on their legs. They can be easily distinguished from Dytiscidae by the form of the antenna. In Hydrophilidae the antenna is held beneath the head and has a 3-segmented club; in Dytiscidae the antenna project anterior-laterally from the head and has a regular filamentous shape. At least 2 species of *Deralus* have been collected on the Mambilla Plateau.

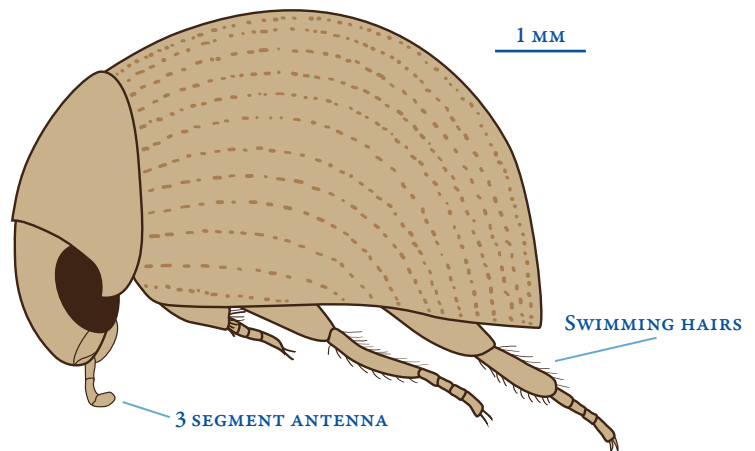


FIGURE 37.
Generalised Hydrophilidae
adult.

Ecological notes

Hydrophilids found on the Mambilla Plateau are small, and mostly occur in forest and river valley forest streams.

FAMILY **Gyrinidae** *whirligig beetles*

Whirligig beetles have aquatic larvae and adults. Adults are strongly streamlined, shiny black and the middle and hind legs are like oars. They also have two pairs of large compound eyes. Both pairs are at the side of the head and lie above one another so that one pair looks up and the other down. At least 3 species of Gyrinidae have been collected on the Plateau. Gyrinid larvae are elongate with a white abdomen and orange head and prothorax. The abdominal segments support pairs of long pointed lateral filaments, and there are 4 hooks on the last segment.



FIGURE 38.
Gyrinidae adult
Orectochilus. This large beetle has tufted hair-like brush on the maxilla. The divided compound eyes can be seen.



FIGURE 39.
(A) Gyrinidae larva and (B) adult beetle.

Ecological notes

Gyrinid species are widely distributed in medium to high quality flowing streams on the Mambilla Plateau. They are mostly found in forest and river valley forest streams.

FAMILY Chrysomelidae

The yellow and black striped alligator weed beetle (*Agasicles hygrophila*) has been introduced to Nigeria and is found on the Mambilla Plateau. It feeds on alligator weed and other plants that emerge above the water.



FIGURE 40.
Agasicles hygrophila.

FAMILY **Psephenidae** *water penny beetles*

Only the larvae of Psephenidae are aquatic. They are highly distinctive being oval to round and flat with the head and legs invisible from above.



FIGURE 41.
Psephenidae larva dorsal
view.

Ecological notes

Larvae are found attached to stony or woody substrates in flowing streams, with medium to high quality water.

FAMILY *Scirtidae* *marsh beetles*

Only the larvae of marsh beetles are aquatic. They are small somewhat flattened, and have long multi-segmented antennae, which are easily broken. The thoracic segments are flanged laterally, and the abdomen narrows, posteriorly.



FIGURE 42.
(A & B) Scirtidae larvae
(long antennae broken).

Ecological notes

On the Plateau the larvae found were either flattened or elongate, with multi-segmented antennae usually longer than the head and thorax. They are commonly found in pasture streams.

FAMILY **Elmidae** *riffle beetles*

Both the adults and larval stages of riffle beetles are aquatic, but only larvae have been found in freshwaters on the Plateau. At least two species have been collected. They can be cylindrical or somewhat flattened and tapering posteriorly. The 9th segment of the larval abdomen encloses a chamber with a ventral operculum or cover that opens revealing gills and/or hooks.

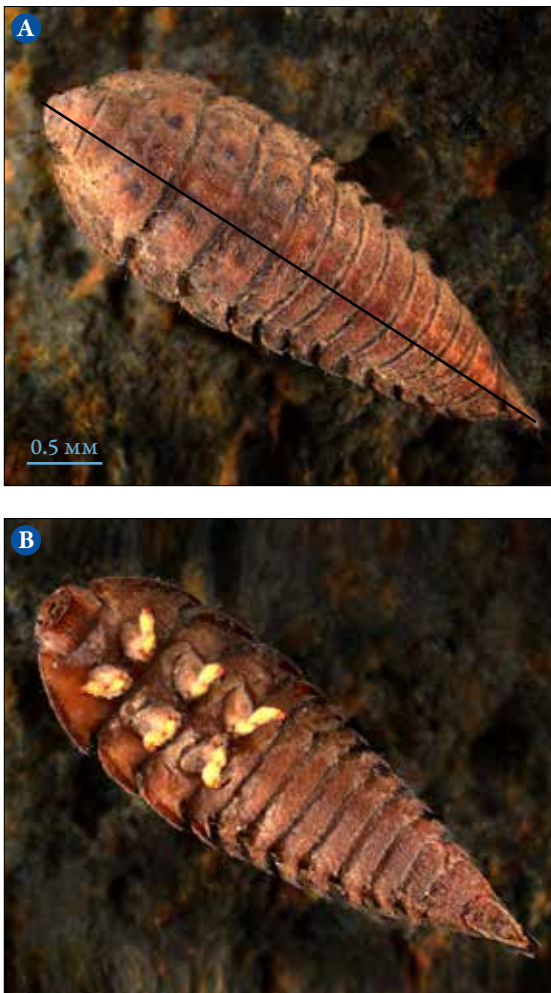


FIGURE 43.
(A) Elmidae larva dorsal view and (B) ventral view.
.....

Ecological notes

The elmids larvae found on the Mambilla Plateau were in forest streams often on wood.

FAMILY **Staphylinidae** *rove beetles*

Few staphylinids are probably truly aquatic, but both the adults and larvae of some species can be found associated with water. Adults have a distinctive elongated body shape. Their elytra are very short and cover little if any of the abdomen. The elongate body has parallel sides, and the beaded antennae are longer than the head (Fig. 44).



