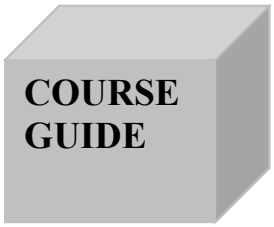

# NATIONAL OPEN UNIVERSITY OF NIGERIA

## SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE:-BIO 220

COURSE TITLE:-FISHERIES AND WILDLIFE




# BIO 220
# FISHERIES AND WILDLIFE

Course Writers/Developers — Dr. A.A. Alarape and Sololu A.O.
Dept. of Wildlife and Fisheries
University of Ibadan
Ibadan, Nigeria

Programme Leader — Professor A. Adebanjo
National Open University of Nigeria

Course Coordinator — Dr. N.E. Mundi
National Open University of Nigeria


NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters
14/16 Ahmadu Bello Way
Victoria Island
Lagos

Abuja office
No. 5 Dar es Salaam Street
Off Aminu Kano Crescent
Wuse II, Abuja
Nigeria

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Published by
National Open University of Nigeria

Printed 2009

ISBN: 978-058-055-7

**CONTENTS** **PAGE**

## Introduction

Aquaculture has been identified as the panacea to the increasing demand for food fish all over the world. The case about Nigeria is not different in terms of the aquaculture industry leading to proliferation of fish farms across the country which is mostly self-subsistence with few having hatchery facilities.

The wildlife aspect gives short descriptions of some of our most important wild animal species which include mammals, birds, and reptiles.

The content of this course shall guide the students as well as practicing fish farmers, aquaculturists and wildlife professionals in having better understanding of their business and profession.

## The Course

This course Guide tells you briefly what to expect from reading this material which bothers on fisheries and wildlife management.

The study of fishery resources and its management is of immense benefit to a nation's economy which is environmentally related. However, the growth of aquaculture as a practical way of fish farming in Nigeria is faced with myriads of problems slowing down its pace thereby given great concern to aquaculturists.

The importance of fish identification can not be overemphasised in the study of fish and for taxonomic purposes. The rudiment of basic anatomy is essential for accurately identifying fish in the field. The majority of species are readily identifiable through mouth orientation, finnage and coloration, all these and many other features used in identifying fish are discussed in this module.

As part of problems facing aquaculture, many new hatcheries are springing up most especially around the south-western part of Nigeria towards bridging the gap between fish seed availability and fish farmers need for stocking their ponds. This course guide shall explain further on this aspect and also discuss in detail the right approach to fish farm planning and design.

The best approach in feed formulation is to use high-quality feedstuffs to manufacture a diet that meets the nutritional and energy requirements of the aquaculture species in question. If a portion or all of the fishmeal in a diet can be replaced successfully

with other high-quality protein sources, doing so will contribute greatly towards protecting the surrounding environment and promoting a sustainable aquaculture industry. Within commercial fish farming operations it is also of importance that feed producers are able to deliver a high and consistent pellet quality.

Good water quality management is a pivot upon which a successful aquaculture programme rests. Regardless of the approach to the culture system adopted, ammonia, dissolved oxygen (DO), nitrite, pH, and alkalinity are major water quality parameters that should be measured on a daily basis. Poor water quality can cause massive fish kills. It is often a major factor contributing to fish disease and parasite infection. Water quality does not remain constant. Diseases occur despite the best preventive efforts. Detecting the diseases as soon as possible is vital. The best way to detect diseases at their onset is by watching the fish feed.

After a successful fish production cycle, harvesting is another tasking exercise which is carried out in order to get the fish ready for sales. There are lots of principles of economics at work in the market analysis of fish and fish products such as demand and supply forces which have effects on the overall success of the activity. Relevance of fish processing and post harvest activity to the aquaculture industry is also elaborated.

In the wildlife section, various wildlife species are discussed and their economic values enumerated. They are grouped into a number of orders. All the members of an order have a number of characteristic features common to them (with which they are grouped into families). Within each family there are many species and in the case of the large mammals each species has a familiar name.

Three well-known species in the order Carnivora (Carnivores) are the Lion (*Panthera leo*), the Leopard (*Panthera pardus*) and the Cheetah (*Acinonyx jubatus*). Three well-known members of the order Rodentia are the grass-cutter (*Thryonomys swinderianus*), the giant rat (*Cricetomys gambianus*) and the Gambian sun squirrel (*Heliosciurus gambianus*). Animals of each species breed together and produce young ones like themselves. Mating between two different species (Cross-breeding) seldom happens in nature.

## Course Aims

This course aims at providing basic understanding about fish. Capture fisheries and aquaculture are linked and are both contributing immensely to the supply of food fish as a cheap source of protein in human diet and fishery products for industrial usage. Production and management of fish and wildlife are concisely explained.

## Course Objectives

In addition to the aims above, this course set to achieve some objectives. After going through this course, you should be able to:

- Understand the major constraints to the realisation of maximum utilisation of fishery resources to meet increasing demand for fish as well as wildlife management.
- Identify common fish species using basic structures and classify wildlife species into their respective families and orders.
- Know different kinds of aquatic environment viz: freshwater, brackish water and marine water, and their relevance to fish and wildlife ecology.
- Understand practical ways of ensuring sustainable fish production in Nigeria.
- Link water quality management in aquaculture with types of feed used and feeding practices.
- Understand the importance of wildlife management and conservation to a nation's economy.
- Identify common wildlife species in Nigeria using their common features.
- Understand the biology of different types of wildlife species in relation to their habitat.

## Working through the Course

A great effort was put into developing this course thereby enriching it with a lot of useful information. This accounts for why you would find it an irresistible companion both in this class and for field purposes. However, it requires that concerted effort is made in reading through this material for appreciating the effort in a commensurable manner so you would be required to spend a lot of time to read it. You are also encouraged to work through and practice all assignments contained in this material.

## Course Materials

You will be provided with the following materials

Course guide and study units. In addition, the course comes with a list of recommended textbooks which though are not compulsory for you to acquire or indeed read, are necessary as supplements to the course material.

## Study Units

The following table presents the study units contained in this course which is expected to be covered in 12 weeks:

**Module 1**

| | |
|---|---|
| Unit 1 | Present Status of Fisheries in Nigeria |
| Unit 2 | Morphology and Basic Structure of Fishes |
| Unit 3 | Morphology and Basic Structure of Fishes |
| Unit 4 | Adaptation of Organisms to Aquatic Life and Evolution |
| Unit 5 | Fundamental Principles of Fish Production and Management |

**Module 2**

| | |
|---|---|
| Unit 1 | Ways of Ensuring Sustainable Fish Production in Nigeria |
| Unit 2 | Fishery Biodiversity Conservation |
| Unit 3 | Water Quality Management in Aquaculture |
| Unit 4 | Understanding Fish Nutrition, Feeds and Feeding |
| Unit 5 | Fish Diseases and Management |

**Module 3**

| | |
|---|---|
| Unit 1 | Post Harvest Handling of Fish and Marketing |
| Unit 2 | General Knowledge and Fisheries Management |
| Unit 3 | Wildlife Management in Nigeria |
| Unit 4 | Principles of Wildlife Management |
| Unit 5 | Orders of Nigerian Mammals |

**Module 4**

| | |
|---|---|
| Unit 1 | Order Rodentia |
| Unit 2 | Order Carnivora and Perissodactyla |
| Unit 3 | Order Artiodactyla |
| Unit 4 | Primates and Proboscidea |
| Unit 5 | Insectivora, Chiroptera, Pholidota, Lagomorpha, Reptiles and Birds |

## Textbooks and References

More recent editions of these books are recommended for further reading.

Ajayi, S. S. and Milligan, K. R. N. (1975). *The Wildlife of Nigeria: A Guide to Yankari and Borgu Game Reserves*. Department of Forest Resources Management, University of Ibadan, Ibadan. 40pp.

Ajayi. S.S. (1979). *Utilization of Forest Wildlife in West Africa* FO.MISC 79/26 December 1979 FAO, Rome.

Ayodele, I.A., Ebin, C.O. and Alarape, A.A. (1999). *Essentials of wildlife Management*, Jachin Publishers, June 1999, 88pp.

Ezenwa, B. (1979). *Supplementary Diets in Fish Culture and Feed Formulation Technology in Nigeria*. *NIOMR Occasional Paper No. 30*.

Faturoti, E.O (2000). *Beneath the Ripples and Sustainable Fish* Production. Inaugural Lecture, University of Ibadan, Ibadan. 14th December, 2000.

Idodo-Umeh, G. (2003). *Freshwater Fishes of Nigeria*, Nigeria: Idodo-Umeh Publishers Ltd. 232pp.

Moses, B.S (1983). *Introduction to Tropical Fisheries*. Ibadan University Press, Ibadan. 117pp.

Omitoyin, B. O. and Alarape, A. A. (2003). *West African Fish and Wildlife*. Ibadan Distance Learning Series. University of Ibadan: Distance Learning Centre. 72pp.

## Assessment

There are two components of assessment for this course. The Tutor Marked Assignment (TMA), and the end of course examination.

## Tutor Marked Assignment

The TMA is the continuous assessment component of your course. It accounts for 30% of the total score. You will be given 4 TMA's to answer. Three of these must be answered before you are allowed to sit

for the end of course examination. The TMA's would be given to you by your facilitator and returned after you have done the assignment.

## Final Examination and Grading

This examination concludes the assessment for the course. It constitutes 70% of the whole course. You will be informed of the time for the examination. It may or not coincide with the university semester examination.

## Course Overview

| Unit | Title of Work | No. of Weeks to Complete Them | No. of Assignments |
|---|---|---|---|
| | **Module 1** | | |
| 1 | Present Status of Fisheries in Nigeria | ½ | 3 |
| 2 | Morphology and Basic Structure of Fishes | 1 | 1 |
| 3 | Morphology and Basic Structure of Fishes | ½ | 2 |
| 4 | Adaptation of Organisms to Aquatic Life and Evolution | ½ | 2 |
| 5 | Fundamental Principles of Fish Production and Management | ½ | 3 |
| | **Module 2** | | |
| Practical | Ways of Ensuring Sustainable Fish Production in Nigeria | 1 | 2 |
| 2 | Fishery Biodiversity Conservation | ½ | 2 |
| 3 | Water Quality Management in Aquaculture | ½ | 2 |
| 4 | Understanding Fish Nutrition, Feeds and Feeding | ½ | 2 |
| 5 | Fish Diseases and Management | ½ | 2 |
| | **Module 3** | | |
| 1 | Post Harvest Handling of Fish and Marketing | ½ | 2 |
| 2 | General Knowledge and Fisheries Management | ½ | 5 |
| 3 | Wildlife Management in Nigeria | ½ | 3 |
| 4 | Principles of Wildlife Management | 1 | 2 |

| | | | |
|---|---|---|---|
| 5 | Orders of Nigerian Mammals | 1 | 2 |
| | **Module 4** | | |
| 1 | Order Rodentia | ½ | 2 |
| 2 | Order Carnivora and Perissodactyla | ½ | 3 |
| 3 | Order Artiodactyla | ½ | 4 |
| 4 | Primates and Proboscidea | ½ | 2 |
| 5 | Insectivora, Chiroptera, Pholidota, Lagomorpha, Reptiles and Birds | ½ | 4 |

## How to Get the Most from this Course

In distance learning the study units replace the university lectures. This is one of the great advantages of distance learning: you can read and work through specially designed study materials at your own pace, and at a time and place that suit you best. Think of it as reading the lecture instead of listening to the lecturer. In the same way that a lecturer might give you some readings to do, the study units tell you when to read your set books or other materials. Just as a lecturer might give you an in-class exercise, your study units provide exercise for you to do at appropriate points.

Each of the study units follows a common format. The first item is introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. You should use these objectives to guide your study. When you have finished the unit you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or reading section.

Self-tests are interspersed throughout the units, and answers are given at the ends of units. Working through these tests will help you come in the study units, work through these when you come to them, too.

When you need help, don’t hesitate to call and ask your tutor to provide it.

1. Read the Course Guide thoroughly.

2. Organise a study schedule. Refer to the "Course Overview" for more details. Note the time you are expected to spend on each unit and how the assignments relate to the units. Important information details of your tutorials and the date of the first day of the semester is available at the National Open University, Study Centres.

   You need to gather together all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on each unit.

3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If you get into difficulties with your schedule, please let your tutor know before it is late.

4. Turn to unit 1 and read the introduction and the objectives for the unit.

5. Assemble the study materials. Information about what you need for a unit is given in the "Overview" at the beginning of each unit. You will almost always need both the study unit you are working on and one of your set books on your rest at the same time.

6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow.

7. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore will help pass the exam.

8. Review the objectives for each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your tutor.

9. When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

10. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting to work on the next unit. Keep to your schedule. When your assignments return, pay attention to your tutor's comments both on the tutor-marked assignment form

and also written on the assignment. Consult your tutor as soon as possible if you have any question or problems.

11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have the unit objectives and the course objectives listed.

## Facilitators/Tutors and Tutorials

There are some tutorials earmarked for this course. You will be notified later about the date, venue and time. You should try your best to attend the tutorials. This is the only chance to have face-to-face contact with your tutor. Prepare a question list before attending the tutorials. You will learn a lot from participating in discussions actively.

## Summary

This course intends to provide you with some underlying knowledge of aquaculture, fisheries and wildlife management. However, the following questions are expected to be adequately answered by the student after completely studying this course.

- Why is fish demand for fish more than its supply in Nigeria?
- Mention 3 approaches towards the sustainability of our fishery resources.
- Mention 5 shell and fin fish species enumerated in this course and give their common names.
- Describe a named commercially important shellfish species in Nigeria.
- Why would you need a medicated feed for your fish on the farm?
- What form of prophylactic treatment would you give to your fish against bacterial infection?
- What management approach would you suggest towards successful fish marketing?
- Write an essay on the relevance of wildlife conservation to development of the Nigerian economy.
- List all the mammalian orders that are represented in Nigeria.
- Provide the scientific names and common names of common wild animal species in Nigeria.
- Describe in details two members of the order Carnivora.
- Mention the families of animals in the order Perissodactyla and give a description of a species of your choice
- The members of the order Artiodactyla are also known as ‘even-toed ungulates’, why?
- List the sub-orders under Artiodactyla.

- The family Giraffidae is under the sub-order …….
- Mention the families of animals in the order artiodactyla and give a description of a species of your choice.
- Describe in details a member of the order proboscidea.
- Enumerate the distinctive features of the sub-species under this order
- List the families in the order primates and give the description of a species of your choice.
- Describe in details a member of the order Lagomorpha.
- Mention the sub-orders of animals in the order Chiroptera and give a description of a species of your choice.
- Write an essay on the characteristic features and biology of the Ostrich.
- Mention 5 species of mammals enumerated in this unit and give their common names.

We wish you success in this course. In particular, we hope you should be able to appreciate the importance of fish farming, management of fisheries and wildlife resources in the development of a nation's economy.

Best wishes.

**MAIN COURSE**

| | |
|---|---|
| Course Code | BIO 220 |
| Course Title | Fisheries and Wildlife |
| Course Writers/Developers | Dr. A.A. Alarape and Sololu A.O.<br>Dept. of Wildlife and Fisheries<br>University of Ibadan<br>Ibadan, Nigeria |
| Programme Leader | Professor A. Adebanjo<br>National Open University of Nigeria |
| Course Coordinator | Dr. N.E. Mundi<br>National Open University of Nigeria |

**NATIONAL OPEN UNIVERSITY OF NIGERIA**

National Open University of Nigeria
Headquarters
14/16 Ahmadu Bello Way
Victoria Island
Lagos

Abuja office
No. 5 Dar es Salaam Street
Off Aminu Kano Crescent
Wuse II, Abuja
Nigeria

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Published by
National Open University of Nigeria

Printed 2009

ISBN: 978-058-055-7

**CONTENTS** **PAGE**

# MODULE 1 IMPORTANT FISHES OF WEST AFRICA WITH EMPHASIS ON NIGERIA SPECIES



## UNIT 1 PRESENT STATUS OF FISHERIES IN NIGERIA

**CONTENTS**



## 1.0 INTRODUCTION

The world's fishing grounds have levelled off in the last decade with the majority of wild stocks being fully exploited due to increase in the demand for fish. Aquaculture production offers great potentials in responding to the increased fish demand and has exclusively increased the world fish production by 20 million tonnes (mt) over the past decade. By the year 2010, the world fish food is set to increase to about 105 mt and the said increase from the current levels would again have to come from aquaculture.

How this huge increase in fish supply would be achieved by aquaculture is contained in this lecture unit.

## 2.0 OBJECTIVES

At the end of this unit, students should be able to:

- understand the present status of aquaculture in Nigeria
- described the internal and external features of fish species
- know the essence of fish identification.

## 3.0 MAIN CONTENT

### 3.1 Fishery Activities in Nigeria

Nigeria occupies between $4^0$16' – $13^0$52'N and longitude $2^0$49 – $14^0$37'E and a coastline of approximately 850km bordering the Gulf of Guinea in the Atlantic Ocean. Consequently, Nigeria is a maritime state with the establishment of the Exclusive Economic Zone (EEZ) of 200 nautical miles in 1978. The major geomorphologic features of the Nigeria continental shelf include the Avon, Mahin and Calabar Canyons. Other geomorphic features are sand banks in the inner continental shelf especially off river mouths and the deep seated of Romanche, Chain and Charcot fracture zones which originate in the mid- Atlantic ridge.

There is numerous inland water bodies in Nigeria estimated at about 12 million hectares which are fairly rich in fresh water fishes. The marine waters are however not too rich in fin fish resources, but are found to be rich in shrimp and tuna resources.

There are two main sub-sectors that contribute to the Nigeria's fish production. They are capture fisheries and aquaculture.

#### 3.1.1 Capture Fisheries

Artisanal fisheries in Nigeria constitute the most significant fishery sector in terms of people engaged in or dependent upon it and the very high percentage (66%) this sector contributes to the country's fish production. Yet, this sector is the poorest in terms of its standard of living, with the fishermen generally making a subsistence living. Small-scale fisheries can be categorised into coastal mechanised and canoe fisheries, brackish water/ lagoon subsistence fisheries and the capture fishery of man-made, natural lakes, rivers and flood plains. Artisanal and industrial fishing activities are of great importance in our coastal and marine waters. Artisanal sector consists of small sub-sectors such as lagoon, estuarine and inshore canoe fisheries, which are characterised by

low capital outlay but remains the backbone of fish production in Nigeria. The industrial sector is characterised by high capital outlay on vessels, cold storage, advanced technology and the foreign exchange generation as its major attribute.

The brackish water canoe fishery operates from small traditional dug-out canoes of about 6m LOA using gears such as set nets, cast nets, bonga drift net, as well as lift and scoop nets and hooks. The coastal canoe fishery operates up to and sometimes beyond seven nautical miles of the inshore waters. While the Nigeria Sea Fisheries Decree (Now Act) of 1971 reserves a 2-mile non-trawling zone exclusively for the artisanal fishermen, they normally go farther than this range particularly when operating motorised crafts. The distance from the coast depends on the range and size of the motorized or non-motorised canoe and the stocks fished for.

### 3.1.2 Aquaculture

Fish farming (Fresh water and mariculture) is presently making significant contribution as well in the world food fish supply. Aquaculture ranges from simple ponds using naturally occurring food sources to highly intensive systems with water control, aeration, and supplemental feeding. It could be practised in many forms including inland fish farming, brackish water systems along the coast and in marine cages and net pens. Farm size can range from thousands of hectares down to the size of a backyard. The majority of global production comes from fresh water aquaculture (58% in 1999), followed by mariculture (36%) and brackish water (6%). Aquaculture now represents more than 30 % of total food fish production, compared with just 7 % in 1973, and presently now, world food fish production is around 72 million metric tonnes. However, Nigeria aquaculture production at 15,000 tonnes is second in Africa after Egypt with Nigeria and Egypt jointly pulling a total of 84% while the rest of Africa countries contribute the remaining 16% at annual growth rate of 3% from 1985-1997. Based on a current per caput fish consumption of about 13.0 kg per year approximately 91 million metric tonnes would be required to meet up the food fish demand by year 2010.

In the coming decades, aquaculture will likely be the greatest source of increased fish production towards meeting the challenge of food fish demand in the country and world over. The public and private investment sector would have to play a major role in the area of fish disease, water pollution control, fish seed propagation and fish feed production and nutrition.

## 3.2 Fishery Resources of Nigeria

Nigeria has diverse fish resources including pelagic and dermersal fin and shell fishes. There are about 199 cultural fish species in Nigeria belonging to 35 families while 9 shellfish families have been identified to be culturable. These resources can be differentiated as pelagic and dermersal fish and shellfish which occur on a total continental shelf area of 251,100km$^2$ in the Gulf of Guinea. Distribution of this area by 3 depth zones, (0-10m, 10-50m and 50-200m), and by country is presented in table 1.

### 3.2.1 Shrimp Resources

Shrimp resources are abundant in river mouths and lagoon entrances. Among important species are the pink shrimp (*Penaeus notalis)*, the tiger shrimp (*P. kerathurus*).*Parapeneopsis atlantica* occurs in abundant quantity in coastal shallow water, 0-20m depth and commands a local economic importance. The royal shrimp (*Parapenaeus longirostris*) occurs in deep waters, 60-400m depth but its distribution of abundance with depth varies between 60 and 120m in Nigerian water.

### 3.2.2 Pelagic Fish Resources

The major pelagic resources include the Bonga fish (*Ethmalosa fimbricata*) *Sardinella aurita* and *Sardinella mandarensis.* Others are the anchovy and the horse mackerel. The Bonga is the most valuable and abundant fish in the artisanal fisheries in the country while the sardinella are less abundant but also of economic importance. The bonga fish occurs along the whole length of tropical West African coastline with concentrations in Sierra Leone to Senegal and Nigeria to Cameroun. *Sardinella aurita* is considered the most valuable clupeid is the Gulf of Guinea supporting large canoe fishing in Ghana, Sierra Leone and Cote d'Ivoire.

### 3.2.3 Off-Shore Pelagic Resources

This include tuna and other related fish species and perhaps the most commercially important fish species of all fisheries resources in West Africa. The prevalent species include the skipjack (*Katsuwonus pelamis*), the yellow fin tuna (*Thunnus albacares*), the big eye tuna (*Thunnus obesus*) and the frigate tuna (*Euthynnus alletteratus*). The skipjack and the yellow fin tuna are the most abundant and constitute about 75% and 18% respectively by weight of pole-and-line catches. Other countries rich in tuna fish resources are Senegal, Sierra Leone, Ghana and Sao Tome and Principe.

### 3.2.4 Fauna Resources of the Equatorial Zone

The resources in the equatorial zone are characterised by their heterogeneity in the size and variety of fish species. Longhurst (1961) classified the dermersal fish resources into three main faunistic groups:

(i) Croaker fauna- This consists of the silver to grey fish including croakers *Pseudolithus senegalis, P. typus, P. elongates* and *P. brachygnathus,* the thread fins (*Galeoides decadctylus*), *Pentanemus quinrifilis* and *Polydactylus quadrifilis* and *Polydactylus quadrifilis,* the Ariid catfishes and spade fish (*Drepane africana*). The croaker fauna live mostly above the thermocline on mud and muddy sand deposits and hardly penetrate into the cold water mass of the South Atlantic Central water below the thermocline.

(ii) Snapper fauna- This consists mainly of red fish including the breams (*Pagrus spp*.), *Lutjanus spp*., *Epinephelus spp*. and the gurnards (*Trigla spp*.). They are found on clean sand with shell and oral above and below the thermocline to a depth of over 100m. However, some species are found to occur above and below the thermoclines which are known as the eurybathic species

**Table 1: Distribution into Zones of the Continental Shelf Area (0-200Km$^2$) of the Gulf of Guinea**

| Coastal Country | Surface of continental shelf (Km$^2$) | | | Total surface area (Km$^2$) |
|---|---|---|---|---|
| | 0-10m | 10-50m | 50-200m | |
| Senegal | 3,600 | 11,600 | 8,400 | 23,600 |
| The Gambia | 1,100 | 2,600 | 1,400 | 5,100 |
| Guinea Bissau | 16,300 | 14,000 | 6,800 | 37,100 |
| Guinea | 5,600 | 28,700 | 7,900 | 42,200 |
| Sierra Leone | 5,000 | 16,200 | 6,300 | 27,500 |
| Liberia | 1,500 | 5,300 | 11,600 | 18,400 |
| Ivory Coast | - | 4,700 | 7,600 | 12,300 |
| Ghana | - | 11,700 | 8,500 | 20,200 |
| Togo | - | 1,100 | 500 | 1,600 |
| Benin | - | 2,100 | 900 | 3,000 |
| Nigeria | 5,100 | 21,600 | 14,300 | 41,000 |
| Cameroun | 3,400 | 5,700 | 6,300 | 15,400 |
| Equitorial Guinea | - | 2,000 | 1,700 | 3,700 |

**Source: Domain (1980)**

(iii) Semi-abysal fauna- This occur between 100m and 400m and consists of small, red to black fishes such as *Antigonia spp*., *Capros spp*., *Peristedion spp., Penthereroscion mbizi*, *Ariomma melanum* and a variety of deep sea crabs of *Geryon maritae*. The two species of *Ariomma* found in Nigeria waters are very good raw materials for canning. Off the Nigerian coast, the croaker fauna is the main stay of the industrial inshore demersal fishery with catch rate per unit efforts decreasing with depth.

### 3.2.5 Fauna of Northern and Southern Zones

Fish species in the northern and southern zones differ from those of the equatorial zone in major ways:

(i) The snapper and croaker fauna in the sub-tropical zones give the same catch rate per unit effort as far as the edge of the continental shelf.

(ii) The snapper fauna in the two zones have larger and more valuable fishes like the breams and the snappers than the equatorial snapper fauna.

(iii) The occurrence of significant quantities of the commercially valuable large croaker, and the hake.

## 3.3 Major Constraints to Satisfying Increasing Demand for Fish

There are major constraints to the realisation of maximum utilisation of resources to meet increasing demand for fish. Some of these factors shall only be highlighted here while details about some of them shall be well discussed in subsequent units. These factors include:

(i) Poaching by non-registered vessels and illegal transshipment of catches have reduced availability of fish and fishery products to consumers in the West African countries.

(ii) Low per capita income has also made a number of fish and fishery products inaccessible to the majority of the population.

(iii) Extension of national jurisdiction over resources has deprived long distant fleets of coastal states with high population density from gaining access to their former traditional fishing grounds. Conditions for access are stiff and beyond the capacity of the developing neighbouring states in the region to satisfy.

(iv) Continuous use of traditional fishing gears and crude methods of preservation of excess catch resulting in poor quality of fishery products.

(v) Disincentive to production increasing arising from high operational costs e.g. in fuel, spare parts, and general maintenance of vessels.

## 3.4 Economic Advantages of Fishery Resources

(i) Foreign exchange earning either through exports or import substitution of fish and fishery products

(ii) A healthy population with an important source of animal protein rich in essential amino acids

(iii) Gainful employment to a segment of the population particularly those in coastal rural communities

(iv) Promotes the development and growth of ancillary industries e.g. ship building, net making, cold room business in the fish preservation industry.

## 3.5 Management Procedures

Management of fish resources is designed therefore to exploit them at optimal level on a sustained basis to achieve economy of operation at minimum cost. The following are measure taken by the country in managing her marine resources which at the same time check all abnormal fishing activities going on around the water bodies of economic value.

- **Limitation of the size of vessels**

Limit is placed on the size of vessels allowed to fish in inshore waters, 0-50m for instance only vessels of 100 GRT are allowed to fish in the inshore waters of Nigeria.

- **Establishment of minimum cod-end mesh size**

Nigeria has adopted a cod-end mesh size of not les than 76mm when trawling for fish and 44mm when trawling for shrimps. This is to allow immature fish to escape the net, grow and mature to breed.

- **Licensing of fishing vessels**

Vessels must be licensed and must fly the national flag before they can fish in territorial waters. This measure is targeted at controlling fishing efforts and generates revenue.

- **Restriction of fishing to certain areas of the coast**

Imposition of restriction to designated fishing area is to protect some fisheries. In Nigeria, trawling for shrimps is prohibited West of the Niger delta to ensure that the small mesh size of shrimp trawls do not destroy immature croakers which constitute the backbone of the inshore industrial fishery. Valuable fish stocks are most abundant to the east of it.

- **Prohibition of trawlers from operating within certain limits of the shore**

This is to minimise the conflict between artisanal coastal fishermen and semi-industrial trawlers. Such trawlers often violate this limit and destroy nets of artisanal fishermen. In Nigeria, trawlers shall not fish within the first 2 nautical miles of the coast. However, there is need to extend this limit to 5 nautical miles of the coast.

- **Closed season**

Breeding and nursery grounds of important fishes and shell fish may be closed to fishing at breeding seasons to protect juvenile fish in nursery grounds e.g. the Bonga fish and shrimps. It is very common for the artisanal fishermen to catch the young of bonga fish and the shrimps at their nursery grounds with nets of small mesh sizes less than 25mm.

