INTEGRATION OF FRESHWATER BIODIVERSITY INTO THE AFRICAN DEVELOPMENT PROCESS:
MOBILIZATION OF INFORMATION AND DEMONSTRATION SITES

Demonstration Project of Gambia River Basin

Training of Trainers Module on

The Monitoring of ODONATA

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September 2010
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INTRODUCTION

Wetlands represent essential biological diversity, on which is the basis of the production of primary ecological resources and services that makes them an exceptionally valuable natural heritage.

The Gambia River Basin, is shared by the republics of Guinea, Guinea-Bissau, The Gambia, and Senegal, is a wetland zone of important socio-cultural, economic, and biological function. To fully benefit from the basin, these countries have established The Gambia River Basin Development Organization (OMVG). The OMVG is reviewing, among other projects, the building of a dam on the Gambia River to solve specific development problems, notably those linked to agriculture and energy.

It is however, understood these types of projects, despite their importance for socio-economic development, have adverse impacts on biodiversity and, therefore, on the functioning of wetland ecosystems and their capacity for producing ecological resources and services. It is therefore appropriate to take this aspect into consideration to mitigate the negative effects.

A certain number of taxa are targeted for follow-up purposes within the basin. Among those taxa, are odonates that have heritage importance, but also a practical significance due to the role they play both as essential elements in the structure and function of ecosystems and as bioindicators of the quality of wetlands. The importance of their role as bioindicators has earned them the name of environmental thermometer (Carle, 1979) and the guardians of the critical line (Clausnitzer & Jödicke, 2004).

The overall objective of the follow-up is to avert the possible threats looming over these heritage species and ecosystems, with the construction of the dam and the establishment of hydroelectric and agricultural facilities.

Regarding odonates, the issue will be to study the evolution of the diversity of indigenous species (odonatologic spectrum), odonatologic larvae productivity (reproduction rate) and the proliferation of populations within the selected sites in order to detect possible perturbations.
GOALS AND OBJECTIVES OF THE MODULE

To successfully carry out monitoring in an area as vast as the Gambia River Basin, many people with basic knowledge of odonates and the techniques related to their study are needed.

The objective of the module is therefore to impart the knowledge and know how needed to the trainers who will then be entrusted in turn with the responsibility of selecting people to ensure the monitoring of Odonata in the field.

CONTENU DU MODULE

For a better understanding of the systematic terminology, the course will start with a brief summary of the scientific classification of the living world and some generalities on insects. Then, there will be a reminder of the bioecology and systematics of odonates. To finish the study, the methodology to be used will be addressed.
The module hinges on 5 points: Generalities, Order Odonata, the study methodology, field study and General Discussion and Assessment.

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TRAINING NEEDS

The trainer needs:

1) A video projector and a computer
2) Training schedule
3) Entomologic material (see list of participants needs)

Before the start of the training, the participants should have:

1. Course materials
   2. An evaluation questionnaire (for the end of the training)

For the field, they will need:

1) A means of transportation (4-wheel vehicle)
2) Capture tools, handling and conditioning of samples
3) Performance digital cameras (at least one per group)

EXPECTED RESULTS

At the end of the course, the participants should be able to:

- Understand the classification system and nomenclature of living organisms for a better understanding of the hierarchy of taxa used in taxonomy.
- Know the systematized position of Odonates within the phylum of Arthropods and the Class of Insects.
- Distinguish Odonates (larvae and adults) from other insects.
- Know the broad features of the systematics, biology and ecology of Odonates and their importance.
- Know the parameters of the monitoring of Odonates and the methodology (material and methods) to use.
I. GENERALITIES

1. CLASSIFICATION OF THE LIVING WORLD

Man has always named the plants and animals surrounding him.

*Examples:*

- Cows
- Dogs
- Pigeons

Species of greater importance (food, economy, security...) are given different age- and sex-based names.

*Example:*

- Horse, mare, colt, stallion, gelding
- sheep, ewe, ram, lamb
- lion, lioness, lion cub

Other species are singly named:

- warthog
- hyena

There are other instances where a name is used to designate several species that are more or less closely related:
To find one’s bearings, to understand each other, a nomenclature and a classification system with universal rules were needed: the starting point of the nomenclature and classification system of living organisms being the 10th edition of Linné’s *Systema naturae*. The vast majority of species remained unnamed.

1.1. DÉFINITIONS

**Systematics**: the study of the classification of living organisms.

**Taxonomy**, or **Taxinomy**, is the science of naming things (nomenclature).

A taxon (plural taxons or taxa) is a common scientific name that can be used to designate a group of living organisms.