FIGURE 44.
Staphylinidae adult
with long antennae and
elongated body.
.....

Ecological notes

Staphylinids were found in forest and river valley forest streams attached to macrophytes and other submerged plants.

ORDER

HEMIPTERA

COMMON NAME

BUGS

All aquatic hemipterans belong to the suborder Heteroptera, which is considered to be an order by some authorities. They are hemimetabolous insects with sucking mouthparts that are formed into a tube or rostrum.

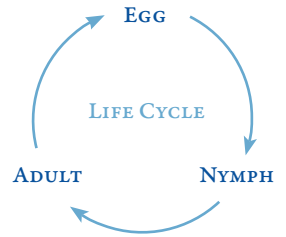
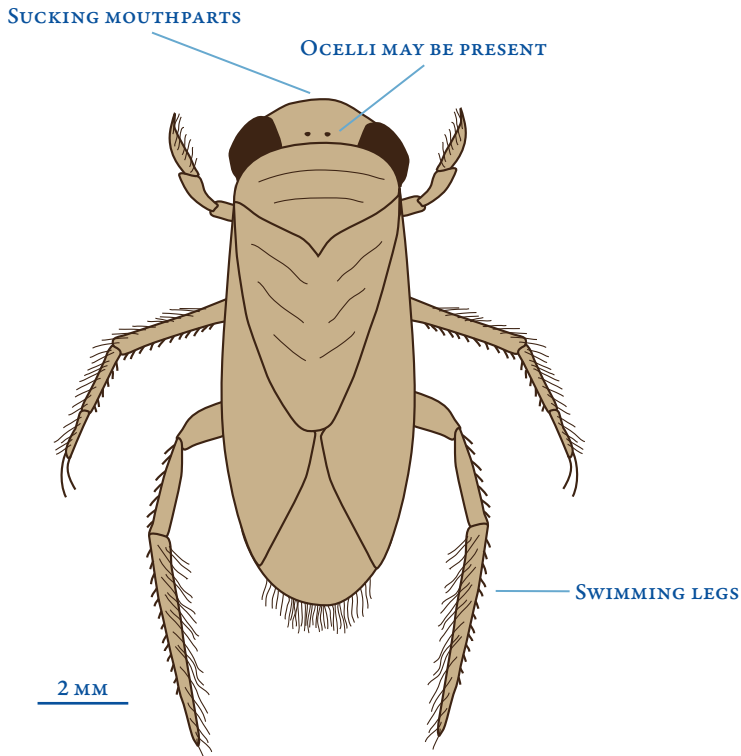


FIGURE 45.
Generalised bug adult and
life cycle.

FAMILY **Belostomatidae** *giant water bugs*

These are large, ovoid, dorso-ventrally flattened insects with a body length greater than 18 mm. Their eyes protrude from the sides of the head and they have a pair of short, flat strap-like respiratory structures at the posterior end of the body. Belostomatids are predators. The species found on the Mambilla Plateau probably belongs to the genus *Belostoma*.



FIGURE 46.
Belostomatid.

Ecological notes

Belostomatidae are fierce predators which stalk, capture and feed on aquatic crustaceans, fish and amphibians. They have also been found to capture and feed on baby turtles and water snakes (Perez-Godwin, 2006). They often lie motionless at the bottom of a body of water, attached to various objects, where they wait for prey to come near. They then strike, injecting powerful digestive saliva with their mandibles, and sucking out the liquefied remains. Their bite is considered one of the most painful that can be inflicted by any insect, however, though excruciatingly painful, it is of no medical significance. Adults cannot breathe under water, and must surface periodically for air. Occasionally, when encountered by a larger predator, such as a human, they have been known to “play dead” and emit a fluid from their anus. Due to this they are assumed dead by humans only to later “come alive” and give a painful bite (Schuh and Slater, 1995).

FAMILY **Naucoridae** *creeping water bugs*

The ovoid, dorso-ventrally flattened naucorids look rather like belostomatids, but are less than 16 mm long and have no posterior respiratory appendages. The head is wider than long and the rostrum is short and thick. The eyes of naucorids do not protrude from the sides of the head, and the femora of the forelegs are very broad.



FIGURE 47.
Naucoridae adult (A)
dorsal view and (B) ventral
view showing broad femora
of forelegs.
.....

Ecological notes

This water bug is widespread in shallow ponds with abundant vegetation on the Mambilla Plateau.

FAMILY **Nepidae** *water scorpions & needle bugs*

Water scorpions and needle bugs have long, rigid posterior breathing tubes, and their antennae are shorter than the head. They are ambush predators and poor swimmers. Two genera are found on the Plateau: *Nepa* and *Ranatra*. The water scorpion *Nepa* has a broad, rather leaf-like body, whereas the needle bug *Ranatra* has a stick-like body.

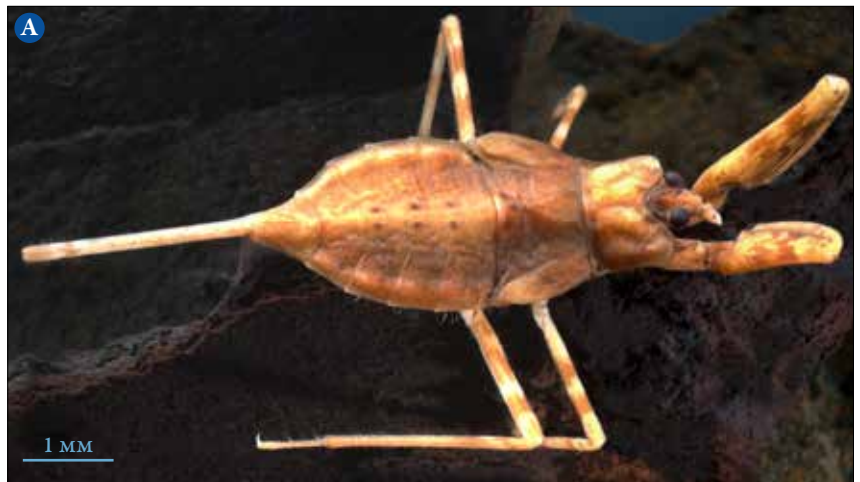


FIGURE 48.
Nepidae (water scorpion),
(A) dorsal view and (B)
head with compound eyes
and stylet.