**Table 2: Important Marine and Brackish Water Fish Species in Nigeria**

| . | Order | Family | Species |
|---|---|---|---|
| 1 | **Rajiformes** | Dasyatidae | ***Dasyatis centroura*****,** *D.margarita, D. pastinaca,* |
| 2 | **Lepidosireniformes** | Protopteridae | *Protopterus annectens* |
| 3 | **Characiformes** | Hepsetidae,Characidae , Distichodontidae, Distichodae, Citharinidae, Icthyboridae | *Citharinus citharus, Distichodus niloticus* |
| 4 | **Clupeiformes** | Clupeidae | *Ethmalosa bidorsalis, E. fimbricata, Ilisha africana* |
| 5 | **Cypriniformes** | Cyprinidae (Carps & Barbs) | ***Labeo senegalensis L. cubie, Barbus occidentalis*** |
| 6 | **Elopiformes** | Elopidae | *Elops lacerta* |
| 7 | **Momyriformes** | Mormyridae, Gymnarchidae | *Gymnarchus niloticus, Mormyrops rume, M. deliciosus* |
| 8 | **Ophiocephaliformes** | Channidae | *Channus obscura, Parachanna africana* |
| 9 | **Osteoglossiformes** | Osteoglossidae, Notopteridae Pantodontidae | *Notopterus afer, N. nigri* |
| 10 | **Perciformes** | Centropomidae, Carangidae, Lutjanidae, Eleotridae, Anabantidae, Cichlidae, Mugilidae, Gobiidae, Nandidae, Monodactylidae | *Lutjanus agennes, Eleotris kribensis, E.nanus, E. vattata, Oreochromis niloticus* |
| 11 | **Polyperiformes** | Polypteridae | *Polypterus ansongei P. senegalus, P. endlicheri* |
| 12 | **Siluriformes** | Ariidae, Bagridae, Clariidae, Malapterinidae, Mochokidae, Schilbeidae | *Clarias anguillaris, C..gariepinus, Heterobranchus longifilis, Chrysichthys nigrodigitatus, C. walkeri C. auratus, Arius gigas, Synodontis sorex, S. ocellifer, S. filamentosus* |

**Source: Adapted from Tobor (1992)**

**Table 3: Important Commercial Shell Fish Species in Nigeria**.

| S/N | Family | Common Name | Scientific Name |
|---|---|---|---|
| 1 | **Penaeidae** | Guinea shrimp<br>Deep water rose shrimp<br>Caramote prawn | *Parapenaeopsis atlantica*<br>*Parapenaens longirostris*<br>*Penaeus kerathurus* |
| 2 | **Geryonidae** | West African geryon | *Geryon maritae*,<br>*G. quinquedens* |
| 3 | **Sepiidae** | Common cuttle fish | *Sepia officinalis* |
| 4 | **Loliginidae** | European squid | *Loligo vulgaris* |
| 5 | **Cardiidae** | Costate cockle<br>Gaping cockle<br>Mangrove oyster | *Cardium costatum*<br>*Cardium ringens*<br>*Crassotrea gasar* |
| 6 | **Octopodidae** | Common octopus | *Octopus vulgaris* |
| 7 | **Palaemonidae** | Congo river prawn<br>Giant fresh water prawn<br>African river prawn<br>Brackish water prawn<br>Creek shrimp<br>Estuarine prawn | *Macrobrachium dux*<br>*M. rosenbergii*<br>*M. vollenhovenii*<br>*M. macrobrachion*<br>*Palaemonetes atlantica*<br>*Nematopalaemon hastatus* |
| 8 | **Palinuridae** | Spiny lobsters | *Panulirus regius* |
| 9 | **Osteridae** | Flat oyster | *Ostrea edulis* |

**Source: Adapted from Tobor (1992)**

## 4.0 CONCLUSION

In this unit you learnt:

1. About the fishery activities in Nigeria.
2. About the fishery resources of Nigeria.
3. The major constraints militating against meeting the increasing fish demands in Nigeria.

## 5.0 SUMMARY

Nigeria is richly blessed with abundant fishery resources of high economic importance in diverse water bodies but many of the existing

illegal activities around it constitute constraints to its proper management and utilisation.

The state of our fisheries despite its inability to meet up with the increasing demand for food fish is continually being depleted through several activities of over exploitation and illegal operations perpetrated by the artisanal and canoe fishermen. It is therefore very necessary to adhere strictly to the rule and regulations guiding the utilisations of the fisheries resources of the nation as enumerated in this unit in order to guarantee its sustainability.

However, exploitation of fishery resources of Nigeria is of great economic importance to the nation in several respects as for this reason deserves a viable management programme to ensure its sustainability.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Why is fish demand for fish more than its supply in Nigeria?
2. Mention 3 approaches towards the sustainability of our fishery resources.
3. Mention 5 shell and fin fish species enumerated in this unit and give their common names.

## 7.0 REFERENCES/FURTHER READINGS

Dublin-Green, C.O. and Tobor, J.G. (1992). *Marine Resources and Activities in Nigeria*. *NIOMR Tech. Paper* No. 84.

Tobor, J.G. (1991). *Marine Fish Resources of Western Africa: Potentials, Management, Development and constraints to Their Utilization to satisfy Increasing Demand*. NIOMR Tech. Paper No. 70.

# UNIT 2 MORPHOLOGY AND BASIC STRUCTURE OF FISHES

**CONTENTS**

## 1.0 INTRODUCTION

Fish identification is important so that another species with different traits is not mistakenly used for an intended purpose(s) thereby originally creating an error in ignorance which reflects in the outcome of its utilisation. A particular fish species may be necessary for consumption purpose by man, it could be for the purpose of research and practical training or for production purpose. The species used for a specified purpose instead of another and that which was not used can both belong to the same family but that does not override the differences between them fish identification to species level is of great importance. In order to safeguard committing such an error of species placement, one need. Thus, to understand procedure and tools that are involved in correctly identifying fishes up to species level and which must be adhered to strictly. A rudimentary understanding of basic anatomy is essential for accurately identifying fish in the field. The majority of species are readily identifiable through mouth orientation, finnage and coloration. Where subspecies and hybrids are present, a qualified professional may be needed. The detail of this shall be discussed in this lecture.

## 2.0 OBJECTIVES

At the end of this unit, student should be able to:

- give reasons for fish species identification
- list tools for fish species identification and carry out some identification.

## 3.0 MAIN CONTENT

## 3.1 Understanding Fish Identification

In identifying a fish, the tools that are relevant can be classified into external and internal features known as meristic characteristics, and biometric characteristics. Fish can be easy to identify if you know what to look for. Just like any plant or animal, we need to understand what features some fish have in common, and what the differences are. Some fish are more familiar than others, such as game fish.

## 3.2 What are Meristics Characteristics?

These are internal and external features of a fish such as fins, gill, mouth and teeth structure. Meristics are countable features that are useful to scientists and fish keepers in identifying their fish. Different species of fish have varying numbers of fins, scales, fin rays, barbells and other features that can be used to help tell them apart. These characteristics can be compared to those listed in books, descriptions and in dichotomous keys to help you work out which species you are looking at. Meristics are often combined with details on anatomy and measurements of certain features called morphometrics.

## 3.3 Basic Rules of Meristic Features

At their most basic, meristics are as simple as counting fins, fin rays or scales. However, there are lots of different features to count and there are slightly different ways of counting the same things, and expressing them in a way so other people can understand what you are going on about.

The first rule with meristic features is that the number is always whole (a discrete variable). Just as most people don't usually have 2.25 arms or 9.2 fingers, most fish have whole numbers of fins, rays, scales and other anatomical features, not parts of them.

### 3.3.1 Internal Features

This is basically the use of gill raker. Gill raker is a comb-like structure usually found inside the gill arches of a fish. The number and shape of

gill raker is the important tool in this respect as it varies from one species of fish to another.

The gill raker performs several functions ranging from protection of the fragile gill filaments to aiding filtering of minute food items from the water as it passes through them. In which case, those fish species with numerous and fine gill rakers feed on fine food particles like planktons and are known to be microphagous while those with stronger and fewer gill rakers feed on large food items and are referred to as macrophagous. However, the gill rakers are protected by the opercula plate, a hard disc-like plate that is a continuum of the rest of the fish body.

### 3.3.2 External Features

These are found and could be outside on the fish like the fins, mouth, teeth, scales, body shape and the colour of fish.

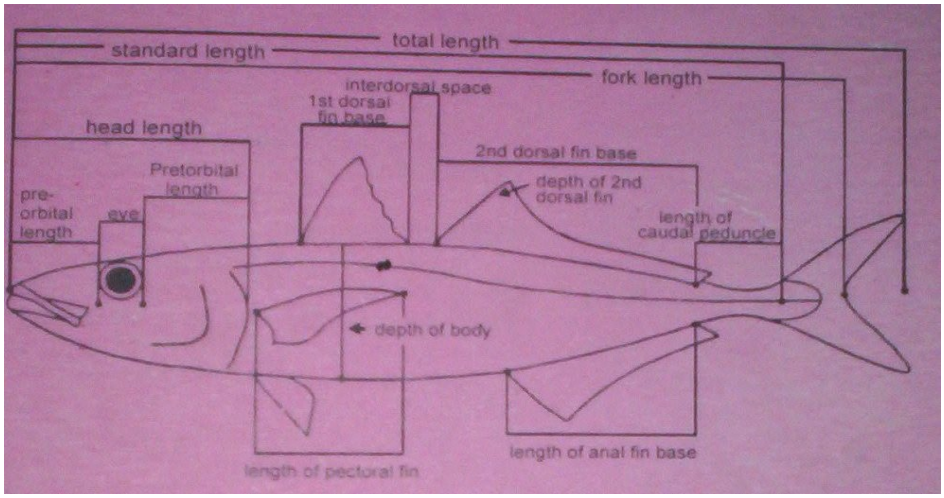



**Fig. 1: Diagram showing measurements of bony fish. (FAO).**

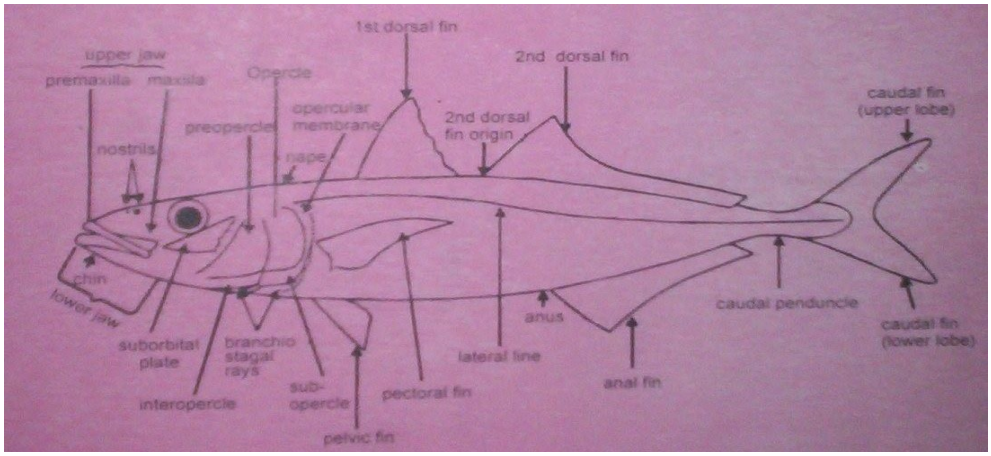



**Fig. 2: Diagram showing meristic features of a bony fish. (FAO).**

**(i) Fins**

These are very important for fish identification and requires taking into considerations their number, sizes, position on the body and a times colour. The number of spines or rays may be branched or not, but the number of spines on the dorsal fins and anal fin is the most relevant and consistent features in a species since two different fish species are most unlikely to have the same number of fins or rays. For data recording purposes, Roman numerals are adopted for spine count. An example of this method is represented by the dorsal fin of *Tilapia zillii* D XIV-XVI, 11-13; A III,7-10. This means that *T. zillii* has dorsal with 14-16 spines and between 11-13 rays, while the anal fin has 3 spines and between 7-10 rays. Meanwhile some fish species have two dorsal fins of which the first (anterior) is truly a fin with spines and rays while the second (posterior) is in the form of flesh called adipose fin. This adipose fin usually vary in sizes from one fish species to another even of the same genera and thus, used sometimes in fish identification. The adipose fin is a soft, fleshy fin found on the back, behind the dorsal fin and just forward of the caudal fin. It is absent in many fish families, but is found in Salmonidae and catfishes.

Tail or caudal fin is another very important fin used in identifying fish species. The shape of caudal fin could be lobed, that is forked, having upper and lower lobes, it could be pointed, blunt or truncated and it could be rounded. Examples of species with the different types of caudal fin shapes are shown below.

**(a) Why is counting features so difficult?**

Some people interpret things differently, so most experts follow the same basic rules on what constitutes a particular type of fin ray and how scales are counted.

Some specialists on certain groups of fishes do their meristic analyses in slightly different ways. If you're reading a description of a new species or a review of a family, you'll often see in the methodology section of the paper detail on whose technique they are following. For cichlids, for example, most people use Barel's recommendations, which were written for those working on Lake Victoria haplochromine cichlids - a notoriously difficult group to work on.

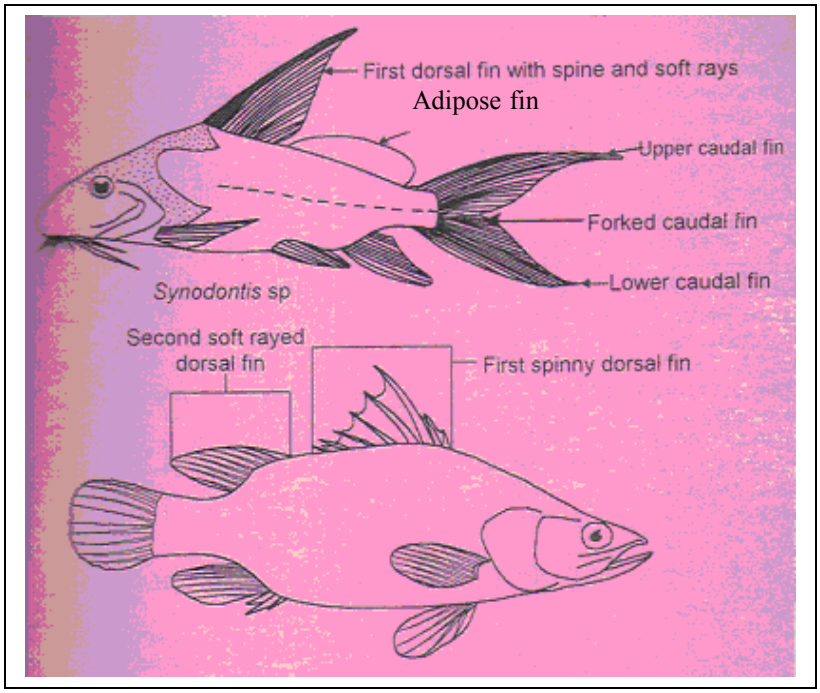



**Fig. 3: Upper (*Synodontis sp)*and Lower (*Lates niloticus*) showing the different types of dorsal fins.**

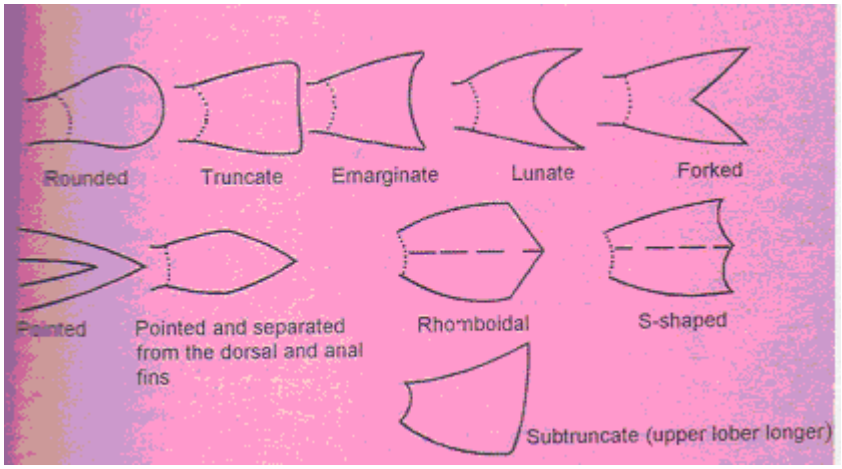



**Fig. 4: Different shapes of caudal fins.**

## (b) How do you actually do the counting?

Meristic studies are usually undertaken by taxonomists working on dead fish that have been pickled in alcohol. Counting the number of scales along the flank of a live Tinfoil barb is a rather trickier proposition.

If you are very patient and the fish you are looking at is fairly large and slow moving, you might be able to get reasonable results by watching the fish in the tank, but it might be easier to take some photographs instead. If you do this, it's wise to use only pictures of the same individual - some numbers might differ between members of the same species.

Some fish are too small to study, unless you are really skillful and have access to a microscope. In the lab, most scientists working on typical aquarium-sized fish use a dissecting microscope and manipulate the fins with a pointed needle so they can count accurately.

If the fish is small, you will have your work cut out, or you will have to wait until a fish dies and you can use the carcass.

**(c) How do I count fin rays?**

Fin rays fall into three main types: spinous (spines), soft and hard rays, and each is counted separately. This means that you need to be able to tell the difference between the two, and fin rays can differ a bit in their overall structure.

Soft rays which are thin, flimsy and usually branched at the top end. The group includes branched rays, caudal fin rays (apart from the principal rays at the top and bottom of the tail).

Hard rays are made from a group of soft rays, are rigid and sometimes pointed. Hard rays are seen in the fins of Perciform fishes, Sisorid catfishes and in the principal rays of the caudal fin.

Spinous rays are harder than hard rays and are made of bony tissue, so they're stronger and often sharper. These aren't usually covered with skin tissue and often have serrated edges, such as in many Doradid catfishes.

All of the rays in all of the fins are counted, including the tiny ones on the inside of the pelvic fins, which is not easy on a live fish. For instance D XII, 10-12 is a fin formula for the dorsal fin. To save repetition, ichthyologists use this special shorthand language for describing the fins.
The first letter stands for the fin, so D here stands for dorsal. Other letters, such as A for anal and P for pelvic, are also used. Roman numerals, such as XII, refer to the number of spinous rays in the fin, while the numerals, 10-12 in this example, describe the number of soft segmented rays.

The range covered, 10-12 here, shows the typical counts seen across the species, something called intraspecific variation. Importantly, not all members of the same species are identical.

Sometimes you might see lower-case Roman numerals used in the same formula alongside Arabic numerals, for example, P ii, 5. These differentiate between branched and unbranched rays.

The lower-case Roman numerals refer to the unbranched rays and the Arabic numerals refer to the branched rays. The rays of the caudal fin or tail are counted by adding up the number of branched rays and adding two, one for the upper and lower principal rays. Sometimes the count is split into two bunches of rays, the dorsal group on the upper half and the ventral group on the lower half. So principal caudal rays 6 + 7 states that there are 13 rays, 6 on the dorsal portion and 7 on the ventral portion. Some fish, like Perch or Polypterids, may have more than one dorsal fin, while others have a dorsal which is divided.

If the fin is divided, a slash shows the position of the split e.g. DX/I; 8-10 shows a dorsal fin that's split into two after the tenth spine. If there are several dorsal fins, each gets a separate number and formula.

**(ii) Scales**

Some fish are scaly while others are without scales, but the scaly fish are in the majority. Presence of scale in fish is a form of mechanical or external support in fish and also a form of beautification to the species having it usually in different patterns. Scales are of different types and these are cycloid scale (rounded shape), ctenoid (comb-like), ganoid (rhomboidal), placoid (tooth-like) and scute.

**(a) Cycloid Scale**

They are small oval-shaped scales with growth rings cyclic in shape at the exposed margins and this gives fish species having it smooth body surface. *Hepsetus odoe*, *Heterotis niloticus* and the cichlid family such as *Oreochromis niloticus* have cycloid type of scale.

**(b) Ctenoid Scale**

They are similar to the Cycloid scales, with growth rings. They are distinguished by the spines that cover one edge at the posterior surface of the scale making it to be rough to touch. This type of scale is found in *Ctenopoma kingsleyae*.

### (c) Ganoid Scale

This is rhombic or diamond shaped. They are flat, basal-looking scales that cover a fish body with little overlapping. Example of fish species with ganoid scale is *Polypterus spp*.

### (d) Placoid Scale

It is also called **dermal denticles** .The shape of a placoid scale is tooth-like with the posterior margin carrying a small cusp. Shark belongs to fish species having such type of scale.

### (e) Scute

Another, less common, type of scale is the **scute**, which is an external shield-like bony plate, or a modified, thickened scale that often is keeled or spiny, or a projecting, modified (rough and strongly ridged) scale, usually associated with the lateral line, or on the caudal peduncle forming caudal keels, or along the ventral profile. Some fish (e.g. pinecone fish) are completely or partially covered in scutes.

The various types of scale in fish are presented in this unit. However in some instances the number of scales on the caudal peduncle and on lateral lines of fish is used in identifying fish.


**Fig. 5: Different types of scales- a. Cycloid; b. Ctenoid; c. Ganoid; d. Placoid.**

### (a) How do I count the scales?

Fortunately, you would not have to count all of the scales, only those in specific places.

The most common scale count looks at the number of scales along the lateral line-the sensory line on the flank of the fish. This normally looks at the number of scales on the lateral line which have a pore in them. The scales on the caudal peduncle (wrist of the tail) after the lateral line do not get included in the count.

But not all fish have a lateral line, and even if present, it is often only partially complete. In these cases, you simply count along an imaginary line.

Other common scale counts include counting the scales below the lateral line to the base of the pelvic, counting the scales from the insertion of the first dorsal fin to the scale above the first lateral line scale; recording the number of pre-dorsal scales and the number of scales around the narrowest part of the caudal peduncle-here (the circumpeduncular count) you'd also indicate how many lie above and below the lateral line

**(iii) Mouth**

Mouth of fish can also be used in their identification and this is based on the variations in their structures and position. However, this form of variations is associated with the feeding habit of fish and the mouth could be regarded as being superior, inferior or terminal. Certain fish species also have a flesh-like structure attached to the mouth making it to be protrusible which may be protracted or retracted.

**(a) Superior Mouth**

Mouth of fish is said to be superior if it is positioned above the snout or situated directly upward. Such fish species like *Epiplatys sexfasciatus* and *Cyprinodonts spp*. feeds on insect that fall onto water or other surface water organisms such as mosquito larvae and pupae. They are said to be insectivorous or larvivorous.

**(b) Inferior Mouth**

The mouth of fish is inferior if it is positioned below the tip of the snout or situated underneath. Fish species with this type of mouthpart are usually bottom dwellers and therefore, feed on detritus, worms and algae attached to the bottom platforms. *Clarias gariepinus*, *Synodontis spp*. and *Petrocephalus bane ansorgei* posses inferior mouth and are known to be omnivorous.

**(c) Terminal Mouth**

A terminal mouth in fish is the one located at the tip or at the extreme end of the snout. This type is seen present in *Hydrocynus brevis*, *Hepsetus odoe* and *Tilapia spp*. The feeding habits of species with terminal mouth type may be carnivorous (predatory) or planktivorous.

### (d) Protrusible Mouth

This is a structural characteristic of any particular mouth type of a fish. It is such that it can be extended or pushed forward and outward or fold backward and inward especially during feeding apart from opening and closing the mouth during ingestion. Fish species with such trait are *Lates niloticus* and *Tilapia spp.*

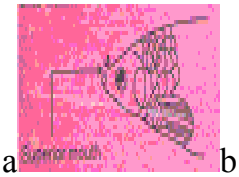
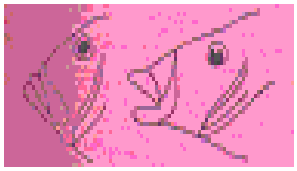
a  b.  c.  d. 

**Fig. 6: Different types of mouth- a. Superior; b. Inferior; c. Terminal and d. Protrusible.**

### (iv) Lateral Line

The lateral line is a set of continuous mark or simple dots that run along the flank of a fish. These dotted lines are used in sensing moving objects in water such as predators or prey through vibrations detection since they are connected to the brain. The lateral line may be the type that runs through the flank of fish in a single line (continuous) or may break along the flank only for another line to begin at another level and run to the end of the flank in an assumed continuation. This point of line termination (synapse) is however taken into consideration by a little overlap by the second line towards ensuring continuous message transmission. Fish species such as *Protopterus annectens* has continuous lateral line while *Barbus callipterus* has discontinuous lateral line.

Situations can also arise whereby fish possess other forms of lateral lines apart from the major ones and these are known as secondary lateral lines. This type is common to the *Clarias spp*. and they may be regular or irregular in distribution.

a. b.

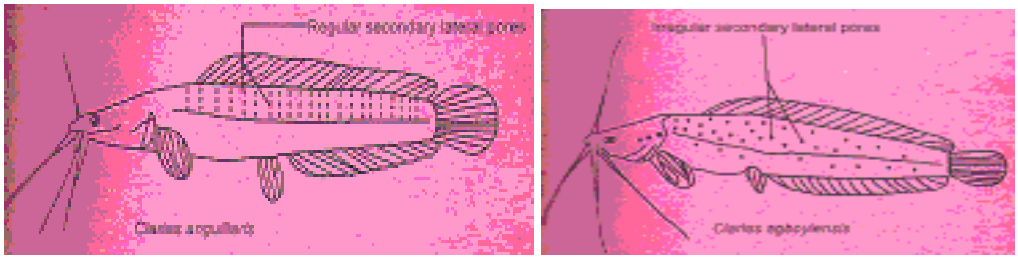



**Fig. 7: *Clarias anguillaris* with regular secondary lateral pores(a)**
***Clarias agboyiensis* with irregular secondary lateral pores (b)**

**(v) Teeth**

It is another very important tool in fish classification. Generally, fish are said to be homodont in dentition (having the same type or shape of teeth all through) on individual fish species basis. However, they may differ in the number of cusps they have which may be unicuspid or bicuspid e.t.c. or they may be of numerous granular structures forming a rough surface in the mouth of the fish. The most common forms of teeth in fish are canine, incisor, molar and villi or granule. Apart from differences in the shape of fish teeth, teeth of fish are also positioned in different ways such as;

**(a) Premaxillary**

This refers to the presence of teeth in front margin of the upper jaw.

**(b) Maxillary**

This means that teeth are present on the sides of the upper jaws of the fish.

**(c) Mandibular**

This means that teeth are present on the sides of the lower jaw of the fish.

**(d) Vomerine**

This refers to the presence of teeth on the pharyngeal bones at the back of the mouth on the ventral and dorsal plates.

**Fig. 8: Premaxillary and Mandibular types of teeth in a Synodont.**

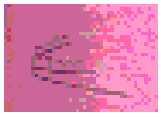
i.  ii.  iii.  iv. 

**Fig. 9: Types of teeth- i. Canine-like; ii. Molar-like; iii. Incisor-like; and iv. Villi-like.**

## 3.4Biometrics Characteristics

This aspect involves taken measurements of certain parts of the body of fish for species identification purpose. This may involve counting the number of certain parts such as fins, which may be dorsal fin or anal fin and the total length. It may be the distance between one fin or the other, or distance between one parts of the fish in relation to another. It may be depth of the body of the fish or percentage size or ratio of the head of a fish to the entire body and so on. This is used in some cases as such variations have been known to be species specific. Terms adopted in this regards include total length, fork length, standard length, length of the head e.t.c. These are represented in figure 1 and 2 of this unit.

## 4.0 CONCLUSION

In this unit, you have learnt how to identify fish. You were also introduced to their meristic characteristics and biometric characteristics

## 5.0 SUMMARY

The importance of fish identification cannot be overemphasised in the study of fish and for taxonomic purposes. The basic rule must be followed in order to represent a desired class or species of fish correctly by practically use of the identification tools and not by mere assumption on physical appearance or at sight. This is because it is a known fact that more than one species of fish may have similar features in certain respects but which are still yet not in the same species and even not in the same class.

## 6.0 TUTOR-MARKED ASSIGNMENT

I am trying to identify an Egyptian cichlid, but the description contains loads of incomprehensible codes like D XII, 10-12. What is this all about?

## 7.0 REFERENCES/FURTHER READINGS

Moses, B.S (1983). *Introduction to Tropical Fisheries*. Ibadan University Press, Ibadan. 117pp.

Omotoyin, B.O and Alarape A.A: WFM 211 (*West African Fish and Wildlife*). Ibadan Distance Learning Centre Series. Ibadan University Press, Ibadan. 73pp.

# UNIT 3 MORPHOLOGY AND BASIC STRUCTURE OF FISHES

## CONTENTS



## 1.0 INTRODUCTION

Water is the environment in which fish is found carrying out its normal activities throughout its life time. It is the habitat in which fish survives. Water is of different types and this determines what species of fish that can be found in it. In the same vein fishes do migrate from one water body to another especially at certain period of the season or stage in their life time. This movement is however characterised by specific requirements of the salt content of the water body needed at a time and

this can be movement from fresh water to salt water or vice versa. However, while taxonomy is the science of classification, the use of migratory pattern of fish and the nature of water in which it is found is used for grouping.