1.2. HIERARCHY OF TERMS

Living organisms are divided into two **Kingdoms**:

- the Animal Kingdom
- the Plant Kingdom

Each kingdom is divided into **Branches** or **Phyla** (singular: Phylum). Examples:

- the Arthropod phylum
✓ the Chordate phylum

Each phylum has **Classes**. Branches of arthropods include:

✓ the Arachnid class,

✓ the Crustacean class,

✓ the Myriapod class,

✓ the Insect class.

Classes are composed of **Orders**. In the Insect class, for instance, there are the following orders:

✓ Lepidopterans

✓ Dipterans

✓ Odonates

Each Order is divided into **Families**. Within the Odonates, for example, there are, among others:

✓ The Lestidae

✓ The Libellulidae

✓ The Aesnidae

Each Family is divided into **Genera** and each **Genus** is subdivided into **Species**. For example:

✓ Hominidae

  - Genus: *Homo*; species: *sapiens*

✓ Muscidae

  - Genus: *Musca*; species: *domestica*
2. THE ARTHROPODS PHYLUM

Arthropods (fig.1 : a, b, c, d) are animals with:

✓ Jointed articulated legs (literal meaning of arthropods);

✓ Metamerized or segmented bodies (succession of inter-related segments); and

✓ Without internal skeletons. Their bodies are covered with a semi-rigid cuticle secreted by the epidermis and which imposes on them ‘periodic’ growth through molting.

As the most important phylum in the animal kingdom, arthropods represent 80% of the known fauna (about 1,500,000 species). They are found in all kinds of habitats (water, land, air, living organisms). They are found in various biotopes and live under all climates and at all altitudes.

The Arthropod phylum is composed of the following classes:

✓ The Arachnids (Spiders, Scorpions, Acarians…)

✓ The Crustaceans (Crayfish, Shrimp, Lobsters, Crabs, Wood lice)

✓ The Myriapods or millipedes (Iules, Scolopendrids…)

✓ The Insects (Cockroaches, Termites, Butterflies, Dragonflies...)

The Phylum is defined on the basis of the type of organization and species by interfertility.
Figure 1. - Type of Arthropods: a. Arachnid (Spider), b. Myriapod (Iule), C. Crustacean (Crayfish), D. Insect (Locust)

3. Insect Class

Insects are characterized by the possession of a pair of antennae and 3 pairs of legs. The primitive insects (Collembola, Protura, Diplura and Thysanura) are wingless. Evolved insects are normally winged. They have two pairs of wings, except the dipterans (flies and mosquitoes) that have one pair of wings, the second pair having regressed.
3.1. THE DIFFERENT ORDERS OF INSECTS

3.1.1. APTERYGOT INSECTS

Collembolla Order

Protura Order

Diplura Order

Thysanura Order

3.1.2. PTERYGOT INSECTS (WINGS)

Ephemeroptera Order (Ephemeridae)

Order Odonata (Dragonflies s. l.)

Order Dictyoptera (Cockroaches and Mantis)

Order Isoptera (=Termites)

Order Plecoptera (Beads)

Order Cheleutoptera or Phasmoptera (Phasms)

Order Orthoptera (Crickets, Grasshoppers, Locusts)

Order Dermaptera (Forficula)

Order Psocoptera (Woodlice or Booklice)

Order Mallophagi (Birdlice)

Order Anoplura (Lice)

Order Thysanoptera (Thrips)

Order Heteroptera (Bugs)
Order Homoptera (Cicadas, aphids, Cocheanil insects)

Order Coleoptera (Tenebrionidae, Beetles, Carabidae, Chrysomelidae, Curculionids…)

Order Nevroptera or Planipennes Order (Antlions, Chrysops,)

Attention: Do not confuse with Odonata!

Order Lepidoptera (Butterflies)

Order Diptera (Flies, Mosquitoes)

Order Siphonapera (Fleas)

Order Hymenoptera (Bees, Ants, Wasps)
II. ODONATA ORDERS

1. MORPHOLOGY

Just as with other insects, the bodies of Odonata are composed of 3 parts:

- The head bearing the antennae, the eyes, and ocelli
- The thorax with the legs (3 pairs) and the wings (2 pairs)
- The abdomen.

1.1. ADULTS

Zygoptera (fig. 2) are often small and slender, reason for which they are called *damselflies*. Their eyes are neatly separated and relegated to the far lateral sides of their heads. The abdomen is always thin and sometimes long. At rest, the wings are vertically placed atop their bodies. They fly slowly and softly.

![Figure 2.- Genus Zygoptera (*Agriocnemis*)](image)

Figure 2.- Genus Zygoptera (*Agriocnemis*)
Anisoptera or Dragonflies (Fig. 3) include small to large size Odonata. Their spheroid heads bear bulging and massive eyes. The abdomen is stretched and often widened. In many cases, they fly swiftly and vigorously. At rest, the wings remain horizontally spread.