.....



FIGURE 49.
Ranatra needle bug, (A)
dorsal view and (B) ventral
view.
.....

Ecological notes

Water scorpions superficially resemble the poisonous terrestrial one. The difference between the two is that the posterior siphon of a water scorpion is used for breathing not for stinging. Nepids are commonly found among debris in ponds and shallow waters in both forest and pasture streams on the Mambilla Plateau.

Ranatra seem to be more common among debris in ponds and shallow pasture streams which are open and have submerged grasses.

FAMILY **Gerridae** *water striders or pond skaters*

Water striders live on the surface of water where they feed on insects and other invertebrates that are trapped in the surface film. They have very long, narrow legs (femora of the hind legs are particularly long) and claws inserted before the tip of the tarsus.

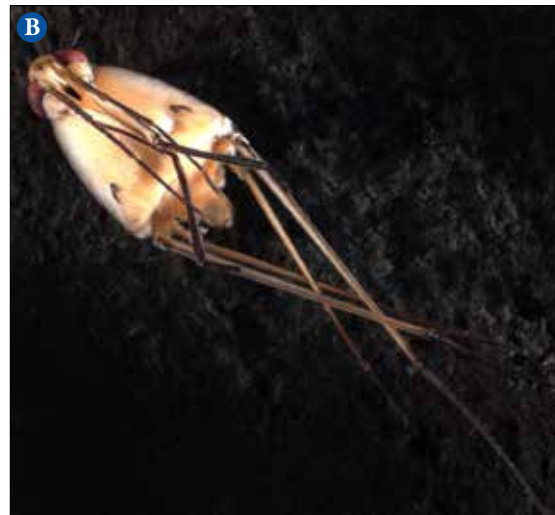


FIGURE 50.
Gerridae adult, (A) dorsal
view, (B) lateral view.
.....

Ecological notes

Gerridae inhabit quiet waters of streams and occasionally ponds, especially in pasture.

FAMILY **Veliidae** *small water striders*

Veliids resemble Gerrids but are smaller and have much shorter legs. They also live on the surface and have pre-apical tarsal claws. One genus of Veliidae found on the Mambilla plateau is *Rhagovelia*, distinguished by the plume of hair on the tarsi of the middle legs (Fig. 51A). Nymphs of *Rhagovelia* resemble the adults but lack the tarsal plumes. Other genera of subfamily Veliinae also occur in Nigeria.

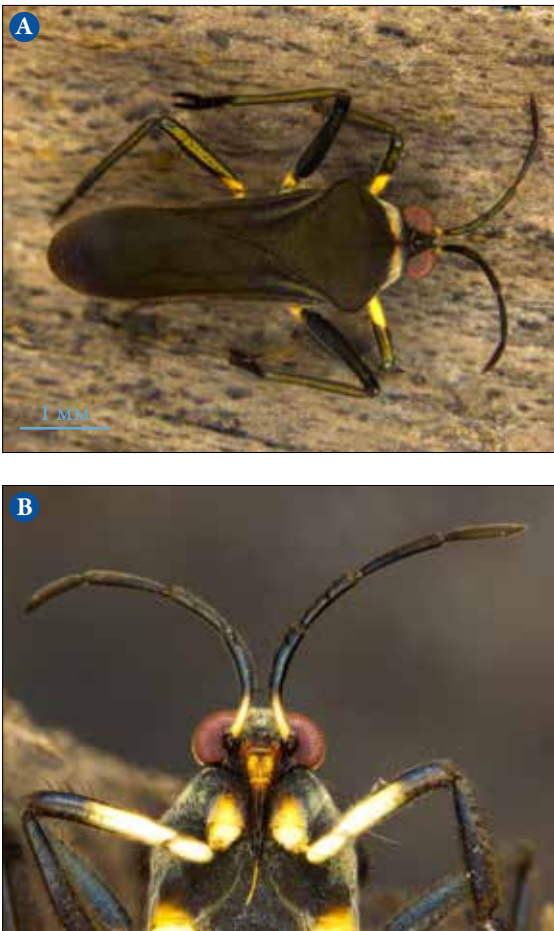


FIGURE 51.
Veliidae: *Rhagovelia* adult,
(A) dorsal view and (B)
head and antenna.
.....

Ecological notes

The water strider is found in large numbers at the surface of quiet waters of streams and occasionally ponds.

FAMILY **Hydrometridae** *water measurers*

Small stick-like insects with an elongate head and exceedingly slender legs. The antennae are longer than the head. The eyes are located about halfway along the head. Hydrometrids walk on the surface film of the water and on plants that project above the water.



FIGURE 52.
Hydrometra, dorsal view.

Ecological notes

Commonly found in the pasture streams, often along the margins or in pools, but very hard to spot, especially in streams with emerging or submerged grasses.

FAMILY *Corixidae* *water boatmen*

Water boatmen are dorso-ventrally flattened and have a short broad rostrum beneath the head. The forelegs are modified as “scoops”, the middle legs have a large terminal claw for grasping plants, and the hind legs are fringed with swimming hairs. Species found on the Mambilla Plateau belong to the tribe Corixini; and are 5–7 mm long.



FIGURE 53.
Corixidae adult, (A) dorsal view and (B) head (ventral) and scoop-like fore-tarsus.
.....

Ecological notes

Corixids inhabit ponds and deep pools of streams, frequently surfacing for air.

FAMILY **Notonectidae** *backswimmers*

Like corixids, backswimmers are strong swimmers. They are not dorso-ventrally flattened and swim ventral-side up using the long, fringed, hind legs as oars. They have a longer, more pointed rostrum than water boatmen and feed on other insects and small crustaceans.