For the purpose of this book, species classification to their respective family shall be highlighted.

## 2.0 OBJECTIVES

At the end of this unit, students are expected be able to:

- classify fish species based on their family levels
- distinguish between categories of fish based on their habitat.

## 3.0 MAIN CONTENT

### 3.1 Grouping of Fish

The habitat in which fish is found varies and these are marine, brackish and fresh water habitat. The salt content of these water bodies makes the distinction between one and the other. The salt content (salinity) is expressed in part per thousand (ppt). Water body with salinity greater than or equal to 35ppt is marine water while brackish water has salinity ranging from 1-34 ppt. Any water-body with salinity less than 1ppt is said to be a fresh water habitat such as lakes, rivers, streams and springs. Fish species are of diverse water quality requirement either at certain stages of their life or throughout their life time for specific activity and therefore have to sojourn through different water bodies of significantly varying salt content. Based on this pattern of migration for which ever reason, fish can be said to be anadromous, catadromous or diadromous.

**(i)** **Anadromous**: Fish are said to be anadromous when they are found migrating from a salt water body like brackish water into a fresh water body e.g. Salmon.

**(ii)** **Catadromous**: They are said to be catadromous when they are found migrating from a fresh water body into a salt water body e.g. Eel.

**(iii)** **Diadromous**: Diadromous fish spend their life both in fresh water and salt water bodies simultaneously without any barrier to period of the season or metabolic activity e.g. *Chrysichthys nigrodigitatus*.

## 3.2 Classification of Fish

Just like in plant classification or other higher animals, fish classification also follows the same pattern which starts from Phylum to species i.e.

Phylum---- Sub-phylum---- Super class---- Class---- Sub-class---- Order---- Sub-order---- Family---- Genus---- Species

Species of fish comprise a group of fish whose member have similarity in structure or and appearance and are capable of breeding among themselves. Species is the last and forms the basis for taxonomic grouping of plants or animal thereby becomes more to be reckoned with for various purposes including research. Stream size plays a critical role in the distribution of freshwater fishes. Some species have specific habitats, such as headwater streams with significant groundwater influences. Others are less particular, inhabiting a wide array of stream sizes through an extensive geographic range. So when a fish is to be identified from within a genera (that group of fish with similar structure or appearance), it is the species name that will be indicated and which does the separation. Therefore, classification to species level has to be done correctly since not all members of the same genera possess the relevant characteristics for culture purposes.

## 3.3 Fish and Shell Fish Species of Nigeria

- **Commercially Important Fin Fish Species in Nigeria**

Among the fin fish families and species recognised in Nigerian waters certain families are of commercial importance therefore, are widely cultured across the country as well as in some parts of Africa. Some of the known families are hereby highlighted with emphasis on few species in each family.

### 3.3.1 Family Clariidae (Catfish)

This family belongs to the catfish family and is generally without scales. They have mouths, very strong heads and the mouth part possess well-developed barbells. They are commonly found in swamps, streams, rivers and lakes. Breeding migration is carried out in school during the onset of rainy season. They move from deep swampy areas or lakes to flowing shallow streams to spawn. Clariidae is divided into two genera: Clarias and Heterobranchus.

They have broad flattened heads, which are rough and granular with wide mouth. They have strong spines in front of each pectoral fin and

also a structure situated close to the gills which aids breathing for some time outside water. The main distinguishing feature between *Clarias* and *Heterobranchus* is that *Clarias* has rayed dorsal fin which extends the entire body length of the fish while *Heterobranchus* has a rayed dorsal fin followed by a large adipose fin.

**(a) Genus *Clarias***

These species are so identical that one could hardly make distinction between them. They are widely distributed around West Africa and Clarias gariepinus remains the most widely cultured fish species in Nigeria for commercial purpose. Other species are *Clarias anguillaris, C. jaensis, C. macromystax, C. albopunctatus, C. camerunensis, C. agboyiensis, C. dahomgensis, C. pachynema.* The head length is about 30.8% of the standard length, front fontanel long and narrow and distance between extremes of dorsal fin and origin of caudal fin is 0.0-7.6% of standard length. Vomerine teeth are present and are mostly pointed or granular. *C. gariepinus* is an omnivorous bottom feeder, feeding on plankton, detritus, insect larva, small fishes such as Tilapia and *Alestes*.

***Clarias gariepinus* (Burchell, 1822).**

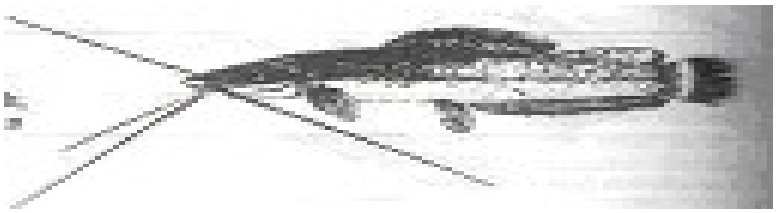
**(b) Genus *Heterobranchus***

There are three species of Heterobranchus widely distributed about in West Africa. They are *Heterobranchus bidorsalis*, *H. longifilis* and *H. isopterus*, *H. bidorsalis* and *H. longifilis* are the most I portent commercial species in Nigeria. Growth is very rapid and it can reach up to 1.5m in length with a weight of 30kg. The head is well depressed and coarsely granulated more than Clarias. Vomerine which is 20.8-255 head length, premaxillary with 25.2-30.9% head length and the dorsal fin consists of the rayed fin and the adipose fin which has no spot. It is an omnivore, feeding on seeds, fruits, other plant materials, gastropods, crustaceans*, Chrysichthys spp*., *Tilapia spp*. and *Brycinus spp*.

**Reasons for Wide Culturing of *Clarias***

1. It is generally acceptable in the market
2. It can breed in captivity
3. Clarias are omnivores and so can be fed with varieties of food materials
4. It has sweet flavor and highly palatable
5. It has ability to withstand stress where other types of fish can not survive.

***Heterobranchus bidorsalis* (Geoffrey Saint-Hilaire, 1809 )**



***Heterobranchus longifilis* (Valenciennes, 1840)**

***Heterobranchus isopterus* (Blecker, 1863)**

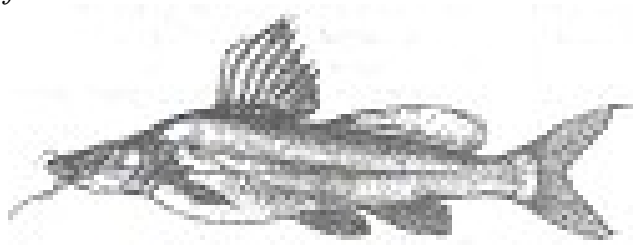
## 3.3.2 Family Bagridae

This family has five genera and these are: Bagrus, Chrysichthys, Clarotes, Anchenoglanis and Parauchenoglanis. The most common species to Nigeria are: *Bagrus domac niger*, *Chrysichthys nigrodigitatus, Chrysichthys auratus, Chrysichthys funcatus, Clarotes laticeps, Clarotes macrocephalus,* and *Bagrus bayad.*

Family Bagridae are also scales but moderately elongated. They have two dorsal fins, the first rayed in all and the second being adipose fin which is large in genera Bagrus and Anchenoglanis but small in Chrysichthys and Clarotes. They have two pairs of maxillary barbells, one pair of maxillary barbells and one pair of nasal barbells present.

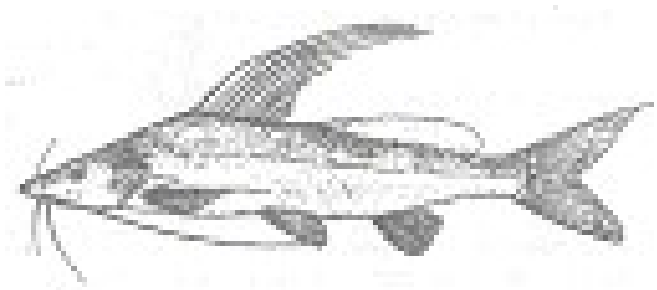
### (a) Genus *Bagrus*

This genus has moderately elongated body and is bluish-grey. It has four pairs of barbells and common species are *B. bayad, B. docmac* and *B. filamentosus.*



***Bagrus docmak*(Forsskall, 1775)**

***Bagrus bayad* (Forsskall, 1775)**



*Bagrus filamentosus* (Pellegrin, 1924)

### (b) Genus *Chrysichthys*

The common species in this genus are: *Chrysichthys nigrodigitatus, C. walkeri*, *C. auratu*s, *C. furcatus* and *C. aluuensis.* They are referred to as silver catfish and have protruding oval-shapes, bulbous eyes. The first large dorsal fin has 5-6 rays proceeded by 1-2 spines.

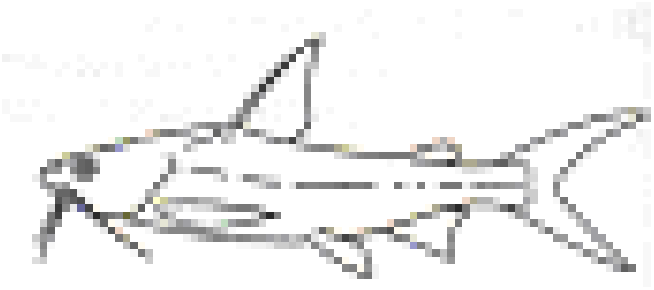
### (c) Genus *Clarotes*

This genus comprises of mainly *Clarotes laticeps* and *Clarotes macrocephalus* as member species. They are basically bottom dwellers in water bodies such as swamps, rivers and lakes. The head of *C. laticeps* is relatively small and cranium ornamentation easily visible but which is not easily visible in *C. macrocephalus*. *C. laticeps* can weigh up to 8kg- 10kg at 70cm in length while *C. macrocephalus* of 10kg

would be about 1000cm. They are piscivorous in feeding habit preying on prawns, species of tilapia, alestes, clupeids and synodontis.

### 3.3.3 Family Ariidae

The common species in this family are *Arius latiscutatus*, *A. gigas,* and *A. heudeloti.* They are commonly referred to as marine catfish being mostly found in marine waters. Apart from *A. gigas* which appears to be the only pure fresh water species all others belong to estuaries, mouth of rivers and lagoon habitats. Members of the Ariidae family are known to live solitary life, piscivorous with inferior mouth type predating small fish species and prawns. They have adipose fin and can weigh up to 50kg.

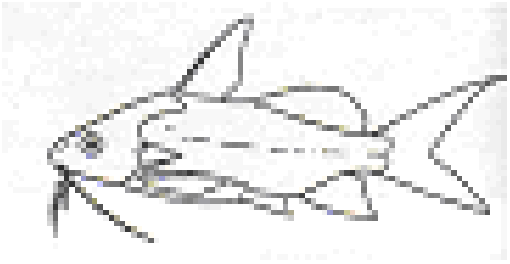


***Arius gigas***

### 3.3.4 Family Mochokidae

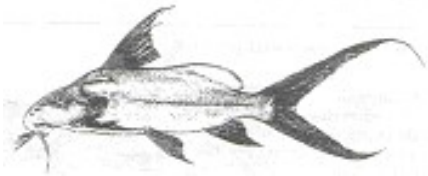
This family consists of basically five genera; Mochocus, Brachysynodontis, Hemisynodontis, Synodontis and Chiloglanis accounting for over twenty species all together. They are characterised by short, stumpy bodies and a bony (cephalonuchal) head shield, both the dorsal and anal fins have serrated spine, which can be locked in an extended position. It is used in self defense which makes it difficult to catch or handle the fish with bare hand. They have large adipose fin extending from the end of the first dorsal fin to the caudal fin. They are referred to as up-side down catfish. Common species of this family include *Synodontis clarias*, *S. resupinatus*, *S. budgetti*, *S. batensoda*, *S. sorex*, S. vermiculatus, *S. ocellifer*, *S. omias*, *S. gambiensis, S. eupterus*, *S. gobroni*, *Mochocus niloticus, Hemisynodontis membranaceous, Chiloglanis niloticus, C. batessi.*

They are characterised by inferior mouth type with barbells and feed mostly on insect larva, detritus, algae and small invertebrates attached to rocks or other under-water-surfaces.



***Mochokus spp***

***Synodontis vermiculatus*** **(Daget, 1954)**



***Synodontis sorex*****(Gunther, 1864)**

***Synodontis violaceus*** **(Pellegrin, 1919)**

***Synodontis courteti*****(Pellegrin, 1906)**

### 3.3.5 Family Cichlidae (Tilapia)

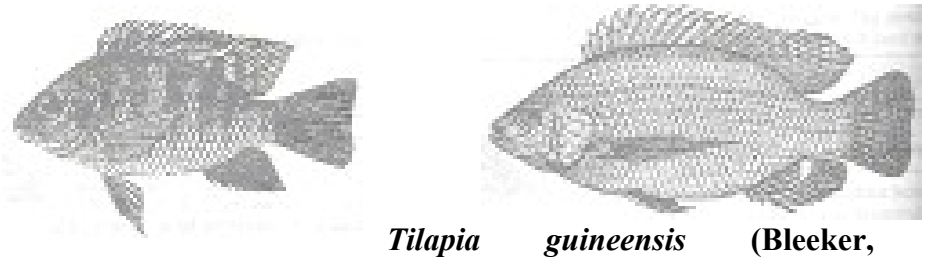
Tilapia are mostly regarded as herbivores but they have been found to also feed on small invertebrates or on small size fishes in which case are better regarded as omnivores. They have usually large cycloid scales and body is laterally compressed. They possess two lateral lines with the upper one running from the head to the base or the end of the dorsal fin and the second running below from the end of the dorsal fin to the caudal fin. The dorsal fin consists of a spiny first half and the second soft-branched rays without a break. Tilapias are characterised by high fecundity in reproduction and are fond of guarding their young ones. There is presence of black spot on tilapia that is more pronounced in the juveniles but which become less conspicuous in the adult. Tilapia have up to six genera which are; *Chromidotilapia*, *Hemichromis*, *Oreochromis*, *Tilapia, Sarotherodon* and *Tylochromis*. They are usually found moving in schools (gregarious).

**Reasons for Culturing Tilapia**

(i) They can grow well on low protein food substances.
(ii) They breed with high fecundity
(iii) They can tolerate wide range of environmental condition.
(iv) The flesh of tilapia is sweet and highly palatable
(v) They can easily convert agricultural wastes to feed ingredient efficiently

(vi) Tilapia can be stocked intensively and under various culture systems

Some of the common known species are *Tilapia zillii*, *T. rendalli*, *Oreochromis niloticus*, *O. mossambicus*, *O. aureus*, *Sarotherodon galilaeus*, *S. melanotheron*, *Hemichromis fasciatus*, and *H. bimaculatus.*



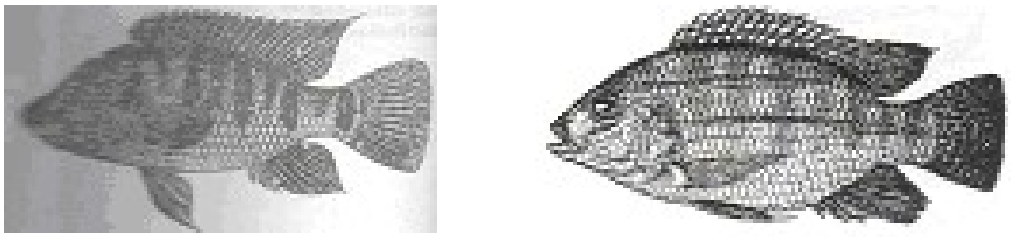
***Tilapia guineensis* (Bleeker, 1862)**

***Oreochromis niloticus* (Linne, 1758)**

*Oreochromis aureus* (Steindachner, 1864)

*Chromidotilapia guntheri guntheri*

(Sauvage, 1882)



***Hemichromis fasciatus* (Peters, 1852)** ***Tilapia zilli* (Gervais, 1848)**

## 3.4 Some Commercially Important Shellfish Species in Nigeria

The shell fish resources of Nigeria waters include marine shrimps, crabs, lobsters, oysters e.t.c. These shell fishes have proven to be very resourceful in terms of rich protein sources in the diets of man and being a good source of foreign exchange thereby enriching Nigerian economy. Artisanal and industrial fishing activities are of great importance in our coastal and marine waters. Artisanal sector consists of small sub-sectors such as lagoon, estuarine and inshore canoe fisheries, which are characterised by low capital outlay and remains the main source of fish production in Nigeria. The industrial sector however involves high capital outlay required to employ advance technology, purchase vessels and build cold storage e.t.c.

### 3.4.1 Shrimps and Prawns

Shrimps and pawns are used jointly in most parts of the world in a state of confusion. In most recent aquaculture study, the name prawn appears to be used for fresh water forms of Palaemonids and shrimps for the others, particularly the marine species. Shrimps and prawns have become high-value commodities in many developing countries, including Nigeria mainly because of their export market potential. Species of prawn (Palaemonidae) include *Palaemonetes monodon*, *P. indicus*, and *P. orientalis* while family Penaeidae includes species such as *Panaeus orientalis*, *P. monodon*, *P. japonicus* and *P. setiferus*.

In the present state of knowledge on shrimp nutrition, fresh food continues to be important in larval and fry rearing, as well as adult grow-out. Commercial feeds are becoming available in many areas, but their acceptance in commercial farming is rather slow. When used, many farmers supplement them with natural foods and feedstuffs.

### 3.4.2 Crayfishes and Crabs

Aquaculturists worldover have devoted more time for the culture of crayfishes (crawfishes), lobsters and crabs due to high market demand for them. However, it is only crayfishes that presently account for any significant production through culture and some small-scale production of crabs have also been exported from tropical countries, Nigeria exclusive. The long time (gestation period) the juveniles take to grow to market size and pronounced cannibalism at both larva and adult stages, have made available technologies for culture uneconomical commercially. Crayfishes belong to families Cambaridae and Astacidae and it is widely distributed over all continents including Africa. The most important species include *Procambarus clarkii*, *Pacifastacus leniusculus*, *and P. acutus*.

The breeding season of crayfish is around September when rising water level entices the females to release the young and become more active outside their burrows. Crayfish are omnivorous but the bulk of their diet consists of microbial-enriched detritus. Vascular plants and epiphytes are also relished as food items while animal matters or remains such as worms, insect larva, mollusks and zooplankton are very much preferred by juvenile crayfish.

Crabs belong to the family *Brachyura* and the common species for commercial purpose is the Pre-moult blue crabs (*Callinectes sapidus*) in the U.S.A. Apart from this, Japan has been the country with the widest or largest commercial production level of crab in the world. Seed stock

of the Japanese blue crab *Neptunus pelagicus* is regularly produced in hatcheries for stocking open waters as well as larva of *Portunus trituberculatus*. Other successfully spawned species in Japan is the king crab, *Paralithodes camtschatica*. This stage of crab production is however not met by Nigeria aquaculture status as it is under exploited.

There are three groups of marine crabs found in Nigeria waters. They are:

(a) The estuarine species which include members of the family *Gecarcinidae* and *Grapsidae.*
(b) The swimming species in inshore waters all belonging to the family *Portunidae*.
(c) The deep sea crabs, mainly *Geryonidae*, which form is an important component of the benthic ecosystem on the continental shelf.

### 3.4.3 Oysters

Cultivated oysters belong to two genera: *Crassostrea* (the cupped oysters) and *Ostrea* (flat oysters). Though aquaculture production of cupped oysters is much higher than that of flat oysters, the latter are held in greater esteem to be served on the half-shell, and command a much higher price in many countries. The more important species being cultivated world over are; *Crassostrea gigas* (Pacific oyster), *C. virginica* (American oyster), *C. angulata* (Portuguese oyster), *C. commercialis* (Sydney rock oyster), *C. glomerata* (Auckland rock oyster), *C. plicatula* (Chinese oyster), *C. rivularis* (Chinese oyster), *Ostrea edulis* (European oyster), *Ostrea edulis* (European oyster), *O. chilensis* (Chilean oyster) and *Crassostrea gasar* (Mangrove oyster).

Although, not yet at commercial production stage, *Crassostrea gasar* is found in abundance in mangrove water of Nigeria coastal swamps and have been exploited subsistently. Other bivalves that are being exploited in Nigeria include the ark clams *Senilla senilis*, *Anadara senegalensis* and *Cardium costratum*.

## 3.5 Classification of Some Exotic/Foreign Fin Fish Species

### 3.5.1 Order Acipenseriformes (Sturgeons and Paddlefishes)

This order contains two families, the sturgeons (Acipenseridae) and the paddlefishes (Polyodontidae - see below) both of which occur in North America. These fishes are found in freshwaters; however, some are anadromous. (Anadromous fish are born in fresh water, migrate to the ocean to grow into adults, and then return to fresh water to spawn.) They

are among the largest freshwater fishes, and are remnants of an ancient and primitive group. Members of this order have largely cartilaginous skeletons, upper jaws that are not united with the skull, and heterocercal caudal fins. (Heterocercal caudal fin which means that the upper lobe is larger than the lower lobe and produces a downward thrust; when used with the pectoral fins it provides a forward motion.

### 3.5.2 Order Lepisosteiformes (Gars)

This order consists of a single family, 2 genera and 7 species worldwide with 5 of them in North America. Gars are mostly fresh water and are long, slender, predatory fishes covered with interlocking ganoid scales that protect them from most predators. Extremely hardy, gars typically inhabit quiet, weedy backwater areas. They have elongated jaws with needle-like teeth, and are equipped with a vascularised swim bladder to permit aerial respiration. The single dorsal fin is located posteriorly on the body above the anal fin.

### 3.5.3 Order Cypriniformes (Minnows Carps and Suckers)

This order of fish has 2,662 species, with the greatest diversity of species found in Southeastern Asia. All the fish in this order lack teeth in their mouths. Many species are used for food, aquarium fish, or research. Some common examples are the goldfish, minnows, and loaches.

### 3.5.4 Order Siluriformes (North American catfishes)

This large order contains 34 families, but in the US there are only 2 native families with most beloning to the Ictaluridae. North American catfishes are closely related to the Cypriniformes because both groups have an organ connecting the swim bladder with the inner ear, providing excellent hearing. The Ictaluridae have four pairs of barbells, an adipose fin, and each dorsal and pectoral fin has a single spine.

### 3.5.5 Order Esociformes (Pikes and Pickerels)

There are two families in this small order, both of which occur in North America. These freshwater fishes have elongated to relatively elongated bodies, with the dorsal and anals fins located far back on the body. They lack adipose fins, and breeding males do not have tubercles.

### 3.5.6 Order Salmoniformes (Trout and Salmon)

This order contains 2 families, both of which are found in North America. Smelts (Osmeridae) and Trouts and Salmons (Salmonidae). They include freshwater, marine, anadromous, and deep-sea species. All have soft-rayed fins, adipose fins, and abdominal pelvic fins.

### 3.5.7 Order Scorpaeniformes (Sculpins)

Head and body tend to be spiny or have bony plates; pectoral fin usually rounded, membranes between lower rays often incised; caudal fin usually rounded (occasionally truncate, rarely forked).

### 3.5.8 Order Perciformes (Temperate Basses, Sunfish, Perches, and Drums)

Perciformes is not only the largest order of fish, but also the largest order of all vertebrates. There are 9,293 species, which is more than one third of all the fish species in the world. Most members of this order are marine fish, but about 2,000 species are fresh water. Many species of marine fish do spend part of their life cycle in freshwater.

## 4.0 CONCLUSION

In this unit, you have learnt how to classify fish species based on their family level. You have also learnt how to distinguish between categories of fish based on their habitat

## 5.0 SUMMARY

It is important to know the class to which a fish species belongs. Perhaps, such a fish could be well represented when preparing grounds for its culture several other merits abound, such are the existence of exotic species which in one way or another may find itself relevant in our environment while the exotic species are mostly from the temperate region.

Therefore understanding these features could assist in expanding aquaculture activities in the country through relating other existing species to the already cultured ones in the country.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Why is aquaculture synonymous to catfish in Nigeria?

2. Describe a named commercially important shellfish species in Nigeria.

## 7.0 REFERENCES/FURTHER READINGS

Idodo-Umeh, G. (2003). *Freshwater Fishes of Nigeria*, pp 232.

Olaosebikan, B.D and Aminu R (1998). *Field Guide to Nigerian Freshwater Fishes*. Federal College of Freshwater Fisheries Technology, New Bussa, Nigeria.

# UNIT 4 ADAPTATION OF ORGANISMS TO AQUATIC LIFE AND EVOLUTION

## CONTENTS



## 1.0 INTRODUCTION

Aquatic environment include freshwater, brackish water and marine which are all in various forms. Fresh water may include lakes and ponds which are static or standing (lentic habitat) while rivers, marine water or ocean is moving or running (lotic habitat) and the study of fresh water ecosystems is known as limnology. Because of the particular environmental effect posed by the different water bodies and across different climatic regions some unique combinations of adaptive

features have evolved for the survival of fish. These include adaptations to arid conditions, variable water levels, fire and high salinity.

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- draw the diagram of the bio-zones
- identify some features that help organisms adapt to certain bio-zones
- mention organisms that have adapted to different bio-zones.

## 3.0 MAIN CONTENT

### 3.1 Aquatic Habitat

Aquatic Life, in this context, relates to organisms that either permanently or periodically inhabits areas associated with permanent or ephemeral freshwater or naturally saline systems and riparian zones. Such areas include rivers, streams, creeks, lakes (permanent or ephemeral), swamps and floodplains. These organisms include crustaceans, fish, turtles and aquatic flora. Open Ocean or pelagic organisms live in four major bio-zones known as the epipelagic, mesopelagic, bathypelagic, and abyssopelagic zones. Several scientists define these zones with the following depths:

- The epipelagic zone (0-100 meters) is the zone in which sufficient light penetrates to allow photosynthesis.
- The mesopelagic zone extends from depths of approximately 200 meters to 1000 meters.
- The bathypelagic zone extends from 1000 meters to 3000 meters, and
- The abyssopelagic zone extends from 3000 meters to the bottom.

The physical environment of these zones varies with the availability of light, oxygen and food resources, pressure levels, and temperature. These physical factors allow a great diversity of organisms. Some organisms may be found in only one zone, while others inhabit more than one zone. Under these varying conditions, marine organisms have adapted and survived. To survive, these organisms must secure food, avoid predation, and successfully reproduce. Adaptive features may include size, coloration, defensive and reproductive strategies, bioluminescence, and specialised teeth and jaws. Due to the limited amount of food in the lower zones, larger organisms tend to live in the upper zones, while organisms living in deep water tend to be smaller. However, there are certain limiting factors to their existence in water and these are given below.

## 3.2 Important Limiting Factors in Aquatic Habitat

**(i)** **Temperature**: Pond waters and lakes undergo seasonal changes in temperature annually and these results in the creation of definite patterns of circulation and stratification of water column. Since aquatic organisms which include fish have narrow tolerance in water temperature levels, it thus greatly influences their activities.

**(ii)** **Dissolved Oxygen**: The total amount of oxygen that dissolved in water is the one available for aquatic animals to use since fish do not depend on atmospheric oxygen for survival. The amount of dissolved oxygen in water has been discovered to be greatest near the surface while it decreases with depth.

**(iii)** **Salinity**: Concentration of salt in which aquatic organisms is found varies greatly from fresh water to brackish and marine waters. This clear distinction gave rise to categorisation of certain fish species into fresh water fish and marine or brackish water fish species thereby averting problem of osmoregulation.

**(iv)** **Light**: Light penetration can be affected by suspended solids thereby affecting turbidity of the water body. It plays a vital role in photosynthetic activities of various aquatic plants.

**(v)** **Currents**: The surface waves caused by the wind pressure affect the shore line and shore organisms consequently, currents affect the distribution of nutrients and small aquatic organisms in the water.

## 3.3 Classes of Aquatic Organisms

Fresh water organisms can be classified as follows:

**(i)** **Benthos**- These are bottom dwelling organisms e.g. flatworms and rhizopods.
**(ii)** **Periphyton**-These are organisms with attaching mechanisms to the rest of plants or projecting surfaces like rock e.g. algae and diatoms.
**(iii)** **Plankton**- These are floating organisms whose movements depends upon currents e.g. diatoms and desmids.
**(iv)** **Nekton**- Theses are swimming organisms such as fish and amphibians.
**(v)** **Neuston**- They are organisms resting or swimming on surface e.g. insects.

## 3.4 Adaptation of Fish Aquatic Environment

Adaptation is a natural phenomenon which is applicable to all living organisms including fish. It is the capacity possessed by the organism living in an environment to utilise the resources available within the environment, undergo development, reproduce at maturity and participate fully in all the ecologically essential dynamic processes that help in sustaining the ecosystem.

Fish is known to be capable of surviving in other environments into which they may be introduced, only if the ecological condition of the place is similar to that from which they were brought. They may need to develop certain structures which may allow their compatibility with the new place over time while some may fail. This however accounts for the restrictions of certain fish species to some water bodies in particular.

Most adaptive features in fish are inheritable which are passed on from generation to generation. Basically, there are three groups of such adaptive features namely; Structural, Physiological and Behavioral features.