![Image of Anisoptera](image)

**Fig. 3. – Genus Anisoptera (Crocothemis)**

**Head**

With Odonata, Zygoptera and Anisoptera, the head is always larger than the thorax. With Zygoptera (Fig. 4) and Anisoptera of the Gomphidae family, the eyes are distantly set. With all the remaining African Anisoptera, the eyes are closer to each other (Fig. 5). In addition to their composite eyes, Odonata have three triangle-shaped frontal ocelli.

![Image of Zygoptera Head](image)
![Image of Anisoptera Head](image)

**Fig. 4. – Zygoptera Head**  **Fig. 5. – Anisoptera Head**

**Thorax**
Instead of the usual 3 parts (prothorax, mesothorax and metathorax), With Odonata the thorax is subdivided in two unequal parts: the prothorax (1st segment at the front) followed by a voluminous synthorax derived from the combination of the mesothorax and the metathorax.

The thorax bears three (3) pairs of legs and two (2) pairs of wings. The legs that are all forward oriented, are short and thorny. The 2 pairs of wings have the same length but their shapes can be different.

The innervation of the wings is an important differentiating criterion for the identification of the various species.

**Abdomen**

The abdomen of Odonata is composed of 11 segments the last of which is rudimentary. It is roughly cylindric as with Zygoptera and many Anisoptera. The last segments can have a larger diameter (*Corduliidae*) or present a development of lateral foliated layer expansions (with certain *Gomphidae*). It is more distinctly triangular in shape with *Libellulidae*. It is of a greater flexibility that facilitates copulation. The sex differentiation is more distinct at the level of the abdomen.

### 2.2. Larvae

Larvae and adult insects have the same organizational structure. However, larvae have a rather bulky silhouette and wear a mask (Fig. 6b), a characteristic formed by the labium (lower lip); they also have a cryptic (mimetic) coloration, which is an adaptation to their habitat and their food pattern.
Attention: Do not confuse with Ephemeroptera (Fig. 7a) and Beads (Fig. 7b) larvae (Plecoptera)

The legs are overall shorter and more robust than those of adult insects. The relative length and the shape of legs vary according to the larvae ethology (habits).

The legs of the Gomphidae are shorter and more massive. The marchers have longer legs. Among the marchers, the Corduliidae have the longest legs. The size and thinness of their legs give the larvae of this family an arachnoid look (spider resemblance). Rupicole larvae found in rapids areas and belonging to the Zygonyx genus (*Libellulidae*), present a flattening of all their legs.

2. BIOECOLOGY

It is now difficult to trace the broad specificities of the biology of African Odonata. The gist of studies done on them is mainly related to systematics and faunistics.

The larvae are aquatic in their vast majority and adult insects are terrestrial. Odonata are predators at all levels of their life cycle.

2.1. DEVELOPMENT CYCLE

Odonata develop through an incomplete metamorphosis (3 stages: egg, larvae, adulthood).
The eggs are relatively small compared to the adult size. Small-sized species lay about a few hundred eggs. As for large-sized species, the number of eggs laid at one time can reach the thousands. The Zygoptera and Aeshnidae (Anisoptera) females have an ovipositor that enables them to lay their eggs within the tissues of aquatic plants. With other Anisoptera that do not have ovipositor, the eggs are laid directly in water.

A few days to a few weeks after laying, the egg hatches and frees a shrouded larva called a pro-larva (phase 1). After a few minutes, the pro-larva leaves its envelope and becomes a free larva (phase 2). After 9 to 16 growth molts, 12 on average, the last phase of the larva phase is reached. It is often qualified as the nymph stage and the larva is the last nymphal stage. Depending on species, larvae:

✓ Climb and live on aquatic plants (Zygoptera, Aesnidae)

✓ Crawl and remain partially buried underwater (Corduliidae)

✓ Dig and live within their habitat sediments (Gomphidae)

The duration of the larva development (from the pro-larva stage to the last phase) varies from a few months to about five (5) years.

The last-stage larva stop feeding and get out of water. They cling to a stalk or to the ground for its transformation into an adult insect called imago. The imago bursts out of the exuviae (larval envelope) that is torn along a longitudinal slot (Fig. 8). The exuviae remains solidly stuck to the stalk or to the ground. The imago is first of all soft and vulnerable. After the hardening of its body and the spread of its wings, it can fly. The water-to-air transition can take about twenty minutes or even a few days.
The newly emerged imago is sexually immature. It the goes through a sexual maturation period that varies according the various species. Sexual maturity is generally achieved in 10-15 days but it can take longer with certain species. During their maturation period, small species remain near aquatic habitats. With larger species, the maturation is often carried out away from water. They can be found in open spaces, in clearings, near forests, hunting or enjoying sunshine.