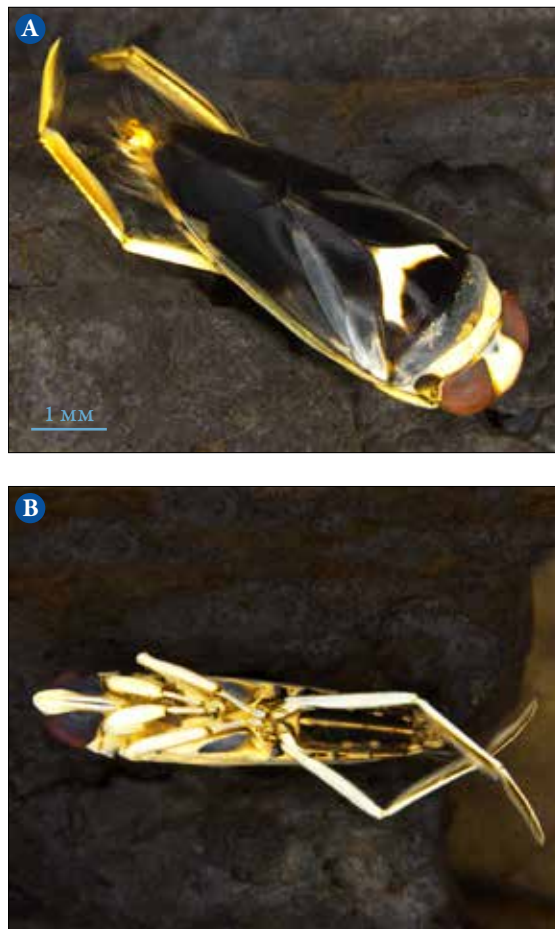


FIGURE 54.
Notonectidae adult, (A)
dorsal view and (B) ventral
view.
.....

Ecological notes

Backswimmers inhabit ponds and deep pools of streams, frequently surfacing for air.

FAMILY *Gelastocoridae* *toad bugs*

Toad bugs have short, broad bodies and are about 10 mm long. The head is wider than long and the prothorax even broader. The femora of the fore legs are very broad, and the tibio-tarsus ends in a point.

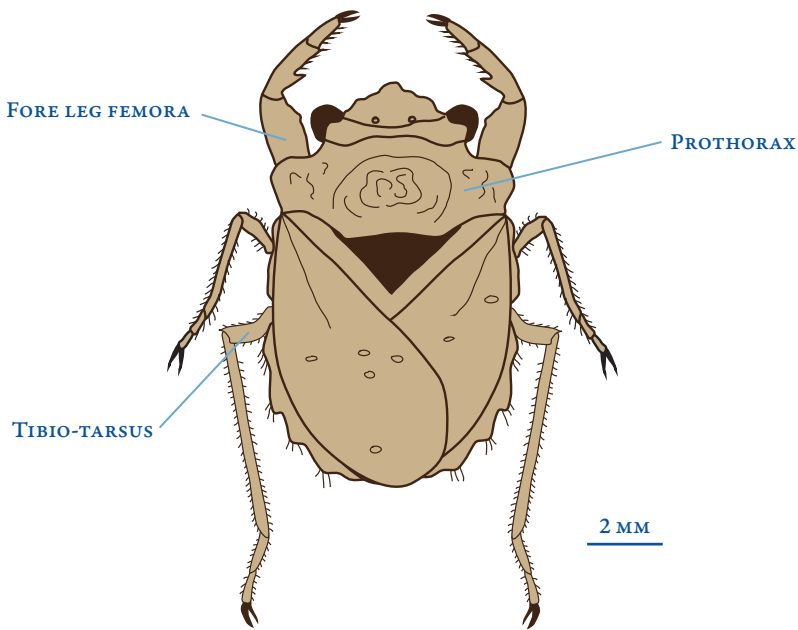


FIGURE 55.
Toad bug adult.

Ecological notes

Toad bugs are predators that live at the edges of water bodies but can crawl into the water. *Gelastocoridae* species occur on the ground and in the leaf litter in a variety of habitats, in both wet and dry sclerophyll forests and open heathland. They are considered to be semi-aquatic species as they occur in riparian and littoral areas of lentic water bodies or very slow flowing areas of rivers. They are found under stones and plant debris or burrowing into wet sand or mud.

ORDER

DIPTERA

COMMON NAME

TRUE FLIES

Larvae and sometimes pupae of dipterans are aquatic. They are a diverse group with many families represented. Because they have no thoracic legs, dipterans larvae can be distinguished from larvae of other aquatic insects. Though sometimes maggots have small prolegs or creeping welts many are maggot- or grub-like with mouth-hooks and no true head, whereas others have a well developed head.

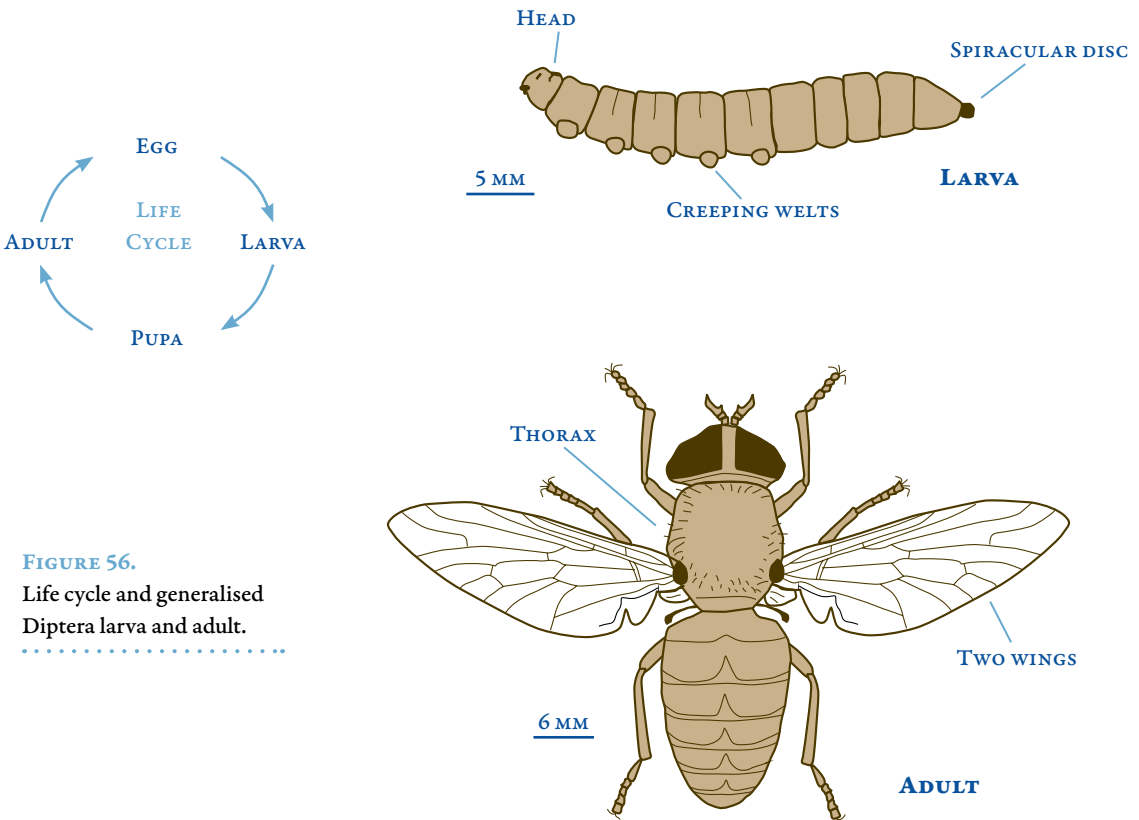


FIGURE 56.
Life cycle and generalised
Diptera larva and adult.