### 3.4.1 Structural Features

The structural features are by far the most obvious to any observer. This include fins (dorsal, pectoral, pelvic and caudal fin), possession of spines or bony structures, presence or absence of scales on the body. Other structures may be associated with differences in fish feeding habit due to variations in the position of the mouth, presence of different forms of dentition. While some have vomerine teeth-like structure, others may have granular or canine teeth-like structures. The possession of adipose fin is another form of such adaptive features which is a modification of the dorsal fin and generally fish have streamlined body, which is more or less egg-shaped and tapering posteriorly thereby facilitating movement along water course without friction.

### 3.4.2 Physiological Features

This includes the production of specific enzymes or certain physiological activities especially that are connected with feeding and digestion processes. The presence of fine and numerous gill rakers in some fish differentiates microphagous feeders from macrophagous feeders with few and very strong gill rakers.

### 3.4.3 Behavioural Features

Behavioral traits of fish may want to appear the same with physiological trait but, they are different in that the former is seen and known to be displayed by fish at all times. The persistent quick movement of the opercular plate in fish during water exchange for gas is different in fresh water fish species and marine with high salt content. Similarly, the migratory pattern of some fishes and shellfishes from fresh water to marine or brackish water habitat or vice versa is an adaptive way to managing the salt level of the water bodies to match their needs during their life cycle.

Certain species of fish are prolific producers of young ones such as tilapia and some are mouth brooders. This habit is developed for the purpose of protecting young ones during adverse situations or on sighting enemy thereby ensuring species sustainability.

## 3.5 Adaptation of Plants to Aquatic Life

Living in a marsh environment is a tradeoff for plants. On the one hand, they are protected from drought and extreme temperature variation, and they enjoy an abundant nutrient source. On the other hand, light may be inadequate, oxygen may be scarce at night, and reproduction must be modified. Despite these disadvantages, aquatic plants are so well adapted to this habitat that most are found only where there is water. This section looks at the unique strategies of aquatic plants for photosynthesis, gas exchange, support, and reproduction.

### 3.5.1 Photosynthesis

Sunlight available to submergent (underwater) plants is often limited, especially in a marsh with a high plankton density, such as the enhancement marshes. Many submergent plants have extra chloroplasts in the outer cell layers of their leaves and stems. In contrast, terrestrial plants protect their chloroplasts with a cuticle, since strong sunlight can harm chloroplasts.

### 3.5.2 Gas Exchange and Support

Common to almost all aquatic plants is air passages and special leaf structure. In emergent plants (those rooted in shallow water), large air passages transport oxygen from the stems and leaves to waterlogged roots. These passages give the plants strong, erect stems and leaves.

In floating-leaf plants, such as water lilies, air chambers in both the stems and the leaves provide buoyancy. Also, whereas terrestrial plants have stomata¼s on the undersides of their leaves, floating leaves have them only on the upper side.

In submergent plants, air passages not only provide buoyancy but also allow for oxygen storage, to supply oxygen at night. Since submergent plants must obtain oxygen from the water, their leaves are very thin and extensively partitioned, allowing for gas exchange directly through the cell walls. Water marigold has this type of leaf below the surface, but the leaves above water exchange gases through stomata's. Reproduction and Winter Survival: A variety of reproductive strategies are found among aquatic plants. In many cases, plants reproduce vegetatively some or all of the time. Some plants are perennial. Those that reproduce asexually often capitalise on the water for pollination and/or seed dispersal.

Even among submergent plants, pollination and seed dispersal usually take place above the water's surface. Wild celery produces male and female flowers. The female flowers are suspended on long stalks extending to the surface. Male flowers develop underwater, float to the surface, open, and drift until they contact a female flower. The female flower is pollinated and then coils down into the water, where the seeds develop.

Cattails, with their familiar “cigar heads” full of seeds, have male and female flowers. Wind carries pollen from the male to the female flowers. After the seeds develop, the water transports them until they settle in a suitable location.

Many aquatic plants use vegetative reproduction some or all of the time. Cattail, pondweed, and water lilies all produce thick rhizomes which serve for both reproduction and food storage. Arrowhead produces tubers, popularly called duck potatoes. The tubers survive over the winter and produce new plants in the spring.

Still other plants use over wintering strategies to survive from one year to the next. Duckweed is one example; this plant rarely produces seeds. As winter approaches, duckweed produces small fronds with undeveloped roots. They accumulate starch reserves, sink to the bottom under their own weight, and remain there throughout the winter. In the spring, as starch is used up in respiration, air spaces develop in the tissues, and the fronds become lighter and float to the surface.

### 3.5.3 Freshwater Zonation

There is a pattern where freshwater plants can grow. Whereas some are found in only the shallowest water, others survive in deeper water. Because depth controls where plants grow, they form zones. Herbaceous plants are categorised according to their position relative to the water.

Emergent plants (cattails, bulrushes, and sedges), grow close to the shore. Rooted in muddy soil or shallow water, they send up tough, rigid stalks and leave as much as six feet above the surface.

Floating-leaf plants (marsh pennywort, lilies, and spatterdock) are rooted underwater. Their flexible, air-filled stems support broad leaves that float on the surface. Since the stems may be several feet long, these plants survive in deeper water than emergent plants.

Submergent plants (widgeon grass, milfoil, and coontail), with weak stems and feathery leaves, grow completely underwater. Thus, they can grow in still deeper water, provided it is clear enough for light to penetrate.

Free-floating plants (duckweed) float on the surface and are not limited by depth. Their dangling roots obtain nutrients from the water. These tiny plants multiply rapidly and form a bright green mat on the water's surface.

Because each type of plant is limited to a range of depth, the plants form zones. The deeper water supports only free-floating and submergent plants, floating-leaf plants grow in somewhat shallower water, and emergent plants are restricted to the shallow perimeter. Although unseen, phytoplankton is a significant marsh producer limited only by the availability of sunlight.

Zonation, or the pattern of growth according to depth, is visible in the enhancement marshes. Because of the shallow depths of the enhancement marshes (typically 1 1/2 to 3 feet), zones are less pronounced than they would be in deeper ponds. The following should be noted about aquatic plants:

- Emergent plants grow only in the shallowest water,
- Floating attached plants are limited by the length, to which their stems can grow,
- Submergent plants are limited by the penetration of light through the water;
  Floating unattached plants are relatively unrestricted by depth.

### 3.5.4 Succession

Succession, the series of replacements of one community by another, occurs in a pond or marsh as organisms die and fall to the bottom. Gradually it fills in and becomes shallower, sometimes over thousands of years. Species previously excluded by depth are able to colonise. The presence of a substantial amount of emergent vegetation marks the transition from pond to marsh. Eventually the marsh dries and is taken over by grasses, then moisture-tolerant woody species (willows and alders), and eventually, hardwoods and conifers.

The stages of succession are reflected by the pattern of zonation from open water to dry land. Imagine starting at the center of the marsh and travelling outward. The progression can be seen as a travel through time, from pond community to more advanced successional communities.

With regard to succession, the enhancement marshes are different from natural marshes in that they are manipulated, through routine harvesting, to retain their marsh characteristics (i.e., prevent succession). Nevertheless, it is important to know that visible stages of succession are a reminder that ecosystems are continually changing.

## 3.6 Evolution and the Study of Fish (Ichtyology)

The early fossil record on fish is not very clear. It appears it was not a successful enough animal early in its evolution to leave many fossils. However, this would eventually change over time as it became a dominant form of sea life and eventually branching to include land vertebrtaes such as amphibian, reptiles, and mammals.

The formation of the hinged jaw appears to be what resulted in the later proliferation of fish because un-jawed fish left very few ancestors. Lampreys may be a rough representative of pre-jawed fish. The first jaws are found in Placodermi fossils. It is unclear if the advantage of a hinged jaw is greater biting force, respiratory-related, or a combination.

Some speculate that fish may have evolved from a creature similar to a coral-like Sea squirt, whose larvae resemble primitive fish in some key ways. The first ancestors of fish may have kept the larval form into adulthood (as some sea squirts do today) known as neoteny, although the reversal of this case is also possible. Candidates for early fish include Agnatha such as Haikouichthys, Myllokunmingia, Pikaia and Conodonts

## 3.7 History of the Study of Fish

The study of fishes dates from the Upper Paleolithic Revolution (with the advent of 'high culture'). The science of ichthyology was developed in several interconnecting epochs, each with various significant advancements.

### 3.7.1 Pre-Historical Era (38,000 BC- 1500 BC)

The study of fish receives its origins from the human desire to feed, clothe, and equip themselves with useful implements. The earliest ichthyologists were hunters and gatherers who had learned how to obtain the most useful fishes, where to obtain them in abundance and at what times they might be the most available." These insights of early cultures were manifested in abstract and identifiable artistic expressions.

### 3.7.2 Judeo-Christian Era (1500 BC – 40 AD)

Informal, scientific descriptions of fish are represented within the Judeo-Christian tradition. Moses, in the development of the kashrut, forbade the consumption of fish without scales or appendages. Theologians and ichthyologists speculate that the apostle Peter and his contemporaries harvested the fish that are today sold in modern industry along the Sea of Galilee, presently known as Lake Kinneret. These fish include cyprinids of the genus *Barbus* and *Mirogrex*, cichlids of the genus *Sarotherodon*, and *Mugil cephalus* of the family *Mugilidae.*

### 3.7.3 Mediterranean Era (335 BC–80 AD)

Aristotle incorporated ichthyology into formal scientific study. Between 335 BC–322 BC, he provided the earliest taxonomic classification of fish, in which 117 species of Mediterranean fish were accurately described. Furthermore, Aristotle observed the anatomical and behavioral differences between fish and marine mammals. Preceding his death, some of his pupils continued his ichthyological research. Theophrastus, for example, composed a treatise on amphibious fish. The Romans, although less devoted to the pursuit of science, wrote extensively about fish. Pliny the Elder, a notable Roman naturalist, compiled the ichthyological works of indigenous Greek, including verifiable and ambiguous peculiarities such as the sawfish and mermaid respectively. Pliny's documentation was the last significant contribution to ichthyology until the European Renaissance.

### 3.7.4 European Renaissance Era (13th–16th Century)

The writings of three sixteenth century scholars, Hippolyte Salviani, Pierre Belon, and Guillaume Rondelet, signify the conception of modern ichthyology. The investigations of these individuals were based upon actual research in comparison to ancient recitations. This property popularised and emphasised these discoveries. Despite their prominence, Rondelet's De *Piscibus Marinum* is regarded as the most influential, identifying 244 species of fish.

### 3.7.5 Exploration and Colonisation Era (16th–17th Century)

The incremental alterations in navigation and shipbuilding throughout the Renaissance marked the commencement of a new epoch in ichthyology. The Renaissance culminated with the era of exploration and colonisation, and upon the cosmopolitan interest in navigation came the specialisation in naturalism. Georg Marcgrave of Saxony composed the *Naturalis Brasilae* in 1648. This document contained a description of 100 species of fish indigenous to the Brazilian coastline. In 1686, John Ray and Francis Willighuby collaboratively published *Historia Piscium*, a scientific manuscript containing 420 species of fish, 178 of these newly discovered. The fish contained within this informative literature were arranged in a provisional system of classification.

The classification used within the *Historia Piscium* was invented by Carolus Linnaeus, the "father of modern taxonomy". His taxonomic approach became the systematic approach to the study of organisms, including fish. Linnaeus was a professor at the University of Uppsala and an eminent botanist; however, one of his colleagues, Peter Artedi, earned the title "father of ichthyology" through his indispensable advancements. Artedi contributed to Linnaeus's refinement of the principles of taxonomy. Furthermore, he recognized five additional orders of fish: Malacopterygii, Acanthopterygii, Branchiostegi, Chondropterygii, and Plagiuri. Artedi developed standard methods for making counts and measurements of anatomical features that are modernly exploited. Another associate of Linnaeus, Albertus Seba, was a prosperous pharmacist from Amsterdam. Seba assembled a cabinet, or collection, of fish. He invited Artedi to utilise this assortment of fish; unfortunately, in 1735, Artedi fell into an Amsterdam canal and drowned at the age of 30.

Linnaeus posthumously published Artedi's manuscripts as *Ichthyologia, sive Opera Omnia de Piscibus* (1738). His refinement of taxonomy was culminated subsequent to the development of the binomial nomenclature which is in use by contemporary ichthyologists. Furthermore, he revised the orders introduced by Artedi, placing significance on pelvic fins. Fish

lacking this appendage were placed within the order Apodes; fish containing abdominal, thoracic, or jugular pelvic fins were termed Abdominales, Thoracici, and Jugulares respectively. However, these alterations were not grounded within the evolutionary theory. Therefore, it would take over a century until Charles Darwin would provide the intellectual foundation from which we would be permitted to perceive that the degree of similarity in taxonomic features was a consequence of phylogenetic relationship.

### 3.7.6 Modern Era (17th Century–Present)

Close to the dawn of the nineteenth century, Marcus Elieser Bloch of Berlin and Gorges Cuvier of Paris made an attempt to consolidate the knowledge of ichthyology. Cuvier summarized all of the available information in his monumental *Histoire Naturelle des Poissons*. This manuscript was published between 1828 and 1849 in a 22 volume series. This documentation contained 4,514 species of fish, 2,311 of these new to science. This piece of literature still remained one of the most ambitious treatises of the modern world. The scientific exploration of the Americas progressed our knowledge of the remarkable diversity of fish. Charles Alexandre Lesueur, a student of Cuvier, who made a cabinet of fish dwelling within the Great Lakes and Saint Lawrence River regions.

Adventurous individuals such as John James Audubon and Constatine Samuel Rafinesque figure in the faunal documentation of North America. These persons often travelled with one another and composed *Ichthyologia Ohiensis* in 1820. In addition, Louis Agassiz of Switzerland established his reputation through the study of freshwater fish and organisms and the pioneering of paleoichthyology. Agassiz eventually immigrated to the United States and taught at Harvard University in 1846.

## 4.0 CONCLUSION

At the end of the unit, you are expected to know the different bio-zones, identify some features used by organisms to adapt to certain bio-zones

## 5.0 SUMMARY

Various forms of adaptation in living organism (both plants and animals) include:

(i) Adaptation to environment
(ii) Adaptation to changes in environment

(iii) Adaptation for self preservation I environments, including those for offence and defense
(iv) Adaptation for different methods of feeding
(v) Adaptation for biotic interactions such as predation, competition and other forms of mutualism
(vi) Adaptation for reproduction and self perpetuation

## 6.0 TUTOR-MARKED ASSIGNMENT

1. What are the different classes of aquatic organisms?
2. Of what relevance is ichthyology to the development of the aquaculture?

## 7.0 REFERENCES/FURTHER READINGS

Fatubarin A. (1985). *Tropical Ecology. Revision Course in 'A'-Level*, 'N.C.E.' and *Intermediate Biology*.pp 112.

Sharma, B.M (1986). *Introductory Ecology*, pp109.

# UNIT 5 FUNDAMENTAL PRINCIPLES OF FISH PRODUCTION AND MANAGEMENT

## CONTENTS



## 1.0 INTRODUCTION

The seemingly inexhaustible oceans have proved to be finite after all. Landings of wild fish have levelled off since the mid-1980s, many stocks of fish have been so heavily over-fished that their future is threatened. And yet the world's appetite for fish has continued to grow, particularly as urban populations and incomes grow in developing countries. Aquaculture-fish farming-has arrived to meet this increased demand. Production of fish from aquaculture has exploded in the past 20 years and continues to expand round the world with rising global production from 99 million tonnes in 1990 to 122 million tonnes in 1997. Despite the surge increase in aquaculture production around the world, there is still the need to intensify effort in the production of fish

in order to meet up with the ever growing demand of whose world supply deficit is put at 1 million tonnes by year 2010.

Nigeria the second largest aquaculture producer in Africa after Egypt, has increased production from 18,000 tonnes in 1990 to 25,000 tonnes in 1997 and still possesses the potential to produce more provided there is proper utilisation and harnessing of aquatic resources which include fresh water bodies, lakes and reservoirs for fish production.

Basically, aquaculture can simply be said to be the raising of aquatic organisms including plants and animals with bias in fish production. The systems can be grouped into three, which is similar to the culture systems of other livestock.

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- various forms of aquaculture practices
- reasons for embarking on fish farming as a business.

## 3.0 MAIN CONTENT

### 3.1 Aquaculture Practices

Fish farming has continued to be a major agriculture activity in Nigeria transcending beyond riverine activity.

#### 3.1.1 Extensive Aquaculture

In this system, fish is raised and is made to depend solely on pond production capacity, yield per unit area is usually low. It is characterised by low inputs, low stocking density and availability of planktons and other live food materials in the pond are aided by fertilisation. Overall pond yield is very low and is not recommended for large-scale commercial purpose as yield is usually about 500kg per hectare.

#### 3.1.2 Intensive Aquaculture

This system makes use of supplemental (or artificial) feeds. Usually, high level protein rich diet is employed in order to meet up with nutritional requirements of fish. Other management practices are equally made to be intensive, which include medication, constant good water quality supply (flow through or Recirculatory system) thereby resulting in high yield per unit area. Yield can be up to 50 tonnes or more per hectare.

### 3.1.3 Semi-Intensive Aquaculture

Under this system, ponds are fertilised in order to enhance phytoplankton growth and supplemental (artificial) feed is also applied which may occasionally be in small quantity. It may not be a pelleted feed in most cases as in intensive system but in the form of locally available or organic wastes-kitchen wastes, brewery wastes, rice bran, groundnut cake e.t.c. Yield is usually moderately higher than in extensive system but not as huge as in intensive aquaculture system.

## 3.2 Purpose of Fish Farming

Unfortunately, the term "fish farming" often suggests large-scale commercial enterprises directed at the production of food fish for marketing in restaurants and supermarkets. This common misconception of fish farming misleads in many respects.

First, many successful fish farming ventures are small, family- run, "backyard-type" operations that produce a limited number of food fish for sale in local markets. Second, many fish farms do not grow food fish at all, but instead rear (1) eggs and fingerlings (2-4 inch fish) for sale to food fish producers; or (2) fingerling sport fish for stocking in private ponds and streams; or (3) catchable-sized sport fish for stocking in recreational ponds and fee-fishing waters; or (4) bait minnows, frogs, crayfish, worms, and aquatic insects for sale to anglers as fish bait; or (5) goldfish, tropical fish, turtles, and other aquatic animals and plants for sale as aquarium pets. Finally, many successful fish farms are non-commercial, hobby-type operations that simply grow fish for home use and stocking personal recreational fishing ponds.

**Table 1. Fish Farming Purposes**

| Non-Commercial | Commercial |
|---|---|
| • Home-Use Food Fish Production<br>• Personal Recreation Fishing<br>• Personal Fish Bait Production | • Food Fish Production<br>• Egg and Fingerling Sport fish<br>• Catchable-sized Sport fish<br>• Fish Bait Production<br>• Aquarium Pet Production<br>• Fee-fishing/Fish-out Pond |

Of the two major types of fish farming (non-commercial and commercial), growing fish on a non-commercial basis for home-food use or personal recreational fishing is the easiest and least expensive way to begin fish farming. Most fish farmers start small by growing a few fish for fun and expand to large-scale commercial operations only after they gain the necessary skills and experience.

Commercial fish farming is a time-consuming, expensive, high-risk business that requires careful planning, a good understanding of fish biology, and sound business management skills. A careful study of economic considerations, especially product demand, financing, production costs, and marketing should be conducted before investing in a commercial fish farm.

**Table 2: Typical Fish Farming Costs**

| Capital Costs | Operating Costs |
|---|---|
| land | Fish |
| Pond Construction | Feed |
| Buildings | Electricity |
| Hauling Trucks | Fuel |
| Water Supply | Labour |
| Plumbing and Pipes | Transportation |
| Hauling Tanks | Maintenance |
| Aerators | Chemicals |
| Oxygen Meter | Drugs |
| Nets and Seines | Telephone |
| Waders and Boots | Taxes |
| Feeding Equipment | Interest |
| Tractors and Mowers | Insurance |

However, in whichever form aquaculture is to be practised, there are certain cultural practices that are crucial towards ensuring high level performance on the farm.

## 3.3 Fish Pond Preparation and Management

It is a known fact that effective management plays a vital role in the success of aquaculture business both on a large and small-scale level. Effective management can simply be put at proper and timely maintenance of the farm in order to meet up with human needs. Farm implies all activities carried out on the farm and installations which include successful broodstock manipulation, seed production, stocking, sorting of fish into sizes, disease and pest/ predator control, proper water management, control of human poaching, timely harvesting, marketing and adequate record keeping.

Scientifically, farm management considered the basic economic principles in business management. These are comparative advantage, diminishing returns, substitution, cost analysis, opportunity cost, enterprise choice and goal trade-off.

However, despite prudent and genuine application of the highlighted principles, an effective, prompt and timely decision has to be taken. All data collected and analysed based on the application of the basic economic principles cannot make decision by themselves, but they have to be harnessed properly by an expert in the field (manager) in making rational decisions. The decision-maker must be well equipped with good and high level skill of reasoning, an economist, a management specialists as he would have to choose between different alternatives, some of which have uncertain consequences.

Despite all said, personal element, including perceptions to risks involved and personal attitude to consequences, plays a major role in the final decision, even though it is preferable to handling complex decisions by mere intuition.

How much effort and time should be spent on decision analysis would depend on the importance and the decision, time and cost involved in the analysis. In fact, an analysis at the simplest level, consisting of evaluating the various choices available and scrutiny of then consequences of each and the chances of the success, can lead to better management decisions.

### 3.3.1 Site Selection

All meteorological and hydrological information about the area (generally available from a reconnaissance survey), such as range and mean monthly rainfall, evaporation, sunshine ,wind speed and direction, flood, water table, e.t.c., have to be assessed. In inland aquaculture, the most commonly used installations are earthen pond farms (rearing and nurseries ponds) and hatcheries therefore, soil characteristics, the quality and quantity of available water and the ease of filling and drainage by gravitational pull are very essential. The nature of site vegetation indicates the soil type and elevation of the water table. Dense vegetation, particularly tall trees make clearing more difficult and expensive while high ground-water level may create problem of poor drainage and inconvenient use of mechanical equipment for pond construction.

### 3.3.2 Pond Construction

The pond is the environment in which fish live and where all activities relating to its life took place (from stocking to cropping), pond may be earthen or tank. If pond is earthen, it could either be drainable or undrainable. Drainable pond is constructed in a way such that water flows into the pond easily by gravity via inlet pipes from its source and the same pond could be easily emptied also by gravity through outlet

pipes buried into the soil. No mechanical energy is needed to carry out either operation and although it may slower but saves cost. Undrainable pond may have inlet pipes to bring water into the pond, but it is unable to empty pond partly or completely except by a mechanical aid (pumping machine) thereby increasing cost of production. However, a practical experience has equally shown that, the construction and operation of a farm with a pumped water supply system can be more economical than that of a tidal water farm.

Fish tank may be concrete, fibre glass, plastic or wooden and in various sizes and shapes ranging from circular, rectangular to trapezoidal forms for different sizes of fish. It could be sub-surface or made to be completely surface and it is expected that such is protected with locks to prevent human pilfering.

### 3.3.3 Soil Test

Soil analysis of the intending fish pond site is an often over-sighted but very important activity to be undertaken when pond is to be constructed. The quality of soil is important in pond farms, not only because of its influence on productivity and quality of the overlying water, but also because of its suitability for dyke construction. The ability of the pond to retain the required water level is also greatly affected by the characteristics of the soil.

Such soil tests to be carried out vary from simple visual and tactile inspection to detailed subsurface exploration and laboratory tests. Sandy clay to clayey loam soils are considered suitable for pond construction. Texture (relative proportion of sand, silt and clay particles) and porosity are the two most important physical properties to be examined. By mere touch and feel, one can determine the texture of a soil sample. A sample of soil that is kneaded and rolled into a bar and bent to form a ring around the thumb without any cracks must be clayey. If it cannot be made into bar and remains separate with visible grains when dry, the sample is sandy. If the sample does not fall into either of the two categories, then it can be categorised as silt or loam.

### 3.3.4 Water Availability

Availability of good water both in terms of quality and quantity is very essential for successful fish farm operations. The availability in required quantity is particularly important in land based aquaculture systems. It is therefore prescribed to investigate thoroughly, the extent and seasonality of water sources as well as liability to pollution, which may arise from agricultural run-offs, industrial effluents, sewage disposal and flooding. Toxic substance in water supplies can affect aquaculture, particularly in

hatcheries and therefore, regular sampling of pond water must be done in order to forestall crisis on the farm. Among water quality parameters of great importance to aquaculture are pH, dissolved oxygen, nitrite-nitrate ratio, temperature and alkalinity.

Ground water from springs, wells, or underground seepage is the best source of water for fish farms. Other sources of water including surface waters, runoff water, and even municipal water can be used to grow fish. Of course, all sources of water must be free of fish diseases and parasites, nuisance fish, predators, silt, pesticides, chlorine, and other chemicals that are harmful to fish life. A good water supply of sufficient quantity and quality is absolutely essential for all fish farms. Water quality also restricts the type of fish that can be reared and production rates. Which ever the source is, the availability of good water supply round the year remains incontestable. In cases where water source is seasonal but very abundant at the peak of the season, it has become the usual practice in certain part of the world to impound water for aquaculture purposes while a water control device called spillway is put in place where farm is susceptible to flooding. Before considering developing a fish farm, have your water shed tested?

### 3.3.5 Pond Preparation

The pond is completely drained of water and the bottom allowed drying till it cracks. Desalting of the pond is done if the pond is very muddy. The pond must be in proper shape and good status if the purpose, aims and objectives of the culturist must be realized. Therefore the following operations are recommended for execution prior to stocking of pond with fingerlings (baby fish).

### 3.3.6 Drying the Pond Bottom

The pond has to be completely drained of water and the bottom is allowed to dry till it cracks. Desalting of the pond should be carried out if the pond is muddy.

### 3.3.7 Removal of Unwanted Organism and Aquatic Weeds

While drying the pond undesirable organisms e.g. Frogs, mollusks, fish predators and aquatic weeds such as Water hyacinth, *Pistia*, *Lemna* weeds e.t.c are removed. After ensuring this, the pond is fenced round and all inlet and outlet pipes are properly screened while surrounding vegetation is kept low. Dense aquatic vegetation occurring either along the pond margin or inside the pond must also be controlled. These weeds compete with the phytoplankton for available nutrient in the pond water and hence diminish overall pond productivity. Unwanted

organisms like lizards and other reptiles must be chased out or killed as well as crabs and birds while aquatic macrophytes can be removed manually by hand or cutting, mechanically or biologically using grass eaters or herbivorous fish species e.g. *Distochodus spp*., Grass carp e.t.c.

### 3.3.8 Repair of Pond Structures

The essence of site survey and farm planning and design is to ensure convenient and effective utilization of pond or farm facilities once they are properly constructed and fitted. However, it may not be out of place to always ensure that adjoining pond structures such as embankments and monks are checked and repaired if necessary and all cracks and holes sealed before pond is filled up with water. Similarly, fish screens and water filtering structures if clogged are thoroughly cleaned or replaced, damaged pipes replaced and eroded dykes should be strengthened before stocking of pond with fish This activities on the farm in synonymous with ensuring the safety of the entire business by minimising risk sources.

### 3.3.9 Liming and Fertilisation

Liming is done in order to improve conditions for fish production although not in the form of fertilisation but terms of favorable edaphic condition of the pond to bring about increased pond productivity. It also increases soil pH thereby creating room for more available carbon dioxide for phytoplankton to photosynthesise. When pH increases water is prevented from being acidic and so pond mud is able to enhance solubility of phosphates. Adequate liming aids flocculation of colloidal particles and soil microbial activities thereby increases the rate of decomposition of organic matter and cycling of nutrients.

Materials commonly used for liming fish pond include calcium oxide (quick lime), calcium hydroxide (hydrated lime), agricultural limestone, basic slag and liquid lime. In the absence of these, wood ashes can also serve the purpose but will require a large quantity in order to achieve the desired performance.

The rate of application of lime in fish pond varies with pH and the amount of clay and organic matter present in it. Agricultural limestone and basic slag are the only liming material that can be applied in large quantity to pond before stocking and even after stocking pond with fish for some make-ups. Calcium oxide and calcium hydroxide can be toxic to fish and should be applied in small quantity to ponds only before stocking due to their toxic effects. Liming rate range from 200-1000kg/ha of liming material depending on individual potency. The higher application rate is for material like agricultural limestone while

the lower application rates go for material like calcium hydroxide. The pond is immediately filled with water to a depth of about 0.6m and left for 2-4 days to observe any leakages or seepages. It is later filled up to required depth and fertilized.

Fertilisation is however done in order to make water more productive by aiding the growth of natural fish food organisms (planktons). Inorganic fertilizer e.g. Urea and N.P.K. and organic manures are the basic two types of fertilization materials that could serve the purpose.

### 3.3.10 Stocking

Stocking of pond means releasing into the pond an adequate number of selected fish species to be cultured over a specified period of time, which are of uniform size. Stocking is usually done a week after fertilization. Usually stocking density (number of fish species per unit area) of a pond is dependent on the system of culturing, which may be monoculture or polyculture.