Maturation is morphologically characterized by the acquisition of their definitive colour, which is generally brighter. At the ethological level, it is marked by the return to their original habitat for reproduction purposes. With many species, the males are territorial and possessive. They fly over their territories searching for partners, easy prey or hunting intruders.

With Odonata, copulation is peculiar. The male grabs the female from behind the head with hooks at the end of its abdomen. The two mating partners fly in tandem. The sperm is transferred from the seminal hole at the 8th abdominal segment, towards a small reservoir next to reproductive organs under the 2nd abdominal segment. Next the female moves her abdominal extremity under the 2nd abdominal segment of the male for the reception of the sperm. The two partners thus form what is called a “copulatory heart” (Fig. 9). With most species, during copulation, males and females are stationed. A rapid flight copulation that lasts a few minutes is observed with certain types of Libellulidae.
Often in tandem with males, females lay their eggs directly into water (Libelluloidea, Gomphidae) or on stalks of floating, submerged, surface, or above water plants. This kind of egg laying called endophyte is practiced by odonata with performing ovipositors (Zygoptera and Aesnidae).

2.2. HABITATS

Based on current knowledge and given the ethological difference between larvae (aquatic) and adult insects (terrestrial), it is difficult to classify Tropical African Odonata by their habitats. With some Odonata, namely the Anisoptera, after their emergence, adults go away from the water during their sexual maturation phase. They only revert to their original habitat for reproduction purposes. It must be noted that some migrating species can find themselves far from their place of birth.

Larvae can be found in various aquatic habitats. They seldom leave fresh water. Only two African species, the Ischnura senegalensis and the Hemianax ephippiger, known for their salinity tolerance, can develop in brackish waters.

Larvae grow in stagnant or flowing water of various sizes and shapes:

**STILL OR STAGNANT WATERS**

- Shallow ponds with plants growth
• Ponds or open marsh

• Forest ponds that are often situated in closed habitats (shady)

• Mountain Lakes

**FLOWING WATER**

• Slow-current streams and rivers;

• Calm sides of big rivers;

• Streams and white water rivers with irregular flow and running on bedrock, gravel or plant-free sand, particularly near rivers in calm areas.

There is certain stratification in the distribution of larvae in their biotope. The “climbing” larvae of Zygoptera, *Aeshnidae* and some *Libellulidae* occupy the top stratum in the grass or along the shores. Those larvae come from the eggs laid by endophytes (eggs laid on plant stalks). The “walkers” move at the bottom or among the rough sedimented debris (*Libellulidae* and *Corduliidae*). The superficial burrowing larvae (of *Libellulidae* and *Gomphidae*) are more particularly limited to thin sediments (clayey, silty, organic or mixt). The deep-burrowers or real burrowers (some *Gomphidae*) are found at the bottom layers of the rough sandy shores of waterways.

The vast majority adult Odonata are terrestrial and heliophile (active during the sunny hours). After emerging, they gather in prairies, wood edges and forest clearings near water points. The imagos of certain species, large-sized species that are well adapted for long-distance flights, can often be found far away from waters.

Examples of biotopes in the Gambia River are given in figure 10.
Fig. 10. – Some biotopes accommodating Odonata on the Gambia river (a, b, c: Sambangalou site; d : Simenti in the national Park of Niokolo Koba).
3. SYSTEMATICS

Odonata are a very old Order of Insects. Fossil dragonflies dating back to the Carboniferous Period (- 300 million years ago) have been discovered.

The Order comprises about 6,000 species throughout the world. The species are split into three sub-orders: **Zygoptera**, **Anisozygoptera** and **Anisoptera**. Only Zygoptera and Anisoptera have African representatives with about 700 known species.

Within the Gambia River Basin, 114 species have been inventoried. Zygoptera are represented by 6 families versus 4 for Anisoptera.
THE DIFFERENT ODONATA FAMILIES IN THE GAMBIA RIVER BASIN

ZYGOPTERA

Calopterygidae

They are large-sized Zygoptera with a metallic reflective colour. Their wings do not present petioles at their bases and they always have 18 antenodal nerve nets. Egg laying is endophyte-dependent.

The larva is thin. The first antenna segment is longer than all the other segments put together. It is the only family with the front parts of their masks opening on to a light («hole».

Chlorocyphidae

They are medium to small-sized and have a short and broadened abdomen. Their wings are narrow and present petioles that are often coloured («metallic» colours).