FAMILY Tipulidae *crane flies*

Tipulidae have a partially complete head that can be retracted into the thorax. A spiracular disc is variably present at the posterior end of the abdomen and may be surrounded by several lobes and long hairs. Some larvae have caterpillar-like creeping welts; their body length is up to 30 mm. Tipulids can be common in high, medium, or low quality water. The large larva shown in Fig. 57 belongs to the subfamily Tipulinae and may be a species of *Leptotarsus*. Other tipulids found on the Mambilla Plateau belong to the subfamily Limoniinae and include representatives of the tribe Hexatomini (Fig. 58).

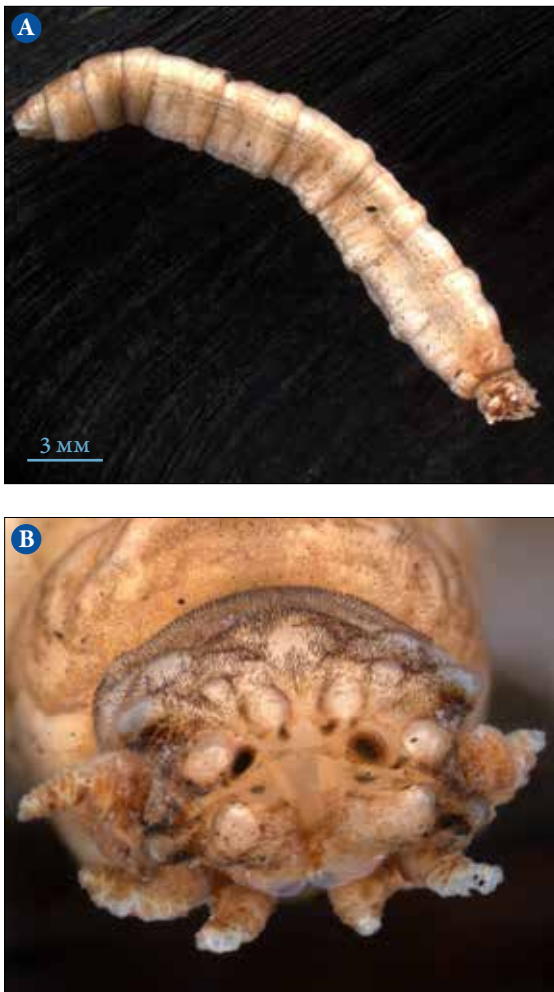


FIGURE 57.
Tipulinae: *Leptotarsus*
(A) larva and (B) spiracular
disc for breathing.





FIGURE 58.
Limoniinae: Hexatomini
(A) larvae and (B)
spiracular disc with the
4 lobes and dark circular
openings of the spiracles.
.....

Ecological notes

Tipulid larvae inhabit ponds and deep pools of streams. They are found in medium and low quality water and are tolerant of organic pollution.

FAMILY *Simuliidae* *black flies*

Black fly larvae are easily recognised by their unusual shape, they have a swollen abdomen, a relatively large head, and single thoracic prolegs. Labral fans that extend from the head are used for filter feeding while the larva remains attached to the substrate with tiny hooks. Body length is up to 5 mm. The genus found in Nigeria is *Simulium*.



FIGURE 59.
(A) *Simulium* larva,
showing labral fans and
swollen abdomen.

Ecological notes

The larvae and pupae inhabit running waters with rocky substrates. Larvae can be common in high, medium or low quality streams. The adult of the species *Simulium damnosum* is known as a blood sucker and vector of the parasitic nematode *Onchocerca volvulus*, which causes the disease onchocerciasis, also known as river blindness, in some parts of Nigeria, including the Mambilla Plateau.

FAMILY *Culicidae* *mosquitoes*

Larvae have a swollen thorax and a caudal breathing tube (siphon) the tip of the abdomen. Larvae are often called wrigglers because of their characteristic swimming motion. Pupae swim with a tumbling motion, and are often found with larvae. Body length is usually less than 4 mm.



FIGURE 60.
Culicidae mosquito larvae.

Ecological notes

Mosquito larvae prefer standing waters of streams or pools. On the Mambilla Plateau larvae of Culicidae are common in both the pasture and forest streams.

FAMILY **Chironomidae** *non-biting midges*

The small worm-like larvae have a distinct head and pairs of thoracic and posterior prolegs. Some larvae are bright red (especially in low oxygen environments) because of the presence of haemoglobin. Some larvae inhabit tubes that are attached to the substrate, whereas others are free-living and can crawl or swim with ‘thrashing’ motion. Body length is up to 20 mm, although most larvae are less than 10 mm. Chironomids are common in high, medium and low quality streams as well as still waters. Members of the sub-families Chironominae (genus *Chironomus*) and Tanytopodinae (tribe Pentaneurini) have been found on the Mambilla Plateau.



FIGURE 61.
Chironomidae larva
showing pairs of thoracic
and posterior prolegs.

Ecological notes

The chironomid larvae found on the Mambilla Plateau inhabit both forested and pasture streams, especially in slow running water with sandy substrates associated with aquatic macrophytes.

FAMILY **Ceratopogonidae** *biting midges*

Larvae found on the Plateau are thin worm-like insects with a dark bullet-like head. A rosette of fine hairs surrounds the posterior tip of the abdomen. Larvae swim in an eel-like manner and are assumed to be predatory.



FIGURE 62.
(A) Ceratopogonidae
and (B) Chironomidae:
Tanypodinae.
.....

Ecological notes

Ceratopogonidae larval gut analysis revealed the presence of animal parts. They are most commonly found in forest and river valley forest streams.