Fish fingerlings for stocking ponds can be produced by the farmer himself or purchased from a reputable hatchery and are transported either early in the morning or in the evening. During stocking of pond, fish should be lowered carefully into the water and allowed to swim out of the container after acclimation in order not to further stress them. The pond should be visited the following morning to check for mortality (ies) and if found, should be removed at once and replaced with healthy ones from the same source. Culturable fish species in Nigeria include *Clarias gariepinus*, *Oreochromis niloticus*, *Heterobranchus bidorsalis, Lates niloticus, Gymnachus niloticus, Chrischthys nigrodigitatus, Heterotis niloticus* e.t.c. and many species of shellfish like Oyster and prawn. There are so many possible reasons for raising fish and also available resources are as well of diverse quality therefore it is important to examine all existing factors before deciding what type or species of fish to be cultured.

## 3.4 Species Selection

A wide variety of freshwater fish and other aquatic animals can be farmed in Nigeria. Table 3 lists types that are most frequently considered and which have particular appeal to the masses. Each species listed has been assigned a farming potential rating. These ratings represent “best-guess” estimates based on the amount of information available, previous experience of growers, and consideration of the current economic conditions associated with each fish species as well as their feeding habits.

These ratings can and probably will change as a result of new research, technological advancements, and changing market values.

The opinions range from growing optimism (very good) to guarded pessimism (poor). However, do not let these opinions discourage you from trying to grow fish with a poor rating or others not on the list. The ratings represent only general guidelines. Adventurous fish farmers with sufficient land, water, and economic resources can grow all of these and probably several other aquatic species in Nigeria.

## 3.5 The Ideal Fish for Farming

Although there is no "perfect" fish for farming, the following are desirable biological and economic attributes when selecting the best fish to farm. The fish species should:

1. be capable of reproducing in captivity;
2. produce numerous and hardy eggs and larvae (young);
3. have well-known culture requirements;
4. be adaptable to many types of culture systems;
5. be adaptable to multi-species farming (polyculture);
6. exhibit rapid growth to a large maximum size;
7. readily adapt to artificial feeds;
8. be tolerant of crowding and high density conditions;
9. exhibit high survival (low mortality) rates;
10. be easy to handle, harvest, and transport;
11. be resistant to disease and parasite infestations;
12. not be cannibalistic or territorial;
13. be readily available as eggs, fingerlings, and adults;
14. have a high market demand;
15. exhibit high feed conversion rates;
16. have good dress-out weight values;
17. have a long shelf life;
18. be easy to process;
19. have a healthy appearance and color;
20. have good eating qualities;
21. have highly regarded fighting abilities;
22. be catchable.

**Table3: Consumers Ratings and Availability of Fish Species for Production**

| Species | Consumers acceptability | Availability of fish seeds for stocking | Feeding habits | Remarks |
|---|---|---|---|---|
| *Heterobranchus bidorsalis* | good | Seasonal | Omnivorous | Respond well to fertilizer and supplementary feeding |
| *Distichodus engycephalus* | good | seasonal | Herbivorous | This species keeps aquatic weeds under control in pond |
| *Malapterurus electricus* | good | Seasonal | Predator | Good species of combination with Tilapia polyculture |
| *Maglops atlanticus* | Good | seasonal | Predator | Comes into pond with tides |
| *Cyprinus carpio* | Very good | Year round and adequate | Omnivorous | Respond well to fertilizer and supplementary feeding |
| *Ictalurus punctatus* | Very good | Year round and adequate | Feeds mainly on in sects and craw-fish | Respond well to fertilizer and supplementary feeding |
| *Clarias gariepinus* | good | Year round but in adequate | Omnivorous | Respond well to fertilizer and supplementary feeding |
| *Oreochromis niloticus* | very good | Year round and adequate | Omnivorous | Respond well to fertilizer and supplementary feeding |

**Source: Adapted from Ezenwa (1979)**

## 4.0 CONCLUSION

In this unit you have learnt the various forms of aquaculture practices used in Nigeria.

## 5.0 SUMMARY

Much as aquaculture practices is becoming widely accepted in the country considering the rate of fish farm proliferation, there are stepwise technical and essential aspect of its establishment as well as management in order for the farm to survive. Once the right approach is given beginning from the planning stage to during its establishment and to its running, then the little that will be left could be handling with the attention of an aquaculture expert around hence minimizing cost of production.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Why is fish demand for fish more than its supply in Nigeria?
2. Mention 3 approaches towards the sustainability of our fishery resources.
3. Mention 5 shell and fin fish species enumerated in this unit and give their common names.

## 7.0 REFERENCE/FURTHER READINGS

Ezenwa, B. (1979). *Supplementary Diets in Fish Culture and Feed Formulation Technology in Nigeria*. *NIOMR Occasional Paper No. 30*.

*National Special Programme for Food Security (NSPFS)* (2005). Fish Pond Construction & Management (A Field Guide and Extension manual).

Symoens, J.J and Micha, J.C (1995). *The Management of Integrated Freshwater Agro-Piscicultural Ecosystems in Tropical Areas*. Seminar Proceedings, Brussels, 16-19 May 1994.

# MODULE 2 FUNDAMENTAL PRINCIPLES OF FISH MANAGEMENT IN NIGERIA



## UNIT 1 PRACTICAL WAYS OF ENSURING SUSTAINABLE FISH PRODUCTION IN NIGERIA

**CONTENTS**



## 1.0 INTRODUCTION

Given the growing importance of both production and consumption of global fish products in developing countries, the fish sector would seem to offer important opportunities for poor farmers to increase their

income by producing fish sustainably and to improve and diversify their diets by increased fish consumption. Therefore towards intensifying aquaculture for sustainable purpose, it is important that productivity is raised and intensified.

## 2.0 OBJECTIVES

At the end of this unit, students should be able to:

- understand the role of aquaculture in Africa
- differentiate between aquaculture production and productivity.

## 3.0 MAIN CONTENT

### 3.1 Current Status of Aquaculture in Africa

It is evident that aquaculture has been in practice in Egypt since around 2500 BC, and many traditional methods of capturing and cultivating fish are still in use. Following these early developments, there was however essentially no further major progress in African aquaculture until modern times when serious efforts to promote aquaculture began after the Second World War. The total production of finfish from sub-Saharan Africa in 1995 is estimated to be 29,434 metric tones. Africa's contribution (about 20,000 metric tonnes in 2001) to global fish production remained insignificant at approximately 0.2%. Nigeria is responsible for more than half the production in sub-Saharan Africa, and only six countries (Nigeria, Zambia, Madagascar, Togo, Kenya and South Africa) account for 89% of production. Aquaculture in Africa is based on Cichlids, Silurid catfish and Cyprinids which contribute 43%, 23% and 15% to total production respectively. This shows marked departure from the worldwide trend which is based principally on cyprinids which accounts for 62% of total production.

The emphasis on the culture of cichlids has been regarded to be one of the factors which constrain aquaculture in Africa, because of the problems inherent in tilapia farming i.e. the tendency towards precocial development and overpopulation of ponds with small-sized fish. Other major technological constraints to aquaculture development in sub-Saharan Africa have been identified as;

- Inadequate supply of fish feed ingredients
- Prohibitive transport costs
- Lack of juveniles for stocking ponds
- Problem of fish health and disease management

## 3.2 Raising Aquaculture Productivity in Nigeria

The expansion and intensification of aquaculture production has been accompanied by increased movements of live aquatic animals and products, making the accidental spread of disease more likely. Poor water quality, high cost of feeding, scarce and poor seed quality for stocking can lead to pond abandonment and land degradation. These observations therefore suggest that there is need to design a framework towards ensuring that fish reach the table of every common man in Nigeria at all times and at affordable prices.

### 3.2.1 Role of biotechnology in the Fish Sector

Compared with the advances achieved in the production of terrestrial animals, breeding technology in aquaculture is in its relative infancy. Genetic modification and biotechnology also hold tremendous potential to improve the quality and quantity of fish reared in aquaculture, although not without significant controversy and risk. Biotechnology has the potential to enhance reproduction and the early developmental success of cultured organisms. Improved feed conversion efficiency in genetically altered fish would reduce the amount of feed inputs and wastes per unit output, possibly placing less pressure on the environment. Better growth and survival rates of cultured fish could reduce production costs per unit of output, possibly bringing down the price of fish to consumers.

## 3.3 Fish Feed and Nutrition

It is rightly observed by aquaculture experts that fish feeding alone accounts for over 60% of the total cost of aquaculture production especially due to the high rising in the cost of fishmeal and fish oil in aqua-feeds. To this end there have been intensive and concerted efforts in researching into using alternative feed ingredients to replace fishmeal and other expensive conventional fish feed ingredients with some levels of success. The replacement of fishmeal with chicken offal was successful at 75% level conferring the best advantage for catfish production likewise, the use of feather meal and shrimp meal in the replacement of fishmeal have also attains some level of success. Similarly, the replacement of some plant protein source with another have also started which is still growing and the presence of anti-nutritional substances as limiting factor should be eliminated to ensure maximum utilisation as in the use of leucaena seeds meal in the replacement of soy bean meal .

## 3.4 Pollution Control and Waste Management

Now that the need for intensive aquaculture has been identified, it follows that large-scale and intensive systems use higher levels of inputs and often generate high levels of outputs that can create environmental problems. Effluent from aquaculture can raise problems both for the environment and for the surrounding farms. However, minimising water exchange through recirculation has the dual benefit of reducing water demand and minimising the effluent problem. Other steps to improve water quality include calibration of the amount of feed used in order to minimise waste, integrated systems that raise complementary organisms to reduce unwanted outputs, and capital improvements such as aerators and pumps.

### 3.4.1 Role of Policy Makers

Policymakers have the task of ensuring that the fish sector contributes to poverty reduction and environmental sustainability in Nigeria. They should facilitate institutions that can help improve the governance of ten marine and coastal resources and fresh water fisheries. There is the need to also develop transparent and process-based food safety systems for consumers and focus on the sources of pollution in fisheries that most endanger human health and sustainability. To ensure the survival of small-scale fish farmers, there should be favourable policies that promote market information, certification and extension system that culminate in and consolidates farmers' cooperatives. They should redirect subsidies presently going to increase marine fishing operations to improving resource management and information systems. Finally, they should create a monitoring and planning function for fisheries policy within relevant ministries to ensure that the sector gets the policy attention it deserves.

## 3.5 Fingerlings Production and Hatchery Management

During the late 1970s and early 1980s government and or donor funded demonstration hatcheries for *Clarias gariepinus* were built in Cameroon, Central African Republic, Ivory Coast and Nigeria, but only those in the Ivory Coast and Central African Republic were still in operation in 1989. In 1989 a hatchery was developed in Rwanda, and in 1992 a hatchery was built in Malawi. Unfortunately by 1997 the Malawi hatchery had fallen into disrepair. The establishment of hatcheries in those countries which lack sophisticated infrastructure requires ingenuity, and some remarkable successes have been achieved. The production from these hatcheries is however low and would not satisfy the needs of large scale operations. Claims have often been made as to the potential of government or donor funded hatcheries but none have

yet lived up to expectation. In South Africa direct comparisons can be made between private hatcheries and government hatcheries. In effect, most government hatcheries were totally inefficient and all but a few have been privatized in the least decade. Since privatization they have all become successful and economically viable.

### 3.5.1 Spawning and Fry Production

Many different hormonal preparations have been successfully used to induce spawning in African catfish. Some of these include HCG, DOCA, Carp Pituitary Suspension, Progestagen, Pimozide, and LH-Rha. However, the catfish farming community in Africa is now using mainly a homoplastic pituitary gland suspension to induce spawning. The method has been found to be highly reliable and, in comparison to synthetic hormone analogs, the technique is cheap and practical. This is of particular importance in African countries where sophisticated chemicals are often expensive and difficult, if not impossible, to obtain.

The whole pituitaries are removed from sexually mature adult catfish during the spawning season and are either used immediately or are stored in absolute ethanol or acetone, or stored dry after acetone or alcohol impregnation for up to 18 months with no loss of efficacy. Pituitaries can be taken from males or females. The pituitaries are homogenised in sterile water or pure rainwater and injected into the female. The dose is calculated on a 1.5:1 (donor: recipient weight basis). Females with suitably developed eggs can usually be stripped 12 hours after receiving a single dose at a temperature of 28$^{o}$C, or 20 hours at a temperature of 22$^{o}$C. At this stage the eggs have hydrated and have gone through the process of ovulation. The ovaries at this stage can occupy up to 70% of the abdominal cavity. Broodstock females usually vary between 1 and 2 kg in weight. Owing to high levels of aggression, the effects of which can be quite severe, broodstock females after injection are usually separated from each other in the holding tanks by way of sturdy screens. A simple and completely reliable method of testing the readiness of the eggs for fertilisation is by holding the females in a head-up vertical position. If the eggs begin to run freely from the genital pore they are ready to be fertilised.

To increase genetic variability a minimum of two males are used to fertilise batches of eggs. To obtain adequate quantities of sperm males are sacrificed and the testes removed. Fertilisation is best effected by first diluting the sperm in physiological saline where after the solution is mixed with the eggs. Fertilisation can also be effected by squeeze the sperm (milt) directly onto the eggs which have been stripped into a bowl, adding some water (which activates the sperm) and then thoroughly mixed. The fertilised eggs become sticky on contact with

water and in commercial hatcheries are spread onto mosquito mesh screens, which are suspended slightly off the vertical axis in hatching troughs. If screens are not available the eggs can also be adhered to the roots of floating aquatic plants (such as water hyacinth) during the incubation period development time is temperature dependent. Once hatching occurs the free embryos fall to the bottom of the tank while the egg envelope remains adhered to the screen. Once a few embryos have hatched the rest follow suit very rapidly. In fact the hatching rate of African catfish embryos is quicker than in most *Clariid* species. All commercial catfish hatcheries in Southern Africa work at 28$^{o}$C at which the larvae hatch after 16-18 hours.

### 3.5.2 Hatching Nutrition and Feeding

After swim-up they flow into rearing tanks. Larval rearing is restricted to a 10-15 day period during which the fish are kept indoors under optimal conditions and fed on a complete dry feed every two hours. During the first 3-5 days they receive a supplement of *Artemia nauplii* three times a day. However, catfish larvae can be reared successfully without *Artemia* or other zooplankton supplementation.

After a 10 - 15 day intensive hatchery period they are transferred to nursery ponds (fertilized and filled two days prior to transfer), at a density of 2,000 fry/m$^2$, or more. During the following 4 - 6 weeks the juvenile fish are graded into three size classes at least two times. The smallest size class is usually discarded each time. The fry are fed every 4 hours, with a 38% protein diet. A water exchange rate of 0.5 l/min/m$^2$ is maintained throughout the phase. At an average weight of 4-5g they are either sold to producers or put into the farms own production ponds. Average total survival rate from the time of hatching to the end of the nursery phase is 40%.

After yolk sac absorption, the larvae are fed on live zooplankton, usually caught from production ponds and are transferred to nursery ponds as early as two days after yolk sac absorption (approximately 5 days old) at an average weight of 5 mg. The rearing of the larvae to fingerling size under small-scale/subsistence conditions is usually achieved in organically fertilized ponds, filled two days prior to stocking, at a stocking density of 30 to 100 larvae/m$^2$. In some instances ponds are equipped with compost enclosures covering 10% to 25% of the surface area. The larval fish are fed on a supplementary basis with substances such as sun-dried brewery waste, rice and wheat bran or other agricultural by-products, if available. Fingerlings are harvested six weeks later at an average weight of 3 to 5 g.

### 3.5.3 Nutrition of Larvae and Early Juveniles

Due to the high densities at which catfish larvae are reared, it is essential that a reliable source of high quality larval feed, which satisfies all the nutritional requirements, is always and readily available. Live organism, particularly rotifers, cladocerans and *Artemia nauplii* have been used in the large scale rearing of African catfish larvae.

However, the collection of live food from ponds is cumbersome and only available on a seasonal basis and the cultivation of *Artemia* is expensive particularly for hatcheries in developing countries in Africa. For this reason, some workers have successfully formulated an artificial dry-feed for larvae, based primarily on a single cell protein (SCP) Torula yeast and fishmeal. Studies on larval nutrition have however indicated that live-food is essential for the first few days after the start of exogenous feeding. The minimum requirement is an *Artemia nauplii* supplement for the first 4 - 5 days after the start of exogenous feeding, during at least three of the 10 - 12 daily feeding periods. In semi-intensive and intensive hatcheries a number of different successful feeding strategies have been used. In Southern Africa larvae are normally reared in the hatchery and fed to satiation at two hourly intervals. This continues for 10 - 14 days at temperatures of $28^0$C at stocking densities of ca. 100 larvae / litres. This protocol results on an acceptable growth rate and survival (80%) at a low cost.

The larval period has been divided into an early phase, when a specific larval diet (consisting mostly of live food) is required, and a later period when the larvae and early juveniles are less dependent on live food. Experience has shown that the earliest time that larvae should be weaned onto a dry feed is approximately 4 - 5 days after the start of exogenous feeding. Weaning onto a dry diet takes place gradually during the 10 - 15 day hatchery period. The proximal composition of an optimized dry feed for early juveniles consists of 55% protein, 9% lipid (1:1 plant and fish oil mixture). 21% carbohydrate, with a methionine supplement of 150ug / g food. Vitamins and minerals are usually added to the diet as per the requirements of channel catfish, on the assumption that they are the same. Work on the vitamin and mineral requirements of African catfish larvae and juveniles has only recently been initiated and much work remains to be done. It has been shown that larvae and early juveniles require at least 1500ug ascorbic acid / g dry weight of food and after approximately 6 weeks the gross dietary protein requirement decreases to between 38 - 42%.

### 3.5.4 Nutritional Requirements during the Grow-out Phase

From the age of six weeks the dietary requirements of African catfish do not seem to change, except that ration size decreases with increasing body size. As the fish grow larger their relative consumption rates decrease from approximately 10% of body weight per day (at 4 weeks) to around 2 - 4% of body weight per day (at 10 weeks and older). Similarly growth rate decreases from 14% (at 4 weeks) to 2% at 10 weeks and older. At this stage the best growth rates and feed conversion ratios are achieved with a diet containing 38 - 42% crude protein and an energy level of 12 kJ/g.

Programmed least-cost formulation is a widespread technique used in the animal feed industry. It is aimed at finding the cheapest way of combining a given set of ingredients with a known nutritional composition, while at the same time satisfying the requirements of the animal concerned and obtaining maximum growth at least cost. During the grow-out phase the fish should be fed twice a day. The recommended daily ration must be adjusted according to temperature and fish size.

**Table 1.1 Approximate Minimum Dietary Requirements for African Catfish**

| Feed | Percentage |
|---|---|
| Crude Protein | 40% |
| Total lipid | 11% |
| Digestible energy | 12 kJ/g |
| Calcium | 1.5% |
| Phosphorus | 0.5% |

**Source: Adapted from Faturoti (2000)**

## 3.6 Fish Health and Disease Management

Fish disease is an unhealthy fish body condition. It is a departure from the normal wholesome state of the fish. A condition of discomfort or sickness which can lead to reduction in the normal physiological activities and development of the fish. It can lead to retarded growth, reduced or impair reproductive capability of fish and cause mortality. Disease outbreak can result in over 80% mortality in pond if not properly managed.

The environment plays a key role in the health status of fish under any culturing system. It is such that a high-density culture pond of *Clarias* when badly managed becoming conducive for disease pathogen to thrive causing colossal fish mortality. Fish disease is more pronounced in temperate (cold) regions of the world as a result of sudden changes in temperature. Winter temperature range is between $0^0$ and $10^0$C, spring $5^0$-$10^0$C and it ranges between $10^0$ and $15^0$C in autumn. However, temperature variation is minimal usually between $20^0$ and $35^0$C therefore experience minimal disease outbreak.

Fish diseases occur in nature (natural water bodies) and in culture systems (ponds, cages and pens). Occurrence of fish diseases is however higher in culture systems than in nature because of the following reasons:

- Large quantities of organic materials introduced into the system during supplementary feeding and fertiliser application.
- High concentration of fish ponds in series with direct water way connections between them.
- Stagnant nature of fish pond water especially when not under flow through system.
- Crowded population of fish especially under maximum stocking density.
- Disease outbreak may also occur as a result of bad or inefficient management practices.

The three most common diseases of cultured catfish are *Trichodina* infection of the gills, bacteria infection of the kidney and Gyrodactylus infection. Infections by *Aeromonas spp*., *Flavobacterium spp*., *Flexibacter columnaris, Pseudomonas spp.,* and *Edwardsiella tarda* have been identified with catfish species. However, most of these diseases have been traced to the fry and fingerling stages of catfish when brought to the farm for stocking. It is therefore very important to purchase good quality fish seeds from reputable fish farms. Accumulation of $H_2S$ in pond water is another cause of catfish mortality. Treatment of pond with formalin is recommended before stocking pond with fingerlings.

It is thus prescribed that fresh good quality water is pumped into the system to replace poor quality ones in order to improve the condition of the pond and ensuring adequate dissolved oxygen level of the pond always.

### 3.6.1 How Does a Farmer Know His Fish Is Diseased?

Fish is suspected to be diseased when there is a change in the normal behaviour and the physical nature of the fish. A well observant farmer would notice the following:

- **Behavioural Signs of Disease in Fish**

(i) Swim sluggishly in an uncoordinated zigzag manner
(ii) Gasp at the surface of the water for air
(iii) Fish rub its body against surfaces in the pond
(iv) Loss of appetite, so fish refuse to eat
(v) Look for shade in order to avoidance light within pond
(vi) Float with underside (ventral) up
(vii) Fail to respond to fright stimulus
(viii) Crowd at water inflow

- **Physical Signs of Disease in Fish**

(i) Ragged or torn fins
(ii) Lesions or sore in the body
(iii) Loss of scales and body discolouration
(iv) Gills turns pale colour
(v) Loss of weight
(vi) Wearing away of the skin and the gill
(vii) Accumulation of liquid in body cavity.
(viii) Gapping mouth

## 3.7 Types of Diseases

The following are identified types of diseases based on their causes.

**(i)** **Infectious Diseases**: These are caused by germs or pathogens such as bacteria, fungi or viruses. They attack living tissues, live and multiply there and eventually cause death.

**(ii)** **Parasitic Diseases:** These are caused by organisms called parasites which live in or on other animals, known as hosts. Fish parasites include protozoan, crustaceans and worms. They derive nourishment from tissue or fluid of their hosts.

**(iii)** **Nutritional Disease**: Improper diet such as deficiency or imbalance in the nutrient composition of feeds.

**(iv) Environmental Diseases**: These are caused by pollutants from various sources including agricultural run-offs, industrial effluents domestic effluents e.t.c.

### 3.7.1 Prevention of Diseases

A fish farmer should aim at preventing (prophylactic) rather than treating diseases (therapeutic). Good farm management is of primary importance in avoiding disease and parasite attacks. The working principles are:

- **Provision of Good Quality and Pathogen Free Water:** Ensure that pond and hatchery water is in sufficient quantity and readily available at all times. Water should not be passed from one pond to another.

- **Control of Wild Fish and Predators:** Wild fish live in canals and other natural water bodies. They are therefore potential hosts and vectors for disease pathogens. It is therefore recommended that they should be bared from gaining access into ones farm by:

- Placing wire mesh screens on all water inlets
- Use of chemical on them before stocking the pond

- **Stocking Density:** Avoid overcrowding of fish at any time particularly during hot weather. Observe recommended stocking rate for each fish species and for species combination.

- **Broodstock Management:** Preventive treatment should be given to broodstock before they are used for spawning. They should be separated from young fish hatchlings as soon as possible.

- **Pond Conditioning:** Pathogens and diseases vectors develop in cycles. In most cases their spores, eggs and cysts survive in pond bottoms. Periodic drying and liming of ponds kill the eggs or spores and their intermediate host (e.g. snail and aquatic weeds).

- **Treatment of Fish before Stocking:** Fish should be given bath treatment before stocking. Transfer of fish from small to bigger ponds reduces the chance of reproduction in parasites.

## 4.0 CONCLUSION

In this unit you were exposed to the role of aquaculture in Africa. You also learnt about the differences between aquaculture production and productivity.

## 5.0 SUMMARY

The call to intensify aquaculture is a laudable idea and which must not be shunned by a nation that is interested in becoming relevant in world food fish supply or other aquaculture products. It is an obvious fact that aquaculture is presently a growing sector in the world economy which has helped many nations in stabilising their economies thereby making them play major roles in international trade. Nigeria must step up her involvement in aquaculture programme in order to put the fishing industry in the rightful position towards improving the nation's economy.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. What are the ways by which aquaculture productivity could be raised in Nigeria?
2. How would you identify a diseased fish in your farm?

## 7.0 REFERENCES/FURTHER READINGS

Ayodele, I.A and Ajani, E.K (1999). *Essentials of Fish Farming* (Aquaculture),pp 46.

Faturoti, E.O (2000). *Beneath the Ripples and Sustainable Fish Production*. Inaugural Lecture, University of Ibadan, Ibadan. 14th December, 2000.

# UNIT 2 FISHERY BIODIVERSITY CONSERVATION

## CONTENTS



## 8.0 INTRODUCTION

Fish diversity, from individual populations to whole species and even complex communities, has been declining in response to the reduced health of aquatic ecosystems and invasions by nonnative species. Pollution is a major health hazard to achieving fresh water fish diversity conservation which may arise through inappropriate agricultural practices, the destruction of watersheds, opening up of river banks leading to silting of river beds and loss of water courses.

Marine fishes are also threatened, primarily by over fishing and pollution, as well as habitat loss. Overall, the status of aquatic species appears to be deteriorating faster than that of mammals, birds, reptiles and other terrestrial animal groups.

## 9.0 OBJECTIVES

At the end of this unit, students are expected to:

- describe the nature in relation to fisheries biodiversity
- demonstrate a practical approach towards conservation of the fishery resources.

## 10.0 MAIN CONTENT

### 3.1 Continental Shelf Ecosystem

The continental shelf area is characterised by a variety of physical and chemical forcing. Physical forcing is represented by tide, major current system, wind mixing, wind-induced upwelling, and sea-level change. Chemical forcing includes salinity and other materials that flow in from rivers and that are deposited from the atmosphere by wind and rain. It is characterised by large spatial and temporal variability.

Productivity on the continental shelf area is much higher than that of the open ocean. The shelf comprises only 7% of the ocean but is responsible for at least 25% of oceanic primary production and interactions between the pelagic (planktonic) community and the benthic community is stronger. However, most of the continental shelf is deep enough so that light cannot reach the bottom, resulting in less primary production there. Accordingly, the benthic community depends mostly on the production in the upper water column.

### 3.5Seasonal Changes

Primary production of the pelagic community often depends on the light energy and nutrient supply, and these factors change with season. Solar radiation increases during the dry season and the water column becomes stratified, whereupon the phytoplankton biomass increases using nutrients in the surface water.

Nutrients and biogenic materials in the upper water used by phytoplankton eventually drop out of the euphotic zone. Nutrients transported as organic particles recycle in deeper layers or on the sediments. When the water is stratified, nutrient depletion is severe in the upper water column because the nutrients transported do not return and as well the increased by zooplankton reduce the biomass of the phytoplankton bloom. This situation of low phytoplankton community remains at the water surface until onset of rainfall when the stratification weakens out and nutrients are supplied from the deeper water.

### 3.6Physical and Chemical Forcing

The seasonal changes just discussed are part of the basic cycle of plankton communities in the ocean. On the continental shelf, additional physical and chemical forcing is important for the enhancement of production and for variability of ecosystem structures. There mechanisms are hereby discussed.

### (i) Estuarine and River Plumes

River and estuarine plumes often extend over the continental shelf or even reach to the open ocean. The fresh and brackish waters of estuarine and river plumes are important sources of nutrient, organic material, and other chemical materials for the continental shelf. Discharges of suspended materials from rivers and bays decrease light penetration in the upper water column and sometimes result in lower primary production near the mouth of the rivers and bays. However, phytoplankton, typically euryhaline diatoms, increased their biomass by using abundant nutrient in the plumes after these sediments settled down and their density peaks at some distance from the river mouth.

### (ii) Tide

The tide is one of the important hydrodynamic forcings in the continental shelf ecosystem. The relationship between tidal current and bottom topography induces the mixing of the water column. A combination of strong tidal energy and a shallow bottom induces thorough vertical mixing and sometimes draws back into the system, too strong a mixing may decrease the light intensity that is required for phytoplankton production. This distribution of tidal mixing also corresponds well to the distribution of fish larva and benthic organisms. It is important to also note that tidal motion is the residual current which is induced by oscillatory motion of the tide and which transports materials on the continental shelf.

### (iii) Internal Wave

When tidal motion or current contacts the bottom topography and the water is stratified, a wave is generated at the boundary between the stratified water. It is thus called internal wave because the wave motion is below the surface. Circulation around the internal waves also creates small-scale divergence and convergence and positive buoyancy materials often converge at the water surface. Floating materials as well as zooplankton that swim upward can be aggregated at the convergent area. This may be an important transport mechanism for zooplanktons on the continental shelf.