Lestidae

Medium-sized, the wings have petioles, are narrow and transparent, always with two antenodal nerve nets, just like Plactycnemidae and the Coenagrionidae.

The first antenna extension of larvae is not very different from other antenna extensions. The very long and petioled mask of Lestidae has two profoundly split labial palps, which differentiate them from Platycnemidae and Coenagrionidae.

Protoneuridae

This family includes tropical species. Their wings are petioled and hyaline with no anal nerve net.

Platycnemidae

They are small-sized and have a clear colour. They are broad-headed and present a marked dilatation of the tibias and median and hind legs, especially in males.
The wings are petioled, narrow, and transparent; they also present 2 ante-nodal nerve nets. The Pterostigma is adjoining a single nerve net.

Larvae are small to medium-sized. They present filament-ended caudal gills.

**Coenagrionidae**

It is the largest family of Zygoptera. They are small to medium-sized. The males are blue, green or red in colour depending on the various species. The females are rather dusky.

Larvae are small to medium-sized. The caudal gills have rounded ends but never present filament ends. The masks are quite compact and have less split labial palps, compared to those of Lestidae.

**Anisoptera**

**Aeshnidae**

They are large to very large-sized and have enormous eyes, the most developed of all dragonflies. When maturing, they can be very far from aquatic habitats (generally stagnant waters). The males are territorial. Egg laying is endophytic.

The larvae that are generally long in shape, have flat masks. The antennae have 6 to 7 articles.

**Gomphidae**

Medium-sized, Gomphidae have widely separated eyes. They live in flowing waters. They lay their eggs in the sediments.

The larvae that are short-legged and dorso-ventrally flat, are a little shorter than those of Aeshnidae. They have 4 different antenna extremities whereas the other Anisoptera have 6 to 7 similar antenna extensions.

**Corduliidae**
Medium to large-sized, they are light-green in colour, often black and some with poorly defined yellow spots. The females do not have ovipositors. Their widely adjoined eyes are indented in their lateral contours.

The medium-sized larva has an abdomen with medidorsal thorns and, on segments 8 and 9, lateral thorns. They have broad legs. Their masks are spoon-shaped. The lower contour of the labial palps is marked by irregular and pronounced indentations.

**Libellulidae**

They are a large family. Species are small to medium-sized. The back of their eyes are subrectilinear or slightly undulated but never with a marked indentation. The males are brown, blue or red in colour, depending on the various species. The females are generally drab; they do not have ovipositors and their eggs are laid on the water or upon contact.

The larvae are small to medium-sized and have mediadorsal and lateral thorns on segments 8 and 9 just like Corduliidae. The legs are shorter than those of Corduliidae.

### 4. IMPORTANCE OF ODONATES

#### 4.1 PATRIMONIAL INTEREST

Having appeared 300 million years ago, Odonata are today threatened in many wetlands throughout the world. Independently from the important roles they play in the development of wetlands, they deserve protection because of their status as local, regional, national or global heritage. Without protection, many species will swiftly disappear in most areas as a result of anthropic impact.

At the level of the Gambia River Bassin, a lack of information prevents the determination of the real status of most species. However, one can note that some species deserve protection
because of their weak distribution and/or small numbers; those species are: *Elattoneura pluotae*, *Mesocnemis dupuyi*, *Pseudagrion epiphonematicum*.

### 4.2. TROPHIC NETWORK

Odonata have an important place in the trophic network of wetlands as prey, but also and above all as predators. The impact of larvae is however more significant than that of adult odonata in the development of wet ecosystems.

**Odonata as prey**

Odonata larvae are the prey of Batrachians, fish and young crocodiles…

Adult odonata are hunted by Spiders, Ants, Birds (bee eaters)… large-size species can prey on small-sized species.

**Odonata as predators**

Odonata feed daily to up to 10-15% of their weight, which could correspond to about 300 mosquitoes and other small insects.

The larvae are carnivorous and occasionally cannibals. They hunt by hiding and capturing their prey with their teethed masks (labia or lower lips). The youngest feed on unicellular animals before hunting, and later, small crustaceans, worms, and aquatic insects of all sorts. The oldest larvae feed on isopods, amphipods, tadpoles, and baby fish. Very opportunistic, they adapt their catch to species richness-habitat relationships. One can note a stratification of predation according to size, capture means (mask shapes) and accessibility of prey (habitats).