FAMILY *Syrphidae* *rat-tail maggots*

Rat-tail maggots may be 15–20 mm long and are broad and blunt anteriorly. They have a very long, posterior, extensible breathing tube (siphon). Syrphids often occur in heavily polluted waters.



FIGURE 63. Syrphidae (rat-tail maggot) with siphon and creeping welts.

Ecological notes

On the Mambilla Plateau the rat-tail maggot is most common in the pasture streams, especially in those that are highly polluted with livestock waste, associated with grazing land.

FAMILY Athericidae

Larvae have pairs of prolegs on the first seven abdominal segments. The eighth segment bears a single proleg and a pair of fringed dorsal projections. Larvae are predatory and feed on other insect larvae.



FIGURE 64.

Athericidae larva, with head to the left, creeping welts and breathing structures at posterior end (right side of photo).

Ecological notes

The larvae of Athericidae are small in size, and very common in polluted streams with poor water quality..

FAMILY **Psychodidae** *moth flies*

The thoracic and abdominal segments of most moth fly larvae have secondary annulations ('pseudo segmentation') and often dorsal plates on many of these annuli. Spiracles on the tips of the posterior projections are surrounded by hydrophobic hairs that keep the water out when breathing at the surface.



FIGURE 65.
Psychodidae larva.
.....

Ecological notes

Psychodidae larvae are often associated with polluted water.

SUB PHYLUM: CRUSTACEA

Crustaceans are a highly diverse group of arthropods with a hard exoskeleton and often numerous jointed appendages. They are distinguished by insects from having two pairs of antennae (the first pair often called antennules).

ORDER

DECAPODA

INFRAORDER

ASTACIDEA *CRAYFISH*

FAMILY *Astacidae*

Nigerian freshwater crayfish belong to the family Astacidae, and include the genera *Astacopsis*.

The first 3 pair of walking legs are chelate (have pincers), the first pair being large. Crayfish also have long, prominent antennae, a long straight abdomen, and a broad tail-fan. Body length is usually less than 150 mm. Crayfish are common in medium to high quality streams.



FIGURE 66.
Crayfish.

Ecological notes

Freshwater crayfish are omnivorous and live in high quality running water. On the Mambilla Plateau crayfish are abundant in the forested streams, but are also found in some fringing forest streams with medium grade water quality.

CARIDINA *SHRIMP*

Shrimps are strong swimmers with the body compressed laterally a little. The first two pairs of legs are chelate but neither pair is particularly large. Shrimps found on the Mambilla Plateau have tufts of hairs at the tips of the first two pairs of walking legs and therefore belongs to the family Atyidae.



FIGURE 67.
Atyidae (shrimp) Lateral
view.

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Ecological notes

On the Mambilla Plateau shrimps are widespread in streams with medium to high quality water.

INFRAORDER **BRACHYURA** *CRABS*

Crabs are dorso-ventrally flattened with a large hard carapace covering the body except the head. The first pair of legs has a large chela. The abdomen is short and folded beneath the carapace-covered thorax so it cannot be seen from above. Eyes are on stalks and the antennae are very short. The principal family of freshwater crabs in Nigeria is the Potamonautidae, which has 80 species in 11 genera. Crabs are common in slow-flowing streams and some Nigerian species occur in forested areas (Dobson 2004).

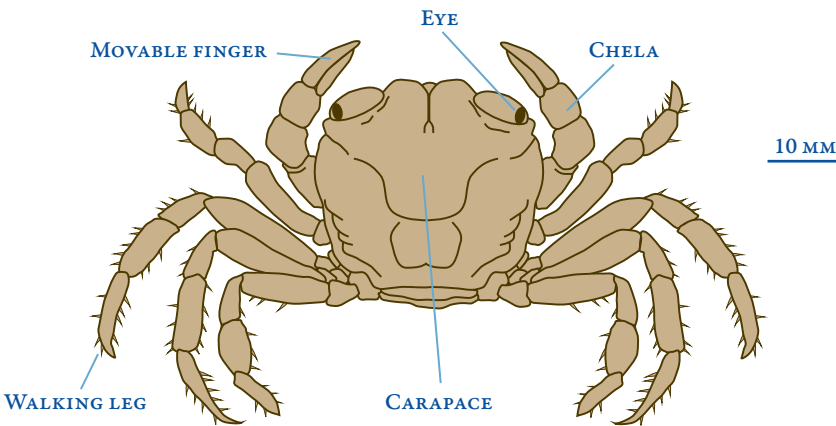


FIGURE 68.
Freshwater crab.



FIGURE 69.
Brachyura:
Potamonautidae (crab).

FIGURE 70.
Brachyura:
Potamonautidae (crab).

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FIGURE 71.
Forest streams with rocky
bottom; good habitat for
crabs.

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Ecological notes

On the Mambilla Plateau crabs are found mostly in the forest and forest fragments, beneath woody substrates, in leaf packs and amongst sand or gravels. Leaf materials were the major food items found in their guts, indicating their role as shredders.

VARIOUS Smaller crustaceans

Several groups of small crustaceans are found in Nigerian streams. They include Amphipoda (hoppers), Isopoda (woodlice and their allies), Copepoda, Cladocera (water fleas) and Ostracoda (seed shrimps). Amphipoda and Isopoda are the largest of these groups and are laterally compressed and dorso-ventrally compressed, respectively. They are common in slow-flowing streams. Most copepods, cladocerans and ostracods are very small (less than 2 mm long) and occur only in lakes, ponds and other still waters. Copepods and cladocerans are mainly planktonic.

ORDER Tricladida *flatworms*

Flatworms are very common in freshwater but are often overlooked because of their small size (generally less than 6 mm long) and drab appearance. They are usually dark coloured and elongate oval in shape. Flatworms have a rudimentary head with a pair of visible eyes. They move with a gliding motion, and can be common in high, medium, and low quality streams.



FIGURE 72.
Tricladida (flatworm).

Ecological notes

Flatworms slide over the stream bed to feed on dead animals or hunt soft-bodied animals, which may be swallowed whole. They respire by the diffusion of air directly through the skin. Should it get cut up, the severed parts of some can grow into new individuals.

SUB-CLASS Hirudinea

Leeches have long very stretchable bodies with suckers at both ends. They move with the help of the suckers, and by extending the body. The body colour of leeches can be grey, brown or green.