### (iv) Coastal Upwelling

Wind-induced coastal upwelling is a well-known hydrodynamic factor on the continental shelf which is common in Oregon, California, North Africa and Angola. Wind action induces an offshore surface current and upward movement of water from the subsurface layer along the coast and this result in the zones being highly productive and excellent fishing

grounds. However, the intensity of upwelling varies spatially because of differences in wind fields and topography and temporally because of the seasonal changes in wind velocity. This variability is important for the biological community, as phytoplankton and fish behaviour are often evolutionary adapted to the variability of these short time scale. Smaller-scale wind-induced upwelling is frequently observed at the various continental shelves and is also important for ecosystem productivity.

## 3.4 Diversity Pattern of Fish

The Nigerian coast is about 850km in length from Lagos in the West to Calabar in the east. The coastal belt has estuaries and lagoons as a transition zone between it and the numerous rivers and creeks flowing southwards into the Atlantic. Many settlements and some major cities like Lagos, Port-Harcourt, Warri and Calabar are located near the estuaries and lagoon. They have seaports and a variety of manufacturing industries producing large volume of effluents of diverse nature. The proliferation of urban settlement and slums in these major cities like Lagos also cause increased human pressures and the generation of domestic effluents which eventually find its way into the nearest water body.

In recent years, a decline in artisanal fishery is an indication of environmental degradation and possible changes in water quality of the lagoon mainly and with biological consequences for the biota in the environment. This situations shall however be addressed in order to safeguard our fishery from total collapse as well as the economic implications and the scientific undertone relent to it.

Worldwide, there are approximately 25,000 species of fishes. Nearly half of these occur in fresh waters, which are surprisingly large considering the small amount of fresh water compared to salt water, and this indicates the amount of isolation and speciation that has occurred in our rivers, lakes, and springs. Within fresh water, riverine habitats typically harbour greater fish diversity than do reservoirs, lakes and springs. Nigeria inshore water provide habitat for approximately 71 families of about 157 species of which the following are prominent; *Pseudotolithus senegalensis, P. typus, P. elongates, Brachydeuterus auritus, Aurius spp. Ilisha africana, Ephippus spp., Lutjanus spp. Ethmalosa fimbricata, Mugil spp.Gymnarchus niloticus* e.t.c. while the offshore waters, tuna and tuna-like fishes are most important. They include the skipjack, the yellow tin tuna, the big eye tuna, *Coryphaena hippurus*, *Euthynnus alletteratus*, *Caranx crysos* and *Elagatis bipinnalata.*

Total biodiversity, however, includes more than species. Genes, population, subspecies, and communities as well as species are species are primary components of diversity. Maintenance of diversity below the species level often is overlooked for those fishes organized more or less into isolated populations, such as anadromous fishes or desert fishes.

### 3.4.1 Fishes as Indicators of Environmental Quality

Flowing waters integrate the landscape. As water flows from mountain tops to valleys and ultimately to lakes and oceans, it collects runoff, sediments, nutrients, and pollutants. Point and nonpoint sources of pollution are synergized and often form complex and lethal compounds as they accumulate downstream. Fishes, as the best-known species of the aquatic world, reflect the health status of the aquatic habitats.

Certain fish or fish guilds may be utilised as indicators of environmental degradation. The presence of certain introduced fishes, such as carp and moisquitofish, may indicate poor-quality habitats because of their broad tolerance to degraded environmental condition. Increasing incidence of hybridization, diseases, and parasites also often indicate degraded habitat conditions.

The use of single fish a species as indicator can be misleading. For that reason, broader measures of fish community diversity have been developed to more clearly qualify and quantify habitat degradation. For example, the Index of Biotic Integrity (IBI) combines attributes of communities, population and species to assess biological integrity by making comparisons between disturbed and relatively undisturbed habitats of the same region. Factors considered in determining the IBI in a particular stream might include fish species richness and community composition, ratios of native versus nonnative species, trophic composition, and overall fish abundance and condition. However, in situations whereby natural fish diversity is relatively low, aquatic macro invertebrates can also be used as partial or total substitutes for fish community data.

### 3.4.2 Fish Conservation Strategies

The development of sound and measurable goals is critical to conservation work. However, the right approach to designing what level of management that should be adopted is diverse and may depend on the nature of the issue itself, geography and may be other factors.

- **Species Based Conservation Effort**

For many species of fish, it is important to maintain the diversity both within population and among population. It is known that for desert fishes, the genetic diversity of one population may differ greatly from another population of the same species. This is the situation with fishes of the Pacific and Atlantic salmon. Striped bass and many anadromous fishes are organised into discrete stocks as a result of homing instincts that lead adults to return to the streams from which they were spawned. Each stock may have distinct genetic qualities worthy of preservation.

Many recovery efforts for fish focus on the species level and include plans for habitat protection and reintroduction. Recovery plans are mandated for each species once identified as threatened or endangered pursuant to the Endangered Species Act. Typically, the plan details specific needs for habitat protection, research, reintroductions, monitoring, and public education.

- **Ecosystem-Based Conservation Efforts**

The increasing rate of endangerment among species has recently led conservationists and the public to question the efficacy of traditional species-based approaches to management. As a result, ecosystem based approaches to management are being developed that focus on critical ecosystem processes and functions that maintain communities. For example, floods often serve to control riparian plant succession, maintain aquatic habitat complexity, and remove nonnative fishes from stream systems. In this way, floods are becoming viewed as beneficial, much like the role of firs in maintaining the vigour of terrestrial ecosystems.

For fish conservation, fundamental areas of focus for ecosystem-based management are riparian areas and watersheds. Riparian areas are the interface between terrestrial and aquatic habitats, and as such, they are one of the most dynamic and critical components of the landscape. Healthy riparian zones dissipate flood flows, moderate drought, store surface waters, and reduce erosion. Riparian areas also directly influence the quality of aquatic habitats by reducing sediments, modifying water temperature, and contributing woody materials that are critical for maintaining habitat complexity and for pool development.

Watersheds are considered to be a logical focus for ecosystem-based management for both terrestrial and aquatic species because:

(i) their boundaries can be easily determined on topological maps and in the field,

(ii) they possess a hierarchical organization by aggregating into larger basins or subdividing into smaller watersheds, and

(iii) their rivers provide focal points for cumulative effects analyses.

- **Improving Aquatic Resource Management**

Implementation of the following management principles would substantially improve the status of fish conservation and would help ensure a sustainable supply of fish resources for future generations**.**

(i) Fishery management practices such as harvest quotas and artificial manipulation should be cautious and conservative in the face of uncertainty.
(ii) Remaining aquatic habitats of high environmental quality should be preserved to conserve fish diversity and demonstrate the components of healthy ecosystem.
(iii) Management efforts should focus on maintaining biodiversity, which provides stability and resilience to communities.
(iv) Genetic studies need to be integrated into management programmes to ensure that the full array of fish diversity is identified and maintained.
(v) Although efforts should continue for species-based conservation, new efforts should focus on community conservation, including the restoration and maintenance of ecosystem processes and functions, such as natural flow regimes, that maintain healthy communities.
(vi) Fishery conservation should include a focus on entire watersheds, particularly riparian zones, which provide the interface between actions on land and quality of aquatic habitats.
(vii) Artificial management tools, such as hatcheries, barging fish past dams, Lake Fertilisation, and so on should be considered as methods of last resort and should not be substitute for habitat restoration.

## 3.5 Diversity Pattern of Fresh Water Invertebrates

Freshwater invertebrates consistently play decisive role in the functioning of all aquatic ecosystems through their diverse participation in energy flow, nutrient recycling, and population regulation. Despite their importance in stream and lake ecosystems, only about 5% of all invertebrates' species live in fresh waters and approximately half of the 40+ phyla of metazoan and heterotrophic protozoa have freshwater representatives. This relatively low faunal diversity and phyletic representation is indicative of the strenuous environmental conditions

found in fresh water, including low osmotic state, thermal extremes and variability, and both ecological and evolutionary instability. Environmental instability, especially the tendency of habitats to become parched, has required special life-history adaptations for survival in ephemeral aquatic ecosystems. The nature of an invertebrate's feeding, respiratory, osmotic, and reproductive systems reflect both the unique habitat conditions to which it has adapted and its evolutionary history.

### 3.5.1 Ecological Roles of Fresh Water Invertebrates

Fresh water Invertebrates consistently play decisive role in the functioning of all aquatic ecosystems through diverse participation in energy flow, nutrient recycling and population regulation. They occupy all heterotrophic functional feeding groups, such as algal grazers, filter feeders, shredders, carnivores, and detritivores. As important components of aquatic food webs, invertebrates bridge the gap between primary producers and fish or other high trophic level consumers. Few invertebrates' species occupy the only one functional feeding group in all ecosystem, seasons and life stages. Meanwhile it is usually unrealistic to assign many invertebrates e.g. crayfish to one feeding guild because these omnivores eat a great variety of living and dead animals and plants and all feeding guild of freshwater invertebrates fall victim in turn to predator such as benthic and pelagic fish.

By recycling carbon and other nutrients, invertebrates reduce loss of energy and vital elements to sediments down the stream and shorten the time to recycle materials through community food webs. This recycle process is termed nutrient recycling in lakes and nutrient spiraling in rivers. Without invertebrates contributions to recycling process, aquatic ecosystems would support far fewer species owing to lower available productivity and many shallow ponds would soon fill with non-decomposed plants.

In addition to roles in nutrient recycling, parasitic and predaceous invertebrates may function as density-dependent regulators of population sizes of lower trophic level species. Furthermore, by preying selectively on dominant species, a carnivore or herbivore may influence relative abundance and species diversity within an entire community far out of proportion to the predators' abundance; such species are sometimes called "keystone predators"

## 3.6 Diversity of Habitat

Aquatic ecosystems consist of entire drainage basins. The nutrient and organic matter content of drainage water from the catchments area is modified in each of the terrestrial, stream, and wetland-littoral components, as water moves down the gradient to and within the lake or reservoir. Autotrophic photosynthetic productivity is generally low to intermediate in the terrestrial components, highest in the wet-land interface region between the land and water, and lowest in the open water. Autotrophic productivity in river channels is generally low, as in the pelagic regions of lakes. Most of the organic matter of running waters is imported from floodplain and terrestrial sources.

The land-water interface region of aquatic ecosystems is always the most productive per unit area along the gradient from land to open water of both lakes and reservoirs. Because most aquatic ecosystem occur in geomorphologically mature terrain of gentle slopes and are small and shallow, the wet-land littoral components usually dominate in productivity and the synthesis of organic matter. The region of greatest productivity is the emergent macrophytes zone. Emergent aquatic plants have a number of structural and physiological adaptations that not only tolerate the hostile reducing anaerobic sediments but exploit the high nutrient and water availability of this habitat. Nutrients entering the zone of emergent aquatic macrophytes zone tend to be assimilated by the microflora of the sediments and detritus particles, and are then recycled to the emergent macrophytes.

The deep-water pelagic zone of lakes is least productive along the gradient from land to water, regardless of nutrient availability. Growth of phytoplanktonic algae of the pelagic zone is limited by sparse distribution in a dilute environment where nutrient recycling is restricted by the sinking of senescent phytoplankton below the depth of photosynthesis. When nutrient recycling and availability are increased, greater phytoplankton cell densities attenuate underwater light and reduce the volume of water in which photosynthesis occurs. Despite low productivity per unit area, pelagic productivity can be collectively important in large lakes and for higher trophic levels that depend on this organic matter.

A second trophic level consists of zooplankton dominated by four major groups of animals: protozoa, rotifers, the crustaceans and benthic invertebrates. In the pelagic zone these herbivorous organisms are consumed by small fishes, fry of larger fishes, and predatory zooplankton, which comprise a third trophic level. A fourth trophic level may consist of medium-sized piscivorous fishes, and the fifth level includes piscivorous fishes. Higher trophic levels are rare in fresh water.

The species composition of the higher trophic levels affects the pathways of energy utilization from lower trophic levels. For example, efficiency of consumption of primary production by zooplankton is often appreciably greater in the absence of zooplankton-feeding fishes than in their presence. The community structure of phytoplankton responds variably to grazing impacts in concert with their available resources (light, nutrients, organic constituents) and may or may not be able to compensate for grazing losses in overall primary production.

## 11.0 CONCLUSION

In this unit, you were exposed to the biodiversity of ecosystem in order to understand the status of the species, population trends and causes of population and species changes in order to develop sound biodiversity conservation and sustainable strategies.

## 12.0 SUMMARY

The continental shelf area is the marginal sea around the continents, and the average width and depth of the edge are about 75 km and 130 m, respectively. It is one of the most productive ecosystems, and it is suggested that more than 90% of the world fish yield comes from this zone. Different kinds of external physical and chemical forcing, from Open Ocean, land, and atmosphere, give the system its high primary production.

The major physical forcing is different for each continental shelf and varies even with area of shelf and with time. The continental shelf is important for the global material cycle and energy flow because of its high productivity. However, the variable, open nature of this ecosystem makes it difficult to quantify the material and energy budgets. Human activities directly and indirectly affect the continental shelf and the global feedback effects are still uncertain.

## 13.0 TUTOR-MARKED ASSIGNMENT

1. Describe the importance of fishery conservation and its relevance to the environment
2. Of what importance is the understanding of the aquatic habitat?

## 14.0 REFERENCES/FURTHER READINGS

Ajayi, T.O and Talabi, S.O (1984). *The Potential and Strategies for Optimum Utilization of the Fisheries Resources of Nigeria*. *NIOMR Tech. Paper* No. 18.

Di Turo, J.W and Hurtak, J.J (1998). Innovative Technique for In Situ Treatment of Contaminated Surface Waters and Submerged sediments by Enhanced Aerobic Bioremediation. 33rd Intersociety Engineering Conference on Energy Conversion Colorado Springs, CO, August 2-6, 1998.*The Academy For Future Science*.

Williams, J.E (1995). *Fish Conservation. Encyclopedia of Environmental Biology* Volume 2, 33-47pp. Academic Press, Incorporation.

# UNIT 3 WATER QUALITY MANAGEMENT IN AQUACULTURE

## CONTENTS



## 1.0 INTRODUCTION

Fish perform all their bodily functions in water. Because fish are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance, and reproduce, understanding the physical and chemical qualities of water is critical to successful aquaculture. To a great extent, water determines the success or failure of an aquaculture operation. This unit is designed to help students understand the properties of water as they affect fish culture.

## 2.0 OBJECTIVES

At the end of this unit, students are expected be able to:

- understand the importance of good quality water to aquaculture
- explain the need for choice making in different sources of water for fish farming.

## 7.0 MAIN CONTENT

### 3.1 Physical Characteristics of Water

Water can hold large amounts of heat with a relatively small change in temperature. This heat capacity has far reaching implications. It permits a body of water to act as a buffer against wide fluctuations in temperature. The larger the body of water, the slower the rate of temperature change. Furthermore, aquatic organisms take on the temperature of their environment and cannot tolerate rapid changes in temperature.

Water has very unique density qualities. Most liquids become denser as they become cooler. Water, however, gets denser as it cools until it reaches a temperature of approximately $4^0$C. As it cools below this point, it becomes lighter until it freezes at $0^0$C. As ice develops, water increases in volume by 11 percent. The increase in volume allows ice to float rather than sink, a characteristic that prevents pond from freezing solid.

### 3.2 Water Balance in Fish

The elimination of most nitrogen waste products in land animals is performed through the kidneys. In contrast, fish rely heavily on their gills for this function, excreting primarily ammonia. A fish's gills are permeable to water and salts. In the ocean the salinity of water is more concentrated than that of the fish's body fluids. In this environment water is drawn out, but salts tend to diffuse inward. Hence marine fishes drink large amounts of sea water and excrete small amounts of highly salt-concentrated urine.

In fresh water fish, water regulation is the reverse of marine species. Salt is constantly being lost through the gills, and large amounts of water enter through the fish's skin and gills. This is because the salt concentration in a fish (approximately 0.5 percent) is higher than the salt concentration of the water in which it lives. Because the fish's body is constantly struggling to prevent the "diffusion" of water into its body, large amounts of water are excreted by the kidneys. As a result, the salt concentration of the urine is very low. By understanding the need to maintain a water balance in fresh waters fish, one can understand why using salt during transport is beneficial to fish.

## 3.3 Sources of Water

Water is always a limiting factor in commercial fish production. Many of the negative chemical and environmental factors associated with most operations have their origins in the source of water selected. Final site selection has to be made based on both the quality and quantity of water available. The most common sources of water used for aquaculture are wells springs, rivers and lakes, groundwater, rainfall and municipal water. Of the sources mentioned, rainfall, wells and springs are considered to consistently be of high quality.

### 3.3.1 Water's Physical Factors

**(i) Temperature:** After oxygen, water temperature may be the single most important factor affecting the welfare of fish. Fish are cold-blooded organisms and assume approximately the same temperature as their surroundings. The temperature of the water affects the activity, behaviour, feeding, growth, and reproduction of all fishes. Metabolic rates in fish double for each -8$^0$C rise in temperature. Channel catfish and tilapia are examples of warm water species. Their temperature range for growth is between 24-32$^0$C. Temperature of 29$^0$C for catfish and 31$^0$C for tilapia is considered optimum.

Walleye and yellow perch are examples of cool water species. Ranges for optimum growth fall between 16 and 29$^0$C. Temperature in the upper end of this range is considered best for maximum growth for most cool water species. Coldwater species include all species of salmon and trout. The most commonly cultured coldwater species in the Midwest is rainbow trout, whose optimal temperature range for growth is 9-18$^0$C. Ideally, species selection should be based in part on the temperature of the water supply. Any attempt to match a fish with less than ideal temperatures will involve energy expenditures for heating or cooling.

Temperature also determines the amount of dissolved gases (oxygen, carbon dioxide, nitrogen, e.t.c.) in the water. The cooler than water the more soluble the gas. Temperature plays a major role in the physical process called thermal stratification. As a result of the uniqueness of water in terms of densities and high heat-capacity, nutrients, dissolved gases, and fish wastes are evenly mixed throughout the pond. As the days become warmer, the surface water becomes warmer and lighter while the cooler-denser water forms a layer underneath. Circulation of the colder bottom water is prevented because of the different densities between the two layers of water. Dissolved oxygen levels decreases in the bottom layer since photosynthesis and contact with the air is reduced. The already low oxygen levels are further reduced through

decomposition of waste products, which settles to the pond bottom. Localised dissolved oxygen depletion poses a very real problem to the fish farmer.

**(ii)** **Suspended Solids:** This is associated with plankton, fish wastes, uneaten fish feeds, or clay particles suspended in the water. Suspended solids are large particles which usually settle out of standing water through time. Large clay particles are an exception while small clay particles are kept in suspension due to the negative electrical charges associated with them.

**(iii)** **Plankton:** Turbidity caused by phytoplankton (microscopic plants) and zooplankton (microscopic animals) is not directly harmful to fish. Phytoplankton (green algae) not only produces oxygen, but also provides a food source for zooplankton and filter feeding fish/shellfish. Phytoplankton also uses ammonia produced by fish as a nutrient source. Zooplankton is a very important food source for fry and fingerlings such as hybrid striped bass and yellow perch. However, excessive amounts of algae can lead to increased rates of respiration during the night thereby consuming extra oxygen. Excessive phytoplankton buildup or "blooms" which subsequently die will also consume extra oxygen. Any wide disparity between day and night oxygen levels can lead to dangerously low oxygen concentrations.

**(iv)** **Fish Wastes:** Suspended fish wastes are a serious concern for water recirculating culture systems. Large amounts of suspended and settle able solids are produced during fish production. Therefore fish waste particles can be a major source of poor water quality since they may contain up to 70 percent of the nitrogen load in the system. These wastes not only irritate the fish's gills, but can cause several problems to the biological filter. The particulate waste can clog the biological filter, causing the vitrifying bacteria to die from lack of oxygen. Particulate waste can also promote the growth of bacteria that produces rather than consumes ammonia.

**(v)** **Clay:** Most clay turbidity problems are the result of exposed soil on the pond levee, exposed watershed, or feeding on bottom dwelling organisms. In natural bodies of water, turbidity values seldom exceed these critical levels. Even muddy looking ponds rarely have concentrations greater than 2,000 ppm. Turbidity caused by clay or soil particles, however, can restrict light penetration and limit photosynthesis. Sedimentation of soil particles may also smother fish eggs and destroy beneficial communities of bottom organisms.

Removal of clay turbidity can be accomplished by adding materials that attach to the negative charges of the clay particles, forming particles heavy enough to settle to the bottom. Common remedies for clay turbidity are 7-10 square bales of hay per surface acre, or 300-500pounds of gypsum per surface acre. Gypsum application may be repeated at two week intervals if pond is still not clear.

### 3.3.2 Water's Chemical Factors

**(i)** **Photosynthesis:** Photosynthesis is one of the important biological activities in standing pond aquaculture. Many water quality parameters such as dissolved oxygen, carbon dioxide, pH cycles, and nitrogenous wastes products are regulated by the photosynthetic reaction in phytoplankton. It can be simply put as the process by which phytoplankton uses sunlight to convert carbon dioxide into food source and release oxygen as a by-product. This process can be summarised as the equation below;

$$CH_2O\ (food) + O_2 \leftrightarrow CO_2 + H_2O + energy \uparrow$$

In addition to supplying oxygen in fish ponds, photosynthesis also removes several forms of nitrogenous wastes, such as ammonia, nitrates, and urea. The phytoplanktonic plant pigments involved in this chemical reaction is referred to as chlorophyll. Because the photosynthetic process is driven by sunlight, greatest concentrations of oxygen occur when the sun is highest on then horizon while phytoplanktons primarily respire at night when photosynthesis ceases.

Respiration is the reverse of photosynthesis in that oxygen is used by phytoplankton to convert food to energy and carbon dioxide is released as a by-product. Phytoplankton respiration also occurs during the day but the fish framer is fortunate since there is usually a surplus of oxygen produced to compensate for the loss.

**(ii)** **Dissolved Gases:** These are gases which are in water solution. An example of gas dissolved in water is soda water which has large quantities of dissolved carbon dioxide. Concentrations are measured in parts per million (ppm) or milligrams per liter (mg/l), both units of measure are the same. (One ppm or mg/l is the same as one pound added to 999,999 pounds to 1,000,000 pounds).

**(iii)** **Oxygen:** Dissolved oxygen (DO) is by far the most important chemical parameters in water for fish production. Low DO levels are responsible for more fish kills, either directly or indirectly, than all other problems combined. Like human fish require

oxygen for respiration and the amount of oxygen consumed by the fish is a function of its size, feeding rate, activity level and temperature. Small fish consumed more DO than do large fish because of their higher metabolic rate.

Fish farmer, in an attempt to maximise production, stock greater amounts of fish in a given body of water than found in nature especially when using surface pond or concrete tanks. Therefore, it may be necessary to supply supplemental aeration to maintain adequate levels of dissolved oxygen. Whereas in Recirculatory aquaculture system (RAS) the farmer must supply 100 percent of the oxygen needed for the fish and beneficial nitrifying bacteria.

To obtain good growth, fish must be cultured at optimum levels of DO. A good rule of thumb is to maintain DO levels at saturation or at least 5ppm. DO less than 5ppm can place undue stress on the fish, and levels less than 2ppm will result in death. Some warm water fish species such as tilapia and carp are better adapted to withstand occasional low DO levels, while most coldwater species cannot.

Fish are not the only consumers of dissolved oxygen in aquaculture systems; bacteria, phytoplankton, and zooplankton consume large quantities of oxygen as well. Decomposition of organic materials (algae, bacteria, and fish wastes) is the single greatest consumer of oxygen in aquaculture system. Problems encountered from water recirculating systems usually stem from excessive ammonia production in fish wastes. Consumption of oxygen by nitrifying bacteria that break down toxic ammonia to non-toxic forms depends on the amount of ammonia entering the system.

Oxygen enters the water primarily through direct diffusion at the air-water interface and through photosynthesis. Direct diffusion is relatively insignificant unless there is considerable wind and wave action. Several forms of mechanical aeration are available to the fish farmer. Mechanical aeration can also increase DO levels. Because of the lack of photosynthesis in indoor water recirculating systems, mechanical means of aeration is the only alternative for supplying oxygen to aquatic animals cultured in the systems. Oxygen depletions can be calculated, but predictions can be misleading and should never be substituted for actual measurements. Categories of mechanical aerators include:

(a) Paddlewheels
(b) Agitators
(c) Vertical sprayers
(d) Impellers
(e) Airlift pumps

(f) Ventura pumps
(g) Liquid oxygen injection
(h) Air diffusers

**(iv) Carbon Dioxide:** Carbon dioxide ($CO_2$) is commonly found in water from photosynthesis or from water sources originating from limestone bearing rock. Fish can tolerate concentrations of 10 ppm provided dissolved oxygen concentrations are high. Water supporting good fish population normally contains less than 5ppm of free carbon dioxide. In water used for intensive pond fish culture, carbon dioxide levels may fluctuate from 0 ppm in the afternoon to 5-15 ppm at daybreak. While in recirculating aquaculture systems carbon dioxide levels may regularly exceed 20 ppm. Excessively high levels of carbon dioxide (greater than 20 ppm) may interfere with the oxygen utilisation by the fish.

There are two common ways to remove free carbon dioxide. First, with well or spring water from limestone bearing rocks, aeration can blow off excess gas. The second option is to add some type of carbonate buffering material such as calcium carbonate ($CaCO_3$) or sodium bicarbonate ($Na_2CO_3$). These additions require calculating the exact amount of the material needed for that purpose as it will initially remove all free carbon dioxide and store it in reserve as bicarbonate and carbonate buffers.

**(v) Nitrogen:** Dissolved gases, especially nitrogen, are usually measured in terms of "percent saturation". Any value greater than the amount of gas the water normally holds at a given temperature constitute supersaturation. A gas supersaturation level above 110% is usually considered problematic.

Gas bubble disease which may vary in sign is a symptom of gas supersaturation. Bubbles may reach the heart or brain, and fish die without any visible external signs. Other symptoms may be bubbles just under the surface of the skin, in the eyes, or between the fin rays. Treatment of gas bubble disease involves sufficient aeration to decrease the gas concentration to saturation or below.

**(vi) Ammonia:** Fish excrete ammonia and lesser amounts of urea into the water as wastes. Two forms of ammonia occur in aquaculture systems, ionised and un-ionised. The un-ionised form of ammonia ($NH_3$) is extremely toxic causing brown-blood disease in fish while the ionised form ($NH_4^+$) is not. Both forms are grouped together as "total ammonia". Through biological

processes called nitrification, toxic ammonia can be degraded to harmless nitrates according to the following equation:

$$NH_3 \xrightarrow[\textit{Nitrosomonas}]{1½0} NO_2^- \xrightarrow[\textit{nitrobacter}]{1½0} NO_3^-$$

In natural waters, such as lakes, ammonia may never reach dangerous high levels because of the low densities of fish, but the fish farmer must maintain high densities of fish in his pond and, therefore, runs the risk of ammonia toxicity as it is mostly favoured by rise in temperature and high pH.

**(vii)** **pH:** The quantity of hydrogen ions ($H^+$) in water will determine if it is acidic or basic. The scale for measuring the degree of acidity is called pH scale, which ranges from 1 to 14. A value of 7 is considered neutral, neither acidic nor basic; values below 7 are considered acidic while values above 7 are considered basic. The acceptable range for fish culture is between 6.5 and 9.0.

**(viii)** **Alkalinity:** Alkalinity is the capacity of water to neutralise acids without an increase in pH. This parameter is a measure of bases, bicarbonates ($HCO_3^-$), carbonates ($CO_3^{--}$) and, in rare instances, hydroxide ($OH^-$). Total alkalinity is the sum of the carbonates and bicarbonates alkalinities. The carbonate buffering system is important to the fish farmer regardless of the method of production as it helps to wide daily pH fluctuations.

In recirculating systems where photosynthesis is practically non-existing, a good buffering capacity can prevent excessive buildups of carbon dioxide and lethal decrease in pH. It is recommended that fish farmer maintain totally alkalinity values of al least 20 ppm for catfish production.

**(ix)** **Hardness:** Water hardness is similar to alkalinity but represents different measurements. Hardness is chiefly a measure of calcium and magnesium, but other ions such as aluminum, iron, manganese, strontium, zinc and hydrogen ions are also included. When the hardness level is equal to the combined carbonate and bicarbonate alkalinity, it is refereed to as carbonate hardness. Hardness values greater than the sum of the carbonate and bicarbonate alkalinity are referred to as non-carbonated hardness. Hardness values of at least 20 ppm should be maintained for optimum growth of fish and other aquatic organisms. Low-hardness values can be increased with the addition of ground agriculture lime.

**(x) Other Metals and gases:** Other metals such as iron and sodium, and gases, such as hydrogen sulphide, may sometimes present special problems to the fish farmer. Most complications arising from these can be prevented by properly pre-treating the water prior to adding it to ponds or tanks. The range of treatments may be as simple as aeration, which removes hydrogen sulphide gas, to the expensive use of iron removal units. Normally iron will precipitate out of solution upon exposure to adequate concentrations of oxygen at a pH greater than 7.0.