Adult odonata feed on small flying insects (mainly Diptera). Large-sized anisoptera (*Aeshnidae et Libellulidae*) can eat Zygoptera. The adults of dusk-flying species prey on swarms of Culicidae (mosquitoes).
4.3. BIOINDICATORS

The different species underlying the production of ecological resources and services of an ecosystem are dependent on physical, chemical, hydrological and biological factors. Any modification of those factors will impact on the species, some of whom are highly sensitive and can help detect perturbations (pollution, habitat modification, climate change, ...). The species are called bioindicators, because they inform on the health status of habitats. The larva phases of Odonata that are very sensitive to the conditions prevailing in their living environment, directly undergo the modifications of the biotic and abiotic parameters of wet habitats, which makes Odonata strong bio indicators for the development of wetlands.
III. METHODOLOGY

For the follow-up, the sites along the Gambia River have been proposed. In each site, the various habitats are inventoried. At the level of each habitat, the odonatologic fauna (larvae and adult insects) are sampled together with relevant material. To take the seasonal effect into account, the sampling is done during the dry and rainy seasons once every three years.

1. STUDY SITES

For the follow-up to cover a representative area and relevant habitats of the basin, the following sites have been proposed:

- Upper Gambia (around the source)
- Sambangalou (place of construction of the dam in the Gambia River)
- Middle Gambia (in the Niokolo Koba National Park)
- Lower Gambia (around Lower Satu-Fatoto)

2. EQUIPMENT

- Butterfly Net

The butterfly net (Fig. 11) is composed of a telescopic stick of 1 to 2 meters at the end of which is joined a metallic circle of a diameter of about 30 to 50 cm with a more or less long nylon, polyester or gauze pocket of different colours (white, green, black, ……).
✓ Kick Net

The kick net (Fig. 12) is used in the collection of larvae. It comprises a strong single-piece stick, a solid iron or aluminium circle of a diameter of about 30 cm, with a nylon pocket having an aperture of 800 to 300 cm.

✓ Boxes for the collection of exuviae

✓ Foils to collect Imagos

The foils are made of India paper or cellophane.

✓ Supple entomologic tongs (Fig. 13)
Fig. 13. – Supple entomologic tongs

✓ Cyanide preservative (Fig. 14)

Fig. 14. – Different sizes of cyanide preservative

✓ Boxes
The boxes are used for soil and sediment samples taken along the shores to collect and select burrowing larvae.

✓ Digital Cameras
A digital camera suitable for close-ups is strongly recommended.
✓ **Log book**

A log book is necessary to note all the information related to the samples taken. One should always ensure that the information collected is correctly matched to corresponding samples. Be sure of the exact names of the location of proposed habitats, as well as the geographic coordinates of the station (Universal Transverse Mercator (UTM) or latitude and longitude). Note all relevant habitat-related information (water body, prevailing plants), as well as reproductive behavioural attitudes. Stocktaking is rigorously reported in log books, as well as all observations on species and biotopes.

✓ **Consumables**

Ethanol, acetone, India paper, cellophane, plastic bags, collection tubes and small bottles.

### 3. COLLECTIONS

Since larvae and adult insects have different living patterns, the equipment and methods used for their capture are different.

For a given station, the protocol used initially must be repeated in the following evaluations to allow a valid comparison of collected data.

✓ **Larvae**

The climbing larvae atop aquatic plants are captured with kick nets. To capture burrowers, one can make superficial samplings of soil along the shores on both sides of the water table 50 x 50 cm² sample plots. For a given station, one can make samples on 4 to 5 plots along an 8 to 80 m line bordering the shore. The contents of the net or the underwater soil collected is deposited in a box and then selected later. The selection of animals is done manually with supple tongs. The larvae are fixed in a small bottle containing ethanol 70% with a label indicating the date, place of collection, habitat and possibly the number of the station and the number of the sample plot.
Since the identification of larvae up to adulthood is far from evident, one can envisage breeding them until their emergence for a safer identification of the species.

The study of larvae and exuviae offers safe evidence of the indigenous nature of the species and is a good indicator of population sizes.

 ✓ **Exuviae**

Exuviae are researched over a stretch of about 50 cm on both sides of the shore along a distance depending on the size of the habitat (about 8 to 80 m). The found exuviae are collected manually with supple entomologic tongs and put in tubes. Just like the larvae, exuviae enable the ascertainment of the indigenous nature of species.

The collection of exuviae presents a particular interest in relation to the living organs (larvae and adult insects): their sampling does not affect the population sizes, ii) their presence indicates a full development of the species in the relevant habitat (indigenous status within the habitat), iii) their stocktaking offers insight into the size of the populations. The main difficulty presented by the study of exuviae is that their identification is impossible for most species until adulthood.