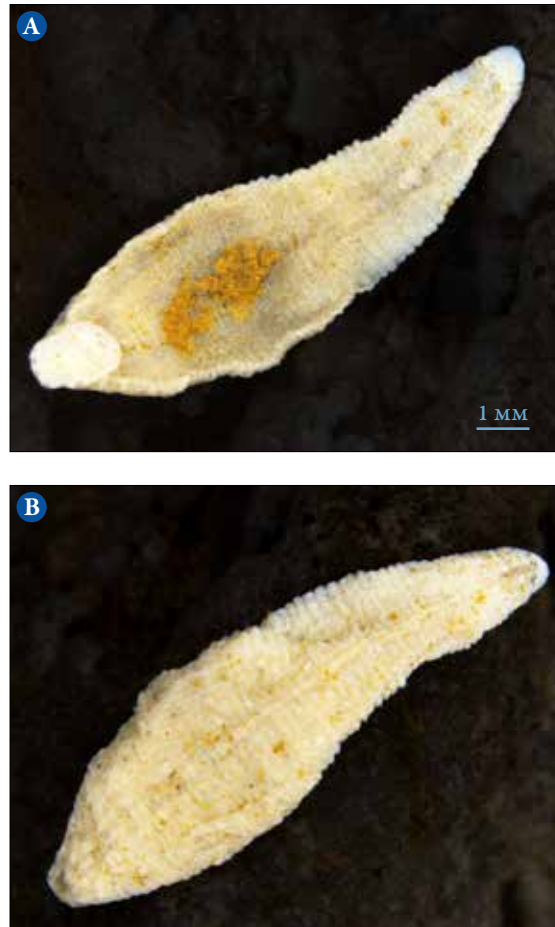


FIGURE 73.

Leech (A) ventral view and (B), dorsal view.

Ecological notes

Leeches live on the stream bed preferring soft silt or hiding between stones. Some suck the blood of fish or frogs, whereas others feed on small animals such as worms, molluscs, or fly larvae. Some leeches can eat more than their own body weight in one meal. They move in an undulating manner, and body size is typically 10–60 mm.

CLASS Oligochaeta

Oligochaetes are segmented worms with 4 sets of chaetae on each segment (visible only with a microscope). Aquatic species resemble small earthworms but most are in different families. The most common family is the Naididae (which now includes Tubificidae). They frequently colonise soft sediments and may be very abundant in poor quality, polluted waters.

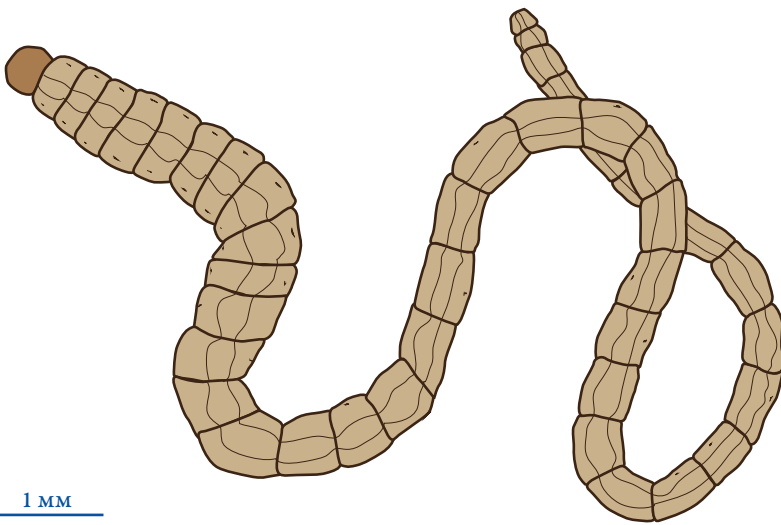


FIGURE 74.
Generalised segmented
worm.

MOLLUSCA

Freshwater molluscs have one or two shells (valves) and no legs. The class Gastropoda contains the species that live in a single shell; the class Bivalvia, those with two valves. Some species have the ability to tolerate a wide range of osmotic pressures and salinities and are described as euryhaline (Winterbourn, 1973).

Gastropod families known from Nigerian freshwaters include Lymnaeidae, Planorbidae, Physidae, Ampullariidae and Thiaridae. The large conical species (Fig. 75) is the thiarid *Melanooides tuberculatus*, an introduced species that is now widespread and abundant in many parts of the world. The upper whorls of the shell have a trellis pattern of crossing spirals and transverse ridges and are brown in colour, although adults can have black incrustations, and an eroded apex. The shell grows up to 38 mm high. The globular species (Fig. 76) is the planorbid *Bulinus globosus* which is widespread in many freshwater systems in Nigeria. Its shell is up to 5 mm in height and is a brown-yellow colour. *B. globosus* is known to be an intermediate host of the trematode *Schistosoma mansoni*, the cause of the human parasitic disease schistosomiasis.

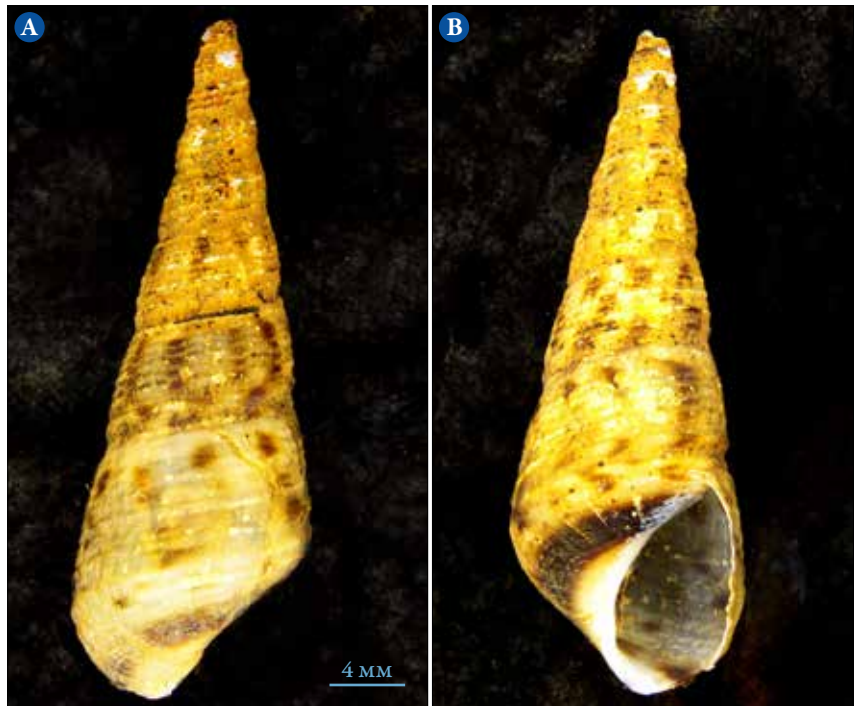


FIGURE 75.
 (A) *Melanooides tuberculatus*
 and (B) the aperture mouth
 and columella area.