## 3.4 The Importance of Water Quality

Phytoplankton are microscopic photosynthetic organisms found suspended in water Phytoplankton are found in most bodies of fresh and salt water, including channel catfish ponds. Soon after a fish pond is dug and filled, samples of different species of phytoplankton can be found. These new ponds can be seeded with phytoplankton through such sources as wading birds, turtles, and wind-blown spores. Many species of phytoplankton will reach a new pond, but only certain ones will survive and flourish. The species that colonises the new pond depends upon the suitability of the environment for growth and, to some respect, chance. It is not uncommon for ponds that are constructed side-by-side with similar soil types and the same water sources to contain very different populations of phytoplankton.

Eutrophication is the aging process, ending in "death" that takes place in a pond as it begins to be overgrown with the characteristics of a bog or lagoon. A dead pond is unable to support aquatic life and so should be guided against for a successful fish farming business. The following descriptions summarise the rate and level of eutrophication attained by a particular water body, based on the physical and chemical characteristics.

### (i) Oligotrophic (Very Healthy)

This indicates a very healthy pond or water body. Such is stable with good clarity water quality and is aging at a slower than normal rate. The ecosystem is balanced an able to convert all nutrients to all levels of the food chain. This situation supports fish life and production is enhanced through maximum utilization of the entire food chain.

### (ii) Mesotrophic (Moderately Healthy)

This pond condition may need aeration and possibly enzyme too. This indicates that the pond is aging progressively at a normal rate with good water quality. Benthic organisms are converting and oxidising the

organics falling to the bottom on demand, or slightly slower than demand.

### (iii) Eutrophic (Unhealthy)

This shows that aeration and enzymes are necessary. Implication of this is that the water quality is eroding at an unhealthy accelerated pace. Efforts must be made to reverse the continued aging process. Organic matter is accumulating, undecomposed and unconverted to the benthic layer, which is strangling the lake and all organisms that inhabit it. The low oxygen condition will result in periodic fish kill if un-aerated.

### (iv) Hyper Eutrophic (Severely Degraded)

It is a must to have aeration and enzyme in this situation. Aging is accelerated beyond normal due to pollution and other influences. The pond will not be able to sustain a balanced ecosystem of life for very long. Immediate and long-term plans must be made to retard the eutrophication process. Stratification is clearly evident and bottom dwelling organisms and bacteria are unable to convert and oxidize the rapid deposition of organic sludge. Also evident are excessive weed and algae growth, low dissolved oxygen and fish kill or asphyxiation as a result of high level of nutrients in the water body. In this regard, phosphorus measured in open water is the most accurate indicator of primary productivity.

## 3.5 Phytoplankton Management

To date there is no effective way to manage a phytoplankton bloom other than reducing nutrient input in the form of feeds. This will limit the nutrients (phosphorus, nitrogen) available for growth and reproduction of the phytoplankton community and will result in a moderate phytoplankton density. In a catfish pond, this is around 40 to 50 pounds of feed/acre/day. (This is not an economical option for most catfish producers.) Other methods have been used to try to control phytoplankton densities but have been completely ineffective. Studies have shown that the use of copper sulfate (CuSO4) to selectively thin the bloom does much more harm than good. Thinning the phytoplankton bloom in this manner results in very poor water quality and overall reduced fish production. The use of dyes to shade out dense phytoplankton blooms has been studied. Dyes probably result in poorer water quality throughout the growing season. Dyes may also select for undesirable blue-green algae in treated ponds.

## 3.6 Beneficial Practices Which Improve Water Quality

Beneficial (or best) management practice (BMPs) is the term used to describe a practice, or system of practices, designed to minimise the impact of agricultural activities on natural resources while at the same time maintain economic viability of the agricultural industry. To ensure a supply of good quality water for aquaculture and agricultural purposes and domestic use it is necessary to consider BMPs at three levels:

- Watershed management; to protect both surface and ground water sources;
- Water source management; (such as a dugout, river or ground water aquifer) and
- Water treatment for use.

### 3.6.1 Watershed Management

Watershed management techniques offer the first water treatment strategy for maintaining good water quality. Watershed management includes beneficial management practices (BMPs) which protect surface water supplies (dugouts, small reservoir, rivers or lakes) and ground water aquifers (shallow or deep water supplies below ground) by reducing the potential for contaminants to enter the water source. Some examples of substances which could contaminate a water source include sediment, fertiliser, pesticides, animal waste, animal pharmaceuticals, fuel, oil and hazardous products used in farming, or by-products used in agricultural processing.

There are three general types of beneficial practices which help reduce the risks of water quality degradation.

- **Managing Agricultural Inputs**

Managing agricultural inputs is an important element of pollution prevention. Proper handling and use of fertilizers, manures and pesticides will prevent or limit the impact on the environment.

- Nutrient management is the practice of applying fertilisers and manures only in the amounts that can be taken up by the crop. Over-applications increase the risk of contaminating surface and groundwater supplies.
- The use of pesticides can be minimised through “Integrated Pest Management”. This refers to a management strategy that includes an understanding of the target pest and use of a combination of physical, chemical, biological and cultural controls. Proper

storage, mixing and handling are also essential in minimizing risk to the environment.

- Another practice includes livestock watering at sites well away from natural water courses (including wells or sensitive aquifers) in order to keep manure out of the water and building fences to prevent cattle access to water courses. Read more about this practice in Controlling erosion and runoff.

- **Controlling Erosion and Runoff**

It is an important beneficial management strategy. Runoff from fields to which pesticides, fertilizer and manure are applied, as well as runoff from livestock operations can contaminate water. Practices such as strip-cropping, shelterbelts and use of cover crops prevent erosion and reduce the movement of nutrients and pesticides from agricultural land.

Residue management through conservation tillage and continuous cropping is also effective at controlling erosion, but requires higher inputs of fertiliser and herbicides.

- **Barriers and Buffers**

Barriers and buffers can be planted to intercept potential contaminants from agricultural lands. In most cases, these are strips of vegetation that slow the velocity of runoff water enough for sediment to settle out, water to infiltrate into the ground and nutrients to be taken up by plants in the vegetated buffer zone. Grassed waterways, vegetative strips and field borders are examples of buffers that can be used in annually cropped fields.

Where buffer zones surround a stream or lake, they are usually referred to as riparian buffers. These strips capture sediment and nutrients from water that is moving into the waterway from surrounding agricultural lands. The vegetation also stabilises the banks and shores from the erosive action of the waterway itself.

### 3.6.2 Management of Water Sources

Management of the water source includes best management practices (BMPs) to sustain the best possible water quality at the source.

BMPs for Surface Water Sources include:

- proper citing and design of river or dugout intakes
- selective and limited use of algicides in farm ponds
- control of surface water inflow to the reservoir or dugout

- use of biological, chemical or physical techniques such as aeration, coagulation or reservoir covering

**BMPs for Groundwater Sources include:**

- diverting surface water runoff away from well pits
- protecting sensitive aquifers,
- preventive maintenance such as shock chlorination of wells when necessary.

### 3.6.3 Water Treatment for Use

Watershed management techniques offer the first barrier for maintaining good water quality. Management of the water source is the second barrier, aimed at maintaining and improving water quality. Recirculating system is the most recent technology in treating waste water from fish pond while at the same time re-using it for the purpose of producing fish. Although both strategies will improve the quality of the source water, they can not drastically improve water quality when pure water is necessary, such as for boilers used in agricultural industry. Watershed management and water source protection strategies must be combined with other treatment processes, such as in-house treatment and disinfection, to ensure that the water is safe for drinking and aesthetically-pleasing for general household use.

## 8.0 CONCLUSION

In this unit you learnt that successful aquaculture depends on healthy fish and proper water quality.

## 9.0 SUMMARY

Far from being a “universal solvent”, as it is sometimes called, water can dissolve more substances than any other liquid. Over 50 percent of the known chemical elements have found in natural waters, and it is probable that traces of most others can be found in lakes, streams, estuaries, or oceans

## 10.0 TUTOR-MARKED ASSIGNMENT

1. How would you manage a case of phytoplankton bloom on your fish farm?
2. Explain different ways of managing water sources to improve its quality.

## 7.0 REFERENCES/FURTHER READINGS

Di Turo, J.W and Hurtak, J.J (1998). *Innovative Technique for In Situ Treatment of Contaminated Surface Waters and Submerged sediments by Enhanced Aerobic Bioremediation.* 33rd Intersociety Engineering Conference on Energy Conversion Colorado Springs, CO, August 2-6, 1998.*The Academy For Future Science*.

Williams, J.E (1995). *Fish Conservation*. Volume 2, 33-47pp. Academic Press, Incorporation.

# UNIT 4 UNDERSTANDING FISH NUTRITION, FEEDS AND FEEDING

## CONTENTS



## 6.0 INTRODUCTION

Good nutrition in animal production systems is essential to economically produce a healthy, high quality product. In fish farming, nutrition is critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. The development of new species-specific diet formulations supports the aquaculture (fish farming) industry as it expands to satisfy increasing demand for affordable, safe, and high-quality fish seafood products.

## 7.0 OBJECTIVES

At the end of this unit, you should be able to:

- understand the essence of good nutrition to a successful aquaculture
- appreciate the need to ensure good nutrition for fish.

## 8.0 MAIN CONTENT

### 3.1 What is Fish Feed?

To consider what a living animal needs to feed on, the first thing that comes to mind is to cover the energy requirements in order to ensure the basic vital functions (moving, growing, reproduction and metabolism). The energy for these is provided by the intake and uptake (metabolism) of the proteins, fats (lipids) and carbohydrates contained in the food. Also, the animal needs a certain number of substances to be able to grow and function properly: for example, vitamins and minerals that have a secondary but essential role in the body.

In this respect, fish are not so different from other animals, needing to eat to be able to live, grow and reproduce. However, farmed fish are a bit special when compared to other farmed animals because most of farmed fish species in Western Europe are highly carnivorous (salmon, trout, sea bass, sea bream, turbot...). They therefore need a high level of proteins in their diets. Feed manufacturers have a common goal - to produce feeds that are nutritious, easy to handle and economically acceptable in the production chain. If these criteria are met, this allows the production of affordable, high quality fish for the consumer.

### 3.2 Supplementary Diets

Two concept of supplementary diet have recently been recognised. One school of thought defines it as a supplement fed along with another one. While another school of thought regards it as one fed to supplement the natural food present in the environment. The latter definition was accepted and adopted by aquaculture experts. Feed industries in Nigeria are characterized by constant fluctuation in the prices of feed ingredients. This is practically due to the seasonality of most of these feedstuffs and also because of several alternative uses of the ingredients especially in poultry and livestock industries, and even for human consumption, These shortcomings have thus necessitated the use of alternative feed ingredient for possible inclusion in the diet of farmed fish and as a total replacement for fishmeal where possible. It is however note worthy that in finding a replacement, the aim of producing a high quality food (fish) for humans' consumption that is

environmentally friendly, cost effective and that is sustainable must not be compromised. These occurrences have been traced to the presence of elements within vegetable meals that inhibit nutrition of fish species. These elements, called antinutritional factors have the potential of precipitating adverse affect on the productivity of farm livestock including fish and are found present in the foliage and /or seeds of virtually every legume plant that is used in practical feeding.

In the quest to find alternative protein sources using locally available materials in fish feed preparations, much attempts and successes have been recorded. It has however been pointed that, most of the feed ingredients have not performed credibly well in terms of their protein digestibility and biological value to fish when tested as replacer for fish meal. With the unequal position occupied by fishmeal as " chief protein source" due to its balanced amino acids composition in the diet of fish and livestock it therefore become a better practice that a vegetable protein be made to replace another one in practical fish fed formulation.

## 3.3 Fish Meal as a Component of Fish Feed

For the production of high quality fish most of the fish species farmed around the world including catfish that is popular in Nigeria are essentially omnivorous and carnivorous, their metabolism requires access to fish or fish materials in their feed. So, fish meal is composed of the following materials.

### 3.3.1 Fish Meal

Fishmeal is a high protein feedstuff often included in poultry diets. It is usually marketed at 65% crude protein, but the crude protein content can vary from 57 to 77%, depending on the species of fish used. Several species of fish can be processed into fishmeal, but the most common are Anchovy and Menhaden. Major fishmeal producing countries are Chile, Norway, Denmark and Peru.

Most fish species can not be harvested year-round. As a result, there is seasonal variation in protein content, depending on the species of fish used. The crude protein content of fishmeal is usually highest during the Menhaden harvest. The price of fishmeal varies throughout the year and is a reflection of the seasonal variation in the supply of fish. The price of fishmeal is usually the highest during the winter months when the supply is lowest. The price also varies from year to year depending on the price of other protein sources, in particular soybean and other oil meals. Fish meal coming from pelagic fish, which are the most used to supply fish oil and fish meal. Generally, these fish species are unsuitable for human consumption because they are small and bony and it would

not be economically viable to process them into products adapted to consumer needs.

To cover all the dietary requirements of carnivorous fish, the feed must be high in energy content. This means it has to be protein rich (from 38% to 45% according to the need of each species). It also has to be of good quality, must be highly digestible and have amino acid profiles adapted to the nutritional requirement of the fish species in question.

### 3.3.2 Fish Oil

Fish oil is also obtainable from pelagic fish. Apart from the essential proteins, the food must also cover the particular requirements for oils. Key requirements are the healthy Omega 3 and Omega 6 poly-unsaturated fatty acids: these control vital life processes including reproduction, physical development (especially of the brain and the nervous system), immunity, inflammatory processes and a healthy cardiovascular system. Pigment such as Astaxanthin, a naturally-occurring carotenoids pigment that is a powerful biological antioxidant but is also essential for protection against UV-light effects and stimulating the immune response. Wild fish get this natural pigment from eating tiny crustaceans.

### 3.3.3 Vitamins

Vitamins A, C, D and E, the B group and others, such as biotin Minerals such as calcium, phosphorus and other essential trace elements are readily available in fish meal. Similarly, vegetable products such as cereals, soybean, glutens and vegetable proteins are increasingly used in modern fish feeds as some of these have been found to contain some of these mineral element and vitamins. A lot of research work has shown that vegetable sources of protein (soy, pea, sunflower) and oils (soy, colza, linen) are perfectly usable in varying proportions in fish feed. At the present time, fish meals and oils represent around 50% or less of certain formulations. In the near future, their percentage will be reduced even further.

### 3.3.4 Moisture

The moisture content of fishmeal is normally low in order to facilitate storage and transport. If the moisture content remains at the acceptable lower limits the meal will be more likely to have a low bacterial and/or mold count. Antioxidants must be added to the meal to ensure proper stabilization during extended periods of storage. Fishmeal contains three major nutrients; protein, fat, energy and minerals (ash).

### 3.3.5 Other Ingredients

In Nigeria, many agricultural and Industrial bye-products have been identified and which have proven useful in fish feed formulation. Notable among these are groundnut cake, soya bean cake, brewery waste, biscuits wastes, palm kernel cake, rice bran and others.

## 3.4 Nutritional Requirements of Fish

Fish like any other livestocks especially farmed for commercial purpose will need food in order to sustain itself and to carry out other metabolic activities such as growth, respiration, reproduction and other life processes. The nutritional requirements for meeting up with such demands are those that will enhance tissue build-ups, chemical synthesis and energy provision among others. Therefore, a properly formulated, prepared feeds must have a well-balanced energy to protein ratio. The following nutrient sources are therefore a must part of fish diet in ensuring good returns to the fish farmer.

### 3.4.1 Protein

Fishmeal is added to fish and poultry diets as a source of highly digestible, “high quality”, animal protein. Animals synthesise proteins from 22 amino acids. However, animals cannot synthesize all 22 of these amino acids. Amino acids which can not be synthesized by animals, and therefore must be supplied in the diet, are classified as essential. Those that can be synthesised by the animal are termed nonessential. Of these, a few cannot be synthesised at a rate fast enough for maximum growth and, therefore, are considered dietary essentials in fish feed.

The nutritional value of any protein is directly related to the amino acid composition of that protein. A protein that does not contain the proper amount of required (essential) amino acids would be an imbalanced protein and would have a lower nutritional value to the bird. Proteins of cereal grains and most other plant protein concentrates fail to supply the complete amino acid needs of fish, due to a shortage of methionine and/ or lysine. Soybean meal, which is widely used in poultry diets, is a good source of lysine and tryptophan, but it is low in the sulfur-containing amino acids methionine and cysteine. Fishmeal is an excellent source of all of these amino acids. A well-balanced protein, such as that found in fishmeal, is considered to be of high nutritional value for the fish.

Feedstuffs are combined to meet the bird's need for the most limiting amino acids, as well as other nutrients and energy. This can sometimes result in a higher than required protein content of the diet due to the

presence of other amino acids in excess. The excess amino acids are not used for the function of protein synthesis. Instead they are deaminated and their carbon skeletons used as an energy source or stored for use as an energy source at a later time. This method of furnishing excess amino acids is very expensive and is an inefficient overall use of the dietary protein.

Using synthetic amino acids, diets can be formulated which meet the bird's amino acid requirements but with a reduced total protein content. This provides the appropriate levels of essential amino acids while avoiding large excesses of other amino acids.

Fishmeal contains an excellent quantity and profile of amino acids which can also offset the deficiencies of certain limiting amino acids in cereal grains. The protein in fishmeal is an excellent source of the essential amino acids lysine, methionine and tryptophan. It is because of this that fishmeal is often used as the supplement of choice for vegetable protein, especially soybean meal.

### 3.4.3 Minerals (Ash)

Minerals are inorganic elements necessary in the diet for normal body functions. They can be divided into two groups (macro-minerals and micro-minerals) based on the quantity required in the diet and amount present in fish. Common macro-minerals are sodium, potassium chloride and phosphorus while examples of micro-minerals include copper, chromium, iodine, zinc and selenium. These minerals regulate osmotic balance in fish and aid in bone formation and integrity. Fishmeal is an excellent source of calcium and phosphorus for fish. The ash (mineral) content of fishmeal can range from 10 to 25%. The higher ash content is usually an indication of a higher calcium and phosphorus level. The calcium and phosphorus are in a highly available form, unlike some of the calcium and phosphorus in plant proteins.

One of the only minerals in fishmeal that is not readily available to poultry is the trace mineral selenium. The selenium in fishmeal exists in the form of seleno proteins which are not considered to provide readily available selenium to the fish. Also fish can absorb many minerals directly from the water through their gills and skin, allowing them to compensate to some extent for mineral deficiencies in their diet.

### 3.4.3 Energy

The energy content of fishmeal is directly related to the percentage of protein and oil (fat) in the meal. Usually the metabolisable energy (ME) value of fishmeal ranges from 2500 to 3200 Kcal ME/kg. The quantity of oil present in fishmeal depends on the species, feeding habits of the fish, and the method of processing.

The use of antioxidants in the preservation of fishmeal is essential in order to ensure a higher ME value for the fish and poultry. Without stabilizing the fishmeal with antioxidants, the ME of the meal may be reduced by as much as 20%. Prior to the development and use of antioxidants by the fishmeal industry, it was common practice to turn piles of processed meal in order to dissipate the heat arising from the oxidative process. Occasionally, these piles of stored meal or during transit, fishmeal would combust spontaneously and cause fires and decrease the nutritive value. It was common several years ago to hear of ships sinking due to fires caused by spontaneous combustion of fishmeal. Today, transatlantic transported fishmeal, by law, must contain an effective antioxidant.

### 3.4.4 Fatty Acids

The oil present in stabilised meal has a relatively low concentration of linoleic acid, an essential fatty acid for poultry. However, the oil is an excellent source of the essential fatty acid, linolenic. The fatty acids present in the oil in fishmeal can contribute to the requirement of poultry for essential fatty acids. Supplementing low levels of fishmeal in broiler and laying hen diets has been shown to increase the omega-3-fatty acid content of broiler meat and eggs. Current knowledge in the area of cardiovascular disease indicates that the presence of the omega-3-fatty acids in the human diet is related to a lower incidence of heart attack.

### 3.4.5 Vitamins

Vitamins are organic compounds necessary in the diet for normal fish growth and health. They often are not synthesized by fish, and must be supplied in the diet. The two groups of vitamins are water-soluble and fat soluble. Water-soluble vitamins include: the B vitamins, choline, inositol, folic acid, pantothenic acid, biotin and ascorbic acid (vitamin C). Of these vitamin C probably is the most important because it is a powerful antioxidant and helps the immune system in fish.

The fat-soluble vitamins include A vitamins, retinols, the D vitamins, cholecalciferols, E vitamins, tocopherols (antioxidants) and K vitamins

such as menadione. Of these, vitamin E receives the most attention for its important role as an antioxidant. Deficiency of each vitamin has certain specific symptoms, but reduced growth is the most common symptom of any vitamin deficiency. Scoliosis and dark coloration may result from deficiencies of ascorbic acid and folic acid vitamins respectively.

## 3.5 Types of Fish Feed

Commercial fish feeds are manufactured as either extruded (floating or buoyant) or pressure-pelleted (sinking) feeds. Both floating and sinking feed can produce satisfactory growth, but some fish species prefer floating, others sinking. Shrimp, for example, will not accept floating fed, but most fish species can be trained to accept a floating pellet.

Extruded feeds are more expensive due to the higher manufacturing costs. Usually it is advantageous to feed a floating (extruded) feed. This enables the farmer can directly the feeding intensity of his fish and adjust feeding rates accordingly as this is an important management strategy in ensuring maximum fish growth and feed use efficiency.

As earlier said manufactured feeds are available in variety of sizes ranging from fine crumbles for small fish (fry, swim-up frys) to large sizes. The pellet size should be approximately 20-30% of the size of the fish species mouth gape. Feeding too small a pellet results in inefficient feeding and feed utilizations because more energy is used in finding and eating more pellets. Conversely, pellets that are too large for fish mouth will depress feeding and, in the extreme, cause choking. Therefore the appropriate feed size for the right fish to eat and the fish will actively eat.

## 3.6 Feeding Rate, Frequency and Timing

Feeding rates and frequencies are in part a function of fish size. Small larval fish and fry need to be fed a high protein diet frequently and usually in excess. Small fish have a high energy demand and must eat nearly continuously and be fed almost hourly. Feeding small fish in excess is not as much of a problem as overfeeding larger fish because small fish require only a small amount of fed relative to the volume of water in the culture system.

As fish grow, feeding rates and frequencies should be lowered, and protein content reduced. However, rather than switching to a lower protein diet, feeding less allows the grower to use the same feed (protein

level) throughout the grow-out period, thereby simplifying feed inventory and storage.

Feeding fish is labour-intensive and expensive. Feeding frequency is dependent on labour availability, farm size, and the fish species grown. Large catfish farms with many ponds usually feed only once per day because of time and labour limitations, while smaller farms may feed twice per day. Generally, growth and feed conversion increase with feeding frequency. In indoor, intensive fish culture systems, fish may be fed as many as 5 times per day in order to maximum growth at optimum temperatures.

Feed acceptability, palatability and digestibility vary with the ingredients and feed quality. Fish framers pay careful attention to feeding activity in order to help determine feed acceptance, calculate feed conversion ratios and feed efficiencies, monitor feed costs, and track feed demand throughout the year. Recommended framed fish feeding rate is between 1-4% of their body weight per day.

## 3.7 Feed Formulations, Care and Packages

The composition of the feed changes according to the nutritional needs of the fish: when it is a larva, it requires a high protein level, since it needs this resource for growth of its muscle tissue. Lipids (fats) are used by fish as their main energy source and, as they get bigger and more active, the lipid content is increased and the protein content reduced.

Prepared or artificial fish feed may be either complete or supplemental. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins and minerals) necessary for optimal growth and health of the fish. When fish are reared in high density indoor systems or confined in cages and cannot forage freely on natural feeds existing in pond, they must be provided with a complete diet. In contrast, supplemental (incomplete/partial) diets are intended only to help support the natural food (insect and insect larva, algae, small fish and other benthic organisms) normally available to fish in ponds or outdoor raceways. Supplemental diets do not contain a full complement of vitamins or minerals, but are used to help fortify the naturally available diet with extra protein, carbohydrate and / or lipid.

Fish, especially when reared in high densities, require a high-quality, nutritionally complete, balanced diet to grow rapidly and remain healthy.

Already prepared feed are pelleted to enhance better utilisation by fish but the size of feeds varies simply because each size corresponds to the different stages of development and also to the physiology of the fish. To get a well-fed fish, pellets are adapted to the development of its mouth size, which varies according to its age and the species. Imported dry feed exists from crumble-size (0.08 mm diameter) to big pellets (20 mm diameter) with several other sizes within the range.

Bagged feeds should be kept out of direct sunlight and as cool as possible. Vitamins, proteins, and lipid are especially heat sensitive, and are readily denatured by high storage temperatures. High moisture stimulates mold growth and feed decomposition. Avoid unnecessary handling and damage to feed bags which may break the pellets and create fines ¾ which may not be consumed by fish.

## 9.0 CONCLUSION

In this unit, you learnt that growth, health and reproduction of fish are primarily dependent upon adequate supply of nutrient both in terms of quantity and quality irrespective of the culture system in which they are grown.

## 5.0 SUMMARY

The most important rule in fish nutrition is to avoid overfeeding. Overfeeding is a waste of expensive feed. It is also results in water pollution, low dissolved oxygen levels, increased biological oxygen demand, and increased bacterial loads. Usually, fish should be fed only the amount of feed that they can consume quickly (less than 25 minutes). Many growers use floating (extruded) feeds in order to observe feeding activity and to help judge if more or less should be fed.

Even with careful management, some feed ends up as waste. For example, out of 100 units of feed fed to fish, typically about 10 units of feed are uneaten (wasted) and 10 units of sold and 30 units of liquid wastes (50% total wastes) are produced by fish. Of the remaining feed, about 25% is used for growth and another 25% is used for metabolism (heat energy for life processes). These numbers may vary greatly with species, sizes, activity, water temperature, and other environmental conditions.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the process of pelleting fish feed and its importance.
2. What are the essential components of a balanced fish ration?

## 7.0 REFERENCES/FURTHER READINGS

Ayodele, I.A and Ajani, E.K (1999). *Essentials of Fish Farming* (Aquaculture),pp 46.

Faturoti, E.O (2000). *Sustainable Fish Production*. Inaugural Lecture, University of Ibadan, Ibadan. 14th December, 2000.

# UNIT 5 FISH DISEASES AND MANAGEMENT

**CONTENTS**

## 1.0 INTRODUCTION

Fish disease is an unhealthy fish body condition. It is the departure from the normal wholesome state of the fish. It is condition of discomfort or sickness which can lead to reduction in the normal physiological activities and development of the fish. Catfish production involves many risks and has been described as one of the most management intensive forms of farming in addition to the high entry cost. As a result of the increased artificial feeding of the heavily stocked fish, metabolic activity of the fish is increased, thus increasing the levels of organic wastes and toxic compounds within the ecosystem. Algae, bacteria and other microorganisms begin to grow. The ponds ecosystem is more difficult to maintain than cages and pens in natural water bodies therefore, the pond system eventually becomes imbalance and cannot be maintained and organic wastes build up to toxic levels (such as ammonia and nitrites) constituting massive blooms of algae growth. The dominant type of algae that is prevalent is blue-green algae which are the major cause of off-flavours in fish. On a general note, fish diseases can be categorised as infectious diseases, parasitic diseases, nutritional diseases and environmental diseases of which environmental, parasitic and bacterial infections-a form of infectious diseases are most prevalent in the tropics.

This unit shall look into the possible ways of controlling the adverse effects of poor fish environment (water quality) and treatment of bacterial infections through medication

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- know different types of fish diseases
- how to prevent fish disease outbreak
- understand bacteria diseases
- list five symptoms of a diseases fish.

## 3.0 MAIN CONTENT

### 3.1 Effect of Microbial Attack on Fish Production

The “low-intensity” management practices used prior to the 1980's generally resulted in good pond water quality and lower overall stress on fish populations. Lower fish densities also meant less efficient transmission of disease organisms. Over the years, stocking and feeding rates steadily increased and producers adopted a multiple-batch cropping system wherein new populations of fingerlings were stocked into ponds with existing populations of larger fish. These production practices lead to the emergence of infectious diseases as the primary limiting factor in catfish production, and disease outbreaks are not uncommon even on well-run facilities.

About forty-five percent of inventory losses on catfish fingerling farms are attributable to infectious diseases. Corresponding survey data for food-sized fish are lacking. Of the overall catfish losses caused by infectious disease, approximately sixty percent are the result of single or mixed bacterial infections, thirty percent result from parasitic infestation, 9 percent from fungal infections, and one percent is of viral etiology. Multiple or mixed infections often occur in pond raised channel catfish making treatment decisions difficult.

Economic losses resulting from infectious diseases are difficult to quantify because record keeping varies among farmers and many diseases go unreported. Nevertheless, infectious disease is believed to cost producers many millions of dollars in direct fish losses each year. In addition, infectious diseases influence profitability by increasing treatment costs, reducing food consumption by fish, increasing feed conversion ratios, and causing harvesting delays. Fish-eating birds may also be attracted to ponds with sick and dying fish causing further losses.
There are several disease syndromes for which the etiology remains in question, such as channel catfish anemia (CCA), which has also been referred to as no blood disease”. Another syndrome is visceral toxicosis of catfish (VTC), believed to be caused by a toxin.

Once a disease outbreak occurs, effective health management requires three basic steps: problem identification, diagnosis, and corrective management-all of which must be performed in a timely manner to avoid further losses. Whenever multiple factors contribute to the disease process, it makes the diagnosis more difficult and often complicates corrective management.

## 3.2 Use of Medicated Feed in Catfish Production

Pond-raised catfish are the most popular species of food fish grown in the southeastern United States. Because of crowding and associated stressors encountered in modern aquaculture, they are more susceptible to disease than free-ranging animals. Bacterial disease is frequently the cause of death of catfish, though often secondary to other problems such as poor water quality or excessive parasitism. Medicated feeds can be used to control bacterial disease. However, the results of treatment may only be temporary unless underlying problems are also corrected.

## 3.5 Bacterial Disease in Fish Production

Bacteria are tiny, single-celled organisms which live in the water, the sediments, on the surface and in the intestines of fish. Most bacteria are beneficial and essential for life. They help to digest foods and produce vitamins, as well as break down ammonia and organic debris in the environment.

A few bacteria are considered opportunistic pathogens. These bacteria are always present and usually cause no problem. However, under certain conditions they can cause disease in fish. Common examples of opportunistic pathogens which can cause disease and death of catfish include *Aeromonas* sp., *Pseudomonas* sp., and *Flexibacter* sp.

A few bacteria are considered obligate pathogen, which means they are likely to be the sole cause of disease rather than a secondary problem. There is some speculation that *Edwardsiella ictaluri* may be an obligate pathogen.

Separate fact sheets on the bacterial diseases mentioned above are available. *Aeromonas* and *Pseudomonas* cause very similar diseases often characterized by large ulcers on the side of the fish, distended abdomen (dropsy), and exopthalmia (popeye). *Flexibacter columnaris* causes a disease called “columnaris disease” or “saddleback disease.” It is usually an external problem which begins by loss of colour (paleness) along the back of the fish. As the disease progresses, large ulcers may

develop. Mixed infections with *Aeromonas* and *Pseudomonas* are common in advanced cases.

Poor management practices are often the cause of these infections. For example, rough handling damages the skin and mucus of the fish and can result in secondary bacterial infections. Control of these infections often requires the use of medicated feed. Because these infections are usually opportunistic, it is sometimes possible to control the spread of the bacterial infections by correcting management problems that preceded disease outbreak (e.g., excessive parasitism or poor water quality).

*Edwardsiella ictaluri* is a bacterium considered by some to be an obligate pathogen. This may not be precisely true, but this organism without doubt causes the most significant bacterial disease of channel catfish-enteric septicemia of catfish, or ESC. Some producers refer to ESC as "hole-in-the-head disease." It frequently causes ulcers in the middle of the skull of fingerlings, just above the eyes.

Medicated feed is almost always recommended to control ESC outbreaks. Catfish which are becoming sick with ESC often stop eating so early diagnosis and treatment is essential to minimize losses.

## 3.6 What is Medicated Feed?

When referring to channel catfish production, the term medicated feed implies a prepared (commercial) feed which contains an antibiotic. Antibiotics are drugs specifically designed to control bacterial infections, but they do not control parasitic, viral, or fungal diseases. There are many different types of antibiotics, but the Food and Drug Administration (FDA) has approved only two for use in catfish in the U.S.A. These are Terramycin and Romet**.** Each is discussed separately below.

### 3.4.1 Terramycin

Terramycin has been available for treatment of channel catfish for many years. It contains the drug Oxytetracycline . This drug is effective against many bacteria which cause disease of channel catfish, including all of those mentioned above. The FDA specifically approved it for control of *Aeromonas* sp. and *Pseudomonas* sp. infections in channel catfish. Terramycin is incorporated into catfish feed by commercial mills and fed at a rate of 2.5 to 3.75 grams of drug for 100 pounds of fish per day. To receive an adequate dosage, fish need to eat at least 2.5 percent of their body weight per day. Therefore, 100 channel catfish

which weigh 1 pound each need to consume 2.5 pounds of Terramycin medicated feed to receive an adequate dosage.

Terramycin must be fed for 10 days, and the fish must be held an additional 21 days before they can be marketed to allow complete elimination of the drug from the fish. This 21-day withdrawal period assures that the drug will be absent from fish intended for human consumption. Slaughter of fish before the end of the withdrawal period is a violation of federal law. Consider market plans before treating fish with Terramycin. Once treatment begins, the fish are non-saleable for 31 days (10-day treatment period + 21-day withdrawal period).

A final consideration when feeding Terramycin is that it is only available as a sinking feed**.** This drug is broken down by the high temperatures needed to make a pellet of fish feed "puff up" so it will float. Feeding a sinking fish food to sick fish is a disadvantage because it is very difficult to determine if fish have eaten the medicated food.

### 3.4.2 Romet

Romet is a relatively new product approved by the FDA for use in channel catfish in 1985. This product is a potentiated sulfonamide which contains two drugs, sulfadimethoxine and ormetoprim. These two drugs work in combination and are more effective than either drug would be if used alone. Romet is also effective against many bacteria which can cause diseases of catfish. However, it is specifically approved for use against *Edwardsiella ictaluri* infections. Generally, Romet is considered ineffective against *F. columnaris*. It is recommended that Romet not be used if catfish have a primary or secondary infection with *F. columnaris.* Romet is prepared by commercial feed mills and fed at a dosage of 22.7 mg drug per pound of fish (50 mg/kg) per day for 5 days.

The withdrawal period for Romet in channel catfish is only 3 days. This is considerably less than the withdrawal period for Terramycin. With only 5 days required for treatment and a 3-day withdrawal period, catfish treated with Romet can be slaughtered 9 days after the drug treatment is started. Another advantage of Romet is its availability as a floating feed. This allows direct observation of the fish eating the medicated pellets. Again, early diagnosis and treatment are necessary because once fish are sick they are unlikely to eat.

## 3.5 Home Made Medicated Feeds

As the popularity of catfish increased, the availability of commercially prepared medicated feeds improved. It is much easier to feed a prepared medication by following label instructions than to mix your own feed. If medicated feed is not readily available in your area, it may be advisable to special order a few bags to keep on hand. Delivery of feed may take several weeks.

Once a bacterial disease is in progress, medicated feed should be used immediately. It is possible under emergency circumstances to mix your own feed in small quantities if the commercially prepared diet is not available. Terramycin premix may be purchased as a soluble powder, which is available at many stockman supply stores. A 6.4 ounce packet should contain 10 grams of oxytetracycline, but check the label to be sure. One 6.4 ounce packet contains 50 level teaspoons of premix. Each teaspoon, therefore, should contain 200 mg of active oxytetracycline. If fish eat 3 percent of their body weight per day, each pound of feed should contain one gram of drug (5 teaspoons). Vegetable oil or fish oil work well as binders. The oil, feed and powdered premix should be thoroughly mixed to assure even distribution of the drug to all pellets. To coat the pellets properly, mix the powdered premix with the oil, and then add this mixture to the feed. This mixture should be made daily immediately before feeding. This is an expensive, time-consuming and laborious process and is practical only in emergency situations. Romet is available in a form called Romet-B. This product has easy-to-follow directions for mixing the premix with the feed. Again, binding agents like fish oil or vegetable oil can be used. A disadvantage of Romet-B is that it is only sold in 10 lb. canisters which are too expensive to be practical for use by small farmers.

### 3.5.1 Storage of Medicated Feed

As with all fish food, store medicated feed in a cool, dry place. Antibiotics and important nutrients will break down more rapidly if kept in a warm, moist environment. Excessive breakdown of antibiotics because of improper storage can be an important reason for unsuccessful treatment. Discard unused medicated feed after 3 to 4 months.

### 3.5.2 How to Know Which Medicated Feed to Use

Terramycin and Romet each has an important role in disease management of catfish. Table 1 is a summary of the advantages and disadvantages of each feed. Fish farmers associations in the U.S.A have approved Terramycin for control of *Aeromonas* and *Pseudomonas* infection and Romet for control of *Edwardsiella ictaluri* infections. Ideally, however, the selection of an antibiotic should be made following isolation of the bacteria and performance of a sensitivity test.

A sensitivity test shows the ability of disease-causing bacteria to grow in the presence of several different antibiotics.

If the bacteria are unable to grow in the presence of a certain antibiotic, a clear area, or "zone of inhibition," is seen around the area treated with that drug. If the drug has no effect on the bacteria, they will grow all over the area containing the drug. The area will then have a cloudy appearance.

A fish health professional can perform a sensitivity test for you and recommend which antibiotic to use. Remember there are some circumstances when treatment with an antibiotic may not be necessary.

**Table 1.** Advantages and disadvantages of the two medicated feeds, Terramycin and Romet, which are currently approved by FDA for use in catfish.

| **Terramycin** | **Romet** |
|---|---|
| **Advantages:** | **Advantages:** |
| (1)Effective against most basteria which cause disease in channel catfish. | (1)Effective against *Edwardsiella ictaluri* and many Terramycin-resistant organisms. |
| (2)Available in many areas. | (2)Five-day treatment period and 3-day withdrawal period. |
| (3)Reasonable cost. | (3)Available in a floating feed. |
| **Disadvantages** | **Disadvantages:** |
| (1)Bacteria can develop resistance to this drug. | (1)Not effective against *Flexibacter columnaris*. |
| (2)Ten-day treatment plus 21-day withdrawal period. | (2)Availability is a problem in many areas. |
| (3)Only available in sinking feed. | (3)More expensive than Terramycin |

There are several ways by which a fish farmer can treat diseases in fish. The specific method applied depends on the type of disease and the situation. These are:

- Dip treatment- this is very effective for small number of fish.
- Flush treatment- this is better in treating a large number of fish.
- Indefinite bath- Chemical is added to the pond water and no flushing is done
- Feed treatment-This is mostly used to combat parasitic infections

## 3.6 Proactive Pond Management

Often, therapeutants are required to manage the disease and parasite problems which accompany or follow poor water quality periods. However, there exist certain guidelines (prophylactics) which can help to maintain sanity within the pond ecosystem if adhered to strictly thereby avoiding use of antibiotics.

### 3.6.1 Important Steps for Implementing Proactive Pond Management

- Prepare pond properly: Pond should be free of disease causing organisms and microbes before stocking. Organic debris accumulates on pond bottoms as a result of any catfish production. Drying and stirring this debris helps to oxidize organic wastes and may help curtail chronic disease problems Therefore, proper pond preparation strategies as described in the previous unit should be employed in order to ensure security of the stock.

- Clean all farm items after use: All materials like scoop nets, plastic baths or buckets and sorting or counting bays, used must be disinfected washed immediately and allow drying properly and storing well before re-using. This concerns all activities such as sorting and grading of fish, cleaning of fish tanks, transferring of fish from tanks to another, counting for sale and slaughtering.
- Grade your fingerlings: Grading of fish at intervals helps to ensure collection of the same size of fish in the pond and effective feeding of the same size of feed pellet. Small fingerlings have difficulty competing with large fingerlings for food throughout the growing season and as such some part of the feed are wasted in the water leading to poor water quality condition.

- Regulate stocking density: Use appropriate stocking density as much higher stocking rates may be difficult to management.

- Use high quality feed. Using a nutritionally complete, floating ration is an important component in proactive pond management. Feed must provide complete nutrition with maximum conversion efficiency. Extra protein is needed to ensure rapid growth without reducing water quality. Lower quality feeds often are less accepted by fish, have poorer conversion efficiency, which results in more waste products.

- Use reduced feeding rates. Catfish need adequate food for growth and health therefore, many commercial catfish producers feed their stock to satiation (all the feed the fish will eat) daily or use a feeding schedule based on estimated fish weight (3 - 5% of fish body weight per day). This may not work all the time as fish performance or

activity is affected by the weather in some situations and so may not eat all the feed that is given to them based on calculation.

- Feed the Fish and not the Water: Spread feed evenly. It is very important to scatter feed over as much of the pond as possible when using reduced feeding rates. Otherwise, aggressive, larger fish will "hog" the feed and reduce feed efficiency. If your feed application system is limited to a small area of the pond, divide the feed into two or more feeding passes. Catfish will learn your feeding patterns, so occasionally reverse or alter your pattern, to provide an opportunity for all fish to obtain feed.

## 4.0 CONCLUSION

In this unit you learnt about the different types of fish diseases and how to prevent outbreaks.

## 10.0 SUMMARY

Medicated feeds are commercially prepared catfish feeds which contain an antibiotic. Bacterial infections are controlled by antibiotics. The most common bacterial infections of catfish are ***Aeromonas*** **sp.,** ***Flexibacter columnaris,*** **and** ***Edwardsiella ictaluri.***

Only two antibiotics are available in medicated feeds for catfish. Terramycin contains the drug oxytetracycline. It is effective against all the organisms listed above, but is only approved for use against *Aeromonas* and *Pseudomonas* infections. Feed against *Aeromonas* and *Pseudomonas* infections. Feed Terramycin for 10 days followed by a 21-day withdrawal period. It is only available in a sinking feed.

Romet is a potentiated sulfonamide which contains two drugs, sulfadimethoxine and ormetoprim. It is approved for use against *Edwardsiella ictaluri* infections and against *Aeromonas* infections which are not sensitive to Terramycin. Romet does not appear to be effective against *F. columnaris* disease, therefore, is not recommended for use during *F. columnaris* outbreaks. Feed Romet for 5 days followed by a 3-day withdrawal period. It is available as a floating feed.

The final choice for an antibiotic should be based on a laboratory test called a sensitivity test. The test determines which antibiotic will work best to control the bacteria isolated from your fish. A fish health professional can complete this test and recommend the best control of a bacterial disease outbreak on your facility. Keep in mind that bacterial diseases are usually a consequence of poor water quality, excessive

parasitism or improper handling. These management problems must be corrected for successful, long-term control of infections.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Why would you need a medicated feed for your fish on the farm?
2. What form of prophylactic treatment would you give to your fish against bacterial infection?

## 7.0 REFERENCE/FURTHER READINGS

Ezenwa, B. (1979). *Supplementary Diets in Fish Culture and Feed Formulation Technology in Nigeria*. *NIOMR Occasional Paper No. 30*.

Murthy, H.S and Thanuja, K. (2006). *INFOFISH* International No. 2/2006 (March/April) 22-26 pp.

# MODULE 3 FISH MARKETING AND MANAGEMENT, AND WILDLIFE MANAGEMENT INDUSTRY

# UNIT 1 POST HARVEST HANDLING OF FISH AND MARKETING

**CONTENTS**



## 1.0 INTRODUCTION

The handling, processing, and marketing of fish products are essential complementary functions of all food production systems. Women traditionally play a major role in these activities. In most developing countries women dominate the markets either as buyers or sellers of food. For most women marketing is a secondary activity which provides the only source of needed cash income. The marketability of fish products is an important constraint in the development of aquaculture. Moreover, processing and marketing activities provide the greatest opportunities for employment within the aquaculture industry.

## 2.0 OBJECTIVES

The objective of this paper is to describe the role of women in the handling, processing, and marketing of aquaculture products. In the absence of adequate statistics, this unit reveals more about the role of women in processing and marketing in general, and of fish in particular. The performance of "fish mammies" is highlighted to gain insight into the abilities, capacities, and constraints of women as fish processors and traders.

## 3.0 MAIN CONTENT

### 3.1 Fish Handling

Pond harvest is highly labour intensive especially in the developing countries including Nigeria. The help of the entire family, as well as other villagers, is generally required in order to reduce cost of labour. Men seine the pond, while women use baskets to catch the remaining fish. In most rural areas all fish are seined at the end of the culture period. The smaller fish are kept for home consumption and the larger fish are sold. All people involved in harvesting the pond receive a share in the production.

Multiple stocking and harvest imply careful handling and restocking of fish of unsuitable size. This practice is usually found on well-managed farms in Asia. Multiple harvests offers better opportunities for women than single harvesting; small quantities (up to 20 kg) which require less time and capital can be marketed more easily by women. Large-scale production farms generally use other marketing channels; often women traders are only found further down the marketing chain.

The timing of pond harvests must be tailored to meet the local supply and demand patterns. The time lapse between fish harvest and purchase by customers is critical for fresh fish. In Asia, the harvested fish are kept in fish holding cages for on-farm sales for a maximum of one day before being sent to the market. Men are trained to transport and sell fish to hotels, supermarkets, and wholesalers. Market facilities (such as containers with aeration devices) may not be accessible to smaller, private retailers.

Fresh fish cannot be held for long periods of time without serious losses. If necessary they are processed. Fresh fish, especially live, are highly preferred by consumers but they present transport and storage problems. Local transport may include baskets or containers carried on the head, on bicycles, or in small pickup trucks. Transport by boats can be found in estuarine areas in the riverine areas along River Niger and Benue as wells as along Lagos lagoon. This practice is also found common in places such as Bangladesh, China, Guinea Bissau, and Benin.

The transport of fresh or live fish requires: (a) location of ponds close to the market to minimise handling and to limit transportation time, (b) early morning harvests to transport fish at cool temperatures, and (c) markets equipped with ice facilities or water tanks (cement or small tin containers) with aeration devices and a drainage system.

Transport of live fish to remote markets is a more complex handling operation and requires investment in trucks with fish holding cages, pumping systems to circulate the water, and aeration devices in the tanks. Long distance transport of fresh fish further requires ice, or trucks with cooling devices. It may not be economically feasible to transport fresh or live fish to rural markets unless economies of scale can be achieved through high-volume transport. Transport is expensive and may be unreliable or unavailable along bad roads during certain seasons. Live transport may only be feasible for urban centers where consumers are willing and able to pay higher prices for quality products. Women do take part in the transportation of fish, but only at a minor level with less professional means. Most women do not have the necessary cash to invest in modern means of transport or the time for long distance travel

## 3.2 Processing

Women have always predominated in the fish processing sector on small-scale private, cooperative, or industrial levels. Small-scale enterprises can be characterised by a high degree of flexibility, and are capable of responding to the supply of fresh products and consumer preferences. Although most processing enterprises are run on a small-scale basis, their importance to the economy needs to be stressed. Large numbers of woman can find employment and income in this type of industry.

The processing methods used can vary greatly and are dependent on:

(a) consumer taste
(b) availability and costs of the processing materials
(c) technical knowledge
(d) time needed for processing
(e) price of the final product
(f) storage facilities
(g) marketability and seasonal fluctuations

In extensive and semi-intensive production systems, fish are processed when the product cannot be sold fresh, when cold storage plants are not present, or when the product is destined for remote markets. Small-scale salting, smoking, drying, and fermenting are performed by women near

or inside the house, and are considered domestic activities. The introduction of special processing facilities off-farm or near the market is often not acceptable to women. Processing at home is preferred because women are able to combine processing activities with other domestic duties. Young girls often help their mothers with different methods of processing. The final product is stored in or near the house for fear of theft. The processed fish is either sold to wholesale traders in large quantities, or brought to the markets for private selling.

Economic pressure to shift from production for subsistence to commodity production has often resulted in reshaping the role of women. Small-scale enterprises tend to be taken over by modern processing plants. Most of the fish processing plants are oriented towards export markets and not for home consumption. The range of fish species available on local markets and the marketing opportunities for women changed as a consequence of the development of industrial processing.

Women have been seriously affected by this process. Inadequate analysis and neglect of the possibilities of traditional processing and marketing structures have excluded women from their main source of income. The need for cash income to buy basic goods has driven large numbers of women to the fish processing industries. Lack of education and vocational training push women into less skilled and lower paying jobs. For example, the deheading of shrimp is primarily a processing task executed by women. Most of these women do not have other options for work and generally belong to the lower social strata of the society. During periods of peak supply they often work through the night to earn some extra income. The number of female workers in the fish processing sector in this aspect of fish business tends to be very high and it is similar to the situation in Southeast Asia.

The fish and seafood processing industries in particular suffer from seasonal fluctuations in supply. These fluctuations affect women more than men because most women are employed as low category workers on a casual basis. Although these fluctuations in supply often predominate in artisanal fisheries, the small-scale processing industry is capable of compensating for periodic deficiencies in supplies. Women may shift to less valuable fish, for example, or fish can be dried and kept for several months as a kind of savings account, this practice is common in the northern Nigeria.

Seasonal fluctuations can be somewhat offset by planning aquacultural harvests. For example, instance shrimp farmers can try to plan their harvest to coincide with a time of slack supply of marine products. Close contact between the industry and the producers, and knowledge

about market fluctuations is needed. In Asia for instance a market survey and analysis of world shrimp aquaculture is regularly published which includes wholesale price trends and projected supplies. In the catfish industry in the USA, 88% of the catfish production is sold to the processors, so that 85% of the plant can be utilised during the year. The remaining 12% of catfish production is sold to live handlers who carry the fish to distant markets. This centralisation in processing regulates the supply to the markets, stabilises prices, and guarantees long term employment for the processors.

## 3.3 Marketing

Restricted time budgets, and social and cultural factors limit women's ability to participate in marketing. Marketing of home products usually provides rural women with their only source of income. Part of the gains are often reinvested in business dealings, with the rest spent to cover domestic and personal expenses such as food, clothing, health care, school fees, etc.

Both in rural and urban areas the fish customers become aware of a pond harvesting by informal contacts and buy their fish at the pond site. Most of the customers are women, who use the fish for home consumption or local marketing. Presently a kilo of live catfish sells for N350-400 depending on location and average size of fish.

The closer the market is to the farm, the fewer intermediaries and the greater the chance that women become actively involved in marketing aquatic products. The catfish farmers association of Nigeria is presently working on this aspect of fish marketing by creating various sales outlets around in the cities so that fish can reach the final consumers at affordable prices. In general, women have been quick to respond to opportunities created by growing demand for their produce.

Confined to domestic tasks, the majority of women are small entrepreneurs on a part-time or seasonal basis. Only a few women have established themselves as full-time fish sellers. Women fish traders either handle the crop of their husbands or buy fish from different sources. Fishmammies collect fish directly at the landing places as seen around Lagos lagoon and most fishmammies are in some way related to the fishermen and often take part in financing fishing operations. These financial commitments guarantee their share in the fish harvest. Fishmongers with a fixed relationship to the fishermen only pay the fishermen after the product is sold. In all other cases the fish is sold directly by auction. In most fishing communities the customers' groups are restricted by traditional relationships. But in the case of marketing of farmed fish, the culturist himself perhaps in relation to a link or network

of market established dictates the trend since he solely finances his business.

There are often distinctive patterns of division in selling different products. Generally, the sale of products requiring large capital investment or long-distance travel is in the hands of men. Although it is impossible to separate factors like freedom of mobility, the efforts and costs of travelling, and transporting goods to the market, etc., women are less mobile and have less access to financial support than men, so in most cases they hire cabs for this purpose. In the eastern part of Nigeria it was observed that three categories of dried fish were sold in Afikpo market. First, the stockfish from Europe was sold exclusively by the men. Indigenous river fish like the bonga and the enyaoca, were sold by both men and women and the smaller dried river fish was exclusively sold by the women, often in combination with a wide range of other food products.

## 3.4 Price Determination

Fish can be obtained by money, barter, or through gift exchange. In non-monetised societies, the barter equivalents are fairly standardised, although bargaining does occur at the retail level as well as in transactions between traders and wholesalers.

The transition from barter to a money economy has seriously affected existing market patterns. The increase in production as a result of the modernisation of the fisheries sector has attracted traders formerly not engaged in fish processing and marketing. Women have often been displaced by new groups of traders with bicycles, greater access to cash, and greater mobility.

In a free market system the prices of fish are not fixed and are determined by a complex of factors. These include:

(a) transport cost,
(b) production cost,
(c) Supply and demand,
(d) competition,
(e) processing technique,
(f) variety of fish.

Traders will take into account their transport and marketing costs as well as prices of substitute foods when deciding what price to charge. Price fluctuations can be explained largely in terms of availability, quality, and purchasing power of the customer. Prices are generally lowest during fish harvest, and rise as supplies diminish. The purchasing power

of rural consumers is greatest just after the agricultural harvest while it is greatest in urban centers at the beginning of the month after pay day.

Greater capital investment in aquaculture will lead to higher market prices. Intensive systems usually supply urban centers where large quantities can be absorbed and high prices obtained. Depending on the intensity of the system, the investment in aquaculture can be quite considerable, compared with the family budget. In the absence of banks, fish farmers often have to borrow money from a money-lender (including market women). Sometimes money is borrowed in exchange for the fish yield. In such a case the money-lender makes a contract with the fish farmer at an agreed price.

In more intensive systems the fish harvest is often sold to fixed traders or by auction. The fish farmer has to know the costs of production to determine his lowest acceptable price. The price obtained will depend on the quality of the fish and the numbers at the auction. On the one hand this can give the fish farmer the security that his products are all sold, while on the other the price might be below the average price for that moment.

Road construction around the intensive farms makes the fish landing sites more accessible to traders with modern trucks. Most fish mammies are not able to modernise because of time, education and cash constraints. Their role is consequently reduced to petty trader of less valuable fish, or as a wage labourer in the processing industry. Only those women who have established an independent financial position are capable of keeping and extending their position as fish traders in this situation.

On the other hand, the flow of money which comes from the development of market transactions and urban centers has opened up new possibilities for market women to extend their trade and even become money-lenders. The dependency of urban centers on rural production is in fact greater and more direct than it first appears. However, urban wholesalers must buy bulk quantities from retailers in local markets. High preservation, transport, and purchase costs therefore raise the prices in urban markets. Consequently, many city dwellers are still willing to travel to rural markets to buy at low prices.

## 3.5 Problems of Post Harvest Activities

Many of the problems and constraints encountered in handling, processing and marketing are common to both men and women. Limited access to resources, insufficient credit facilities, inadequate transport means, bad roads, poor processing and marketing facilities, price policies, etc., are all factors constraining the development of processing and trading of fish and fish products in the developing world.

Production policies and projects often ignore the role of processing and marketing. Interventions usually concentrate on modern enterprises and distribution to larger markets, instead of supporting individual or collective activities. Insufficient incentives and financial support will continue to constrain rural distribution systems.

Apart from the constraints common to both men and women, women often face an extra set of gender-specific problems. Domestic activities, limited time disposition, no title to land or cattle, and no access to credit, make women more disadvantaged compared with men.

An analysis of the role of women in the production, processing, and marketing sectors is often lacking in project planning. The introduction of a new production system or technology often ends up demanding more labour from women while allocating most of the benefits to men.

Project planners cannot foresee the risks and disincentives for women. Processing plants and markets have been constructed without prior consultation with the intended users. On many occasions the inappropriateness of new technologies and constructions could have been avoided if participatory development was pursued.

Small-scale processing and marketing is a competitive rather than a cooperative action. A spontaneous solidarity of women generating a communal enterprise to obtain credit and to protect themselves against other commercial traders is not to be expected.

## 3.6 Management Procedures

Women's participation in aquaculture is not taken into account by planners and policy-makers. A full understanding of the role of women as traders indicates their economic significance for the functioning and further development of aquaculture. Opportunities for women to discuss their constraints and opportunities can draw attention to the risks and disincentives not foreseen by project planners.

In extensive and semi-intensive aquaculture production systems, harvesting the pond is a communal activity and the fish are primarily destined for local consumption and marketing. Women are actively

involved in the handling of fish from small-scale production with local transportation. Small-scale handling has been neglected by project planners. The handling of fish in extensive and semi-intensive systems needs more attention in the form of training, extension, and credit.

Particular attention is needed to improve quality control of fish to prevent deterioration during fish handling operations, and to develop more products for domestic consumption.

Processing of aquatic products is considered to be women's work. Although most processing enterprises are run on an informal basis, their scale and way of operation makes these enterprises important for the employment and income generation of women.

Inadequate analysis and neglect of these enterprises has often resulted in a disruption of the rural fish supply and the position of women. Support of small-scale processing is critically needed. The development and extension of appropriate fish preservation and processing technologies should be promoted. Training of women should be arranged in such a way that disruption of the daily work is avoided.

Intensive systems are capital intensive and their produce are primarily destined for urban centers where better prices can be obtained. Transport to urban centers requires sophisticated equipment and good roads. Women's access to selling and transport is limited by lack of cash, transport, and market facilities. More attention to appropriate transportation services and marketing facilities at local markets can be of benefit to people and can reduce transportation costs.

Inadequate market facilities, such as lack of ice plants, containers with aerating devices, processing facilities, protected (cold) storage facilities, good roads, shelter, transport facilities, etc., often limit the development of trading enterprises. Strategies to overcome constraints for marketing would benefit both sellers and buyers. A seminar (FAO, 1977) on market women in West Africa gives the following recommendations:

(a) more attention to the role of traders in the formulation and development of policies,
(b) development of appropriate technologies for food processing and preservation,
(c) construction and maintenance of rural roads,
(d) provision of transportation and spare parts,
(e) promotion of the establishment of trade associations,
(f) increase of credit facilities to traders by involving trade associations as guarantors for individual loans,
(g) vocational training (bookkeeping, application forms for credit),

(h) improvement and expansion of existing market facilities (storage, loading space for vehicles, shelter, childcare centers, health clinics),
(i) provision of information by marketing advisory services,
(j) supply of essential inputs for farms (fertilizers, seeds, etc.),
(k) improvement of communication channels between traders, producers and relevant local extension agencies and government institutions.

Markets can be focal points for rural development. The better the market facilities