 ✓ **Imagos** (adults)

The capture of imagos is done with a butterfly net. After their capture, the individual imagos are then delicately taken out of the pocket of the net while avoiding their destruction through catching them by their wings. Adult odonata are generally brightly coloured. That coloration has two origins: metallic and pigmentary. The brightly coloured odonata are killed with the cyanide preservative and do not need any particular processing other than drying to keep their original colour. They are placed in foils with all the useful reference data (dates, name of collector, place of collection, reference number, etc.). When the insects are not treated immediately after collection, it is important to dry them, out in the sun, for example. Paradichlorobenzene can be put inside the foils for better preservation. Once dead, pigment-coloured species lose their colours because of the liberation of fat and the decomposition of their guts. Once captured, they must be placed in the acetone substance for about 24 hours. Afterwards, they are pulled out and placed on blotting paper to drip them dry. Once they are
dry, they are put in paper envelopes, cellophane or plastic bags and placed in boxes with the adequate references.

Adult odonata are searched for at water points and meadows, forest outskirts and neighbouring clearings.

Pictures of habitats and individual species (at all stages) can judiciously complete the information on species and their habitats.

Certain dusk-flying species are however likely to be attracted to luminous traps.

### 4. Collection Treatments

Once at base or in the laboratory, the samples are dried and put in Indian paper envelopes or in cellophane, or even plastic bags. Each specimen must be accompanied by relevant information concerning i) the place (date, name, geographic coordinates), ii) habitat (type of waterpoint, open land habitat, closed…), and iii) the specimen (collection place). The specimens are then placed in rigid protecting boxes with a preserving substance (paradichlobenzene) and sent to a specialist or a competent scientific institution (Museum, University) for identification.

### 5. Results

**Spectrum Odonatologic Habitats**

The spectrum of an odonatologic habitat is the list of indigenous species that breed and reproduce in that habitat. It enables the follow-up of the emergence and disappearance within that habitat because of modifications of its physical, chemical and biologic parameters in relation to the construction of the dam. The list of indigenous species is drawn on the basis of
the identification of larvae, exuviae, and mating and egg-laying individual species. One must note that the identification of larvae and exuviae up until adulthood is only possible with species whose different development cycles are known.

## OdonatoLogic Larvae Productivity

The odonatologic larvae productivity defines the reproduction rate of Odonata in a given habitat. Because of the sensitivity of larvae to psychochemical and biological parameters of the habitats, the odonatologic larvae productivity is an important parameter in the follow-up of the quality of habitats.

## Abundance of Populations

The average number of individual species (larvae, adult insects, exuviae) per standardized surface and/or time unit enables the evaluation of the abundance of populations. The abundance of Odonata in a given habitat is related to the water quality, but also the aquatic and land vegetation around waterfronts. The modifications of waterfronts and their related vegetation impact the diversity and abundance of Odonata.

## Data Analysis

An analysis of variance (ANOVA) is carried out to assess the degree of importance of the noted differences.
IV. SITE VISIT

This trip enables the practice of the theories taught to participants. It will therefore take into account the following:

- Preparation of field materials
- Elaboration of protocols
- Group distribution
- Proper Field activities
V. PRESENTATION, DISCUSSION AND EVALUATION OF FIELD REPORTS

It is important to give participants the necessary techniques and tools for the generation of a good report. Therefore, there will be the following:

✓ Preparation of task force reports
✓ Presentation and subsequent discussion of sub-groups field reports
✓ General discussion on training
✓ Assessment of the course by the participants
BIBLIOGRAPHY


http://www.africa-dragonfly.net/ (consulté en août 2010).

ANNEX

SYNOPSIS AND PRACTICAL METHODS FOR COURSE DELIVERY

Within the framework of the mitigation of the negative impacts of the Sambangalou dam on the wetland ecosystems of the Gambia River. Wetlands Africa and its partners (OMVG and IUCN) envisage the follow-up of a certain number of taxa holding heritage, economic, sociocultural and biological interest. Regarding the training of people to ensure the supervision in the field, Wetlands has entrusted experts with the development of the relevant modules.

This module concerns Odonata which, despite their importance, are still not well known in Africa.

Target Groups

The persons targeted for this training could be:

- Wetland resource users
- Water and forest service agents
- National parks agents
- Agricultural extension agents
- Members of nature conservation associations
- Tourist guides
- Earth and life sciences teachers
- Environmental volunteers
- no professional entomologists
- Entomology, Ecology, and Environment MSC students

**Training Objectives**

**Overall Objective**

Provide the trainers with the adequate knowledge and know how to train people who are going to ensure the monitoring of Odonata.