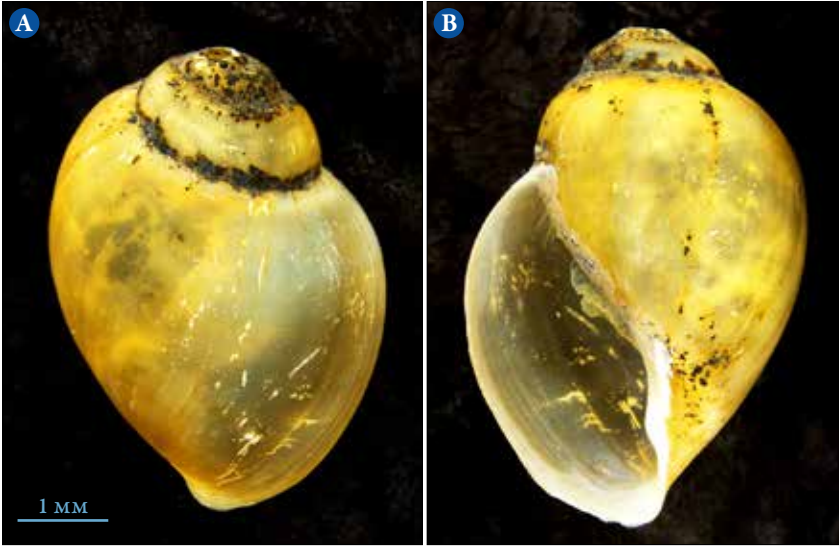


FIGURE 76.
(A) *Bulinus globosus*,
showing body whorl and
globe-like shape and (B)
aperture.

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Ecological notes

Melanoides tuberculatus is widely distributed in ditches, ponds, rivers and streams (Haynes, 1984). On the Mambilla Plateau it is commonly found at the agricultural sites, e.g. maize and tea streams. In these streams, algae are common and provide food. The presence of macrophytes provides protection from being washed away by water currents.

On the Mambilla Plateau *Bulinus globosus* is found mainly in agricultural streams with very low quality water e.g. cabbage, maize and grazing streams.

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GLOSSARY

- Anal claw** – a claw on the posterior segments of the abdomen (often in caddisfly larvae).
- Annulations** – rings
- Antenna(e)** – sensory structure usually at the most anterior part of the head.
- Anterior** – the front of head of the body
- Bifid** – divided in two, e.g. two gill plates joined together
- Carapace** – the hard shell (exoskeleton) in crabs
- Caudal lamella** – plate-like projections at the end of the abdomen, as in a damselfly larvae
- Cerci** – tail projections or filaments
- Chelate** – claw-like or pincer-like
- Dorsal surface** – upper or top surface
- Elytra** – the hard wing covers of an adult beetle.
- Euryhaline** – tolerant of saline water
- Exoskeleton** – the outer sclerotized plates (or cuticle) that protect aquatic insects.
- Femur** – the 3rd segment of the leg
- Filamentous** – long and thin.
- Hemimetabolous** – with incomplete or partial metamorphosis from larva to adult. Not involving a pupal stage.
- Holometabolous** – with complete metamorphosis from larva to pupa to adult.
- Hydrophobic** – water repelling
- Labral fans** – labral mouth parts seen in blackfly larvae to enable filter-feeding of fine particles from the water column.
- Labium** – the “lower” lip.
- Labrum** – the “upper” lip. A mouthpart associated with the labium, maxilla and mandibles
- Larva(e)** – the juvenile stage of an aquatic insect that has a holometabolous life cycle.
- Lateral** – side
- Lentic water** – standing water, e.g. a pond or lake
- Littoral** – the shallow sides of a stream, pond or lake.
- Mandibles** – the jaws or equivalent mouth parts
- Maxillae** – a lateral pair of mouthparts
- Medial** – in the middle (of the body)
- Metasternum** – the plate on the ventral (under) surface of the metathorax.
- Nymph** – the juvenile stage of an aquatic insect that has a hemimetabolous life cycle.
- Operculum** – a plate or “trapdoor lid” in molluscs that seals the opening of the shell
- Pronotum** – the first dorsal plate on the (pro)thorax or “chest” segment. It sits directly behind the head.
- Pupa** – an intermediate life stage where the insect changes from larva to a winged adult. Pupation is the act of turning into a pupa.
- Rostrum** – a forward extension of the carapace at the front of the head, usually in Crustacea
- Sclerotized** – hardened
- Setae** – hairs, often sensory
- Spiracular disc** – a breathing structure with openings for tracheae found in aquatic flies
- Tarsi (us)** – The last segments of legs. The last tarsal often ends in a claw.
- Thorax** – the body segment between the head and the abdomen. In insects the legs and wings are attached to this segment. The thorax consists of three segments; the prothorax, mesothorax and metathorax.
- Tibia** – the 4th leg segment, between the femur and tarsus.
- Trochantin** – a plate often found next to the base of the leg in caddisfly larvae.
- Valves** – the two shells of a mussel or clam



In this book we present an illustrated guide to the most common benthic stream invertebrates found in tropical highland streams on the Mambilla Plateau in Nigeria. They include Crustacea and insects in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), Trichoptera (caddisflies), Odonata (dragonflies), Coleoptera (beetles), Hemiptera (true bugs) and Diptera (true flies).

This photographic guide book is an attempt to assist students and researchers in the field to identify some of the common freshwater benthic invertebrates of Mambilla Plateau. It is not a comprehensive guide to all the animals you might collect. Due to the lack of any existing guide for freshwater invertebrates on the Plateau we anticipate that this will become an essential field tool for students and researchers.