**Specific Objectives**

At the end of the course, the participants are expected to be able to:

- Understand the classification system and nomenclature of living organisms for a better perception of the hierarchy of taxa used in the taxonomy.
- Know the systematic position of Odonata within the phylum of arthropods and the class of insects.
- Distinguish Odonata (larvae and adult insects) from other insects.
- Know the broad features of the systematics, biology, and ecology of Odonata and their importance.
- Know the parameters for the monitoring of Odonata and the methodology (material and methods) to be applied for follow-up.

**Different parts of the module**

The module hinges on the following five points:

- Generalities
- Order Odonata
- Study methodology
- Site Visit
- General Discussion and Evaluation
1. Generalities

This section deals with the classification of living organisms and systematic position of Odonata.

- Living organisms are classified and named scientifically on the basis of a universal system enabling the use of the same taxa to designate groups of animals and plants irrespective of place and language. After the definition of certain terms, the hierarchy of taxa is given.

- The Phylum Arthropoda is defined, as well as its constitutive classes. The various orders composing the Class Insecta are also presented.

2. Order Odonata

This second section deals with systematics, morphology, bioecology and the importance of Odonata.

3. Study Methods

In this section, the follow-up sites are presented, as well as the materials and study techniques used on the field, including the conditioning of Insects. Data processing and expected outcome are also dealt with in this section.

4. Site Visit

After the theoretic course on Odonata, a field demonstration is carried out. The field demonstration will enable the observation of Odonata in their habitat and the practical application of learnt concepts. The participants will, in line with the learnt protocol, search in the surrounding waters and land habitat for Odonata. They will take notes and photographs. Eventually, each group will present a report.

Depending on the number of people and material available, groups will be constituted. The groups should be in the field (wetlands) 10 to 16 hours on a sunny day without strong winds.

5. General discussion and evaluation
That will be an occasion for the trainer and the participants to exchange views, and also an opportunity for participants to discuss the various parts of the course.

At the end, the participants will assess the course by filling in a questionnaire

**METHODOLOGY**

At the beginning of each session, the trainer will make a presentation that the participants will follow with a course handout distributed beforehand. There will be an interaction between the trainer and the participants. The participants shall feel free to interrupt the trainer at any time to ask questions or to make a contribution. The trainer can also ask questions of the participants.

If necessary, at the end of the presentation, a debate can be opened on one or several issues raised by the participants or the trainer.

The projected site visit is planned with the participants: logistics, equipment, protocol, etc. On returning to base, the participants, organized in small groups, will present a brief report on their visit.

For the evaluation, a questionnaire will be used around the following issues:

- The clarity of the message delivered
- The level of interest of the given participants regarding the set of objectives
- The limitations of the course
- The proposals made to improve the module.

**CONTENTS of the SESSIONS**

1. **Generalities** (3 hrs)
   - Course Introduction
   - Generalities
 Classification of the living world

 Phylum Arthropoda

 Class Insecta

2. Order Odonata (3 hrs)

✓ Systematics

✓ Morphology

✓ Bioecology

✓ Importance of Odonata

  ▪ Heritage Interest

  ▪ Food chain

  ▪ Bioindicator

3. Methodology (4hrs)

✓ Study Sites

✓ Materials

✓ Collection Methods

✓ Treatment of collected species

✓ Outcomes

4. Site Visit (8 hrs)

✓ Preparation of field materials

✓ Drafting of protocols

✓ Group Distribution

✓ Field work proper

5. Presentation of field reports, general discussion and evaluation (4 hrs)

✓ Presentation and discussion of the sub-groups field reports
✓ General Discussion of the training
✓ Evaluation of the course by the participants

**COURSE CREDIT HOURS**

✓ Generalities: 3 hrs
✓ Order Odonata: 3 hrs
✓ Methodology: 4 hrs
✓ Site Visit: 8 hrs
✓ Presentation, discussion and evaluation of field reports: 4 hrs

**NEEDS**

The trainer needs:

1) A video projector
2) A computer
3) A pointer
4) The list of participants
5) The training manual
6) Entomologic Materials (see list of participants’ needs)

Before the start of the training, the participants should be possession of:

1) Course materials
2) The training manual
3) A note book and writing utensil for note taking
4) A log book and a pencil
5) An evaluation questionnaire (for the end of the training)
For the field work, they will need:

1) A means of transport (a four-wheel drive vehicle)

2) Butterfly nets (at least as many nets as there are sub-groups)

3) Kick nets (at least as many nets as there are sub groups)

4) Supple tongs for hunting (one pair of tongs per participant)

5) Cyanide preservative (at least one per group)

6) Boxes for the sampling of soil and selection (at least one per sub group)

7) Ethanol 70° (4l)

8) Acetone (4l)

9) Paper, cellophane or transparent zipper-lock plastic bags

10) Performance digital cameras (at least one per sub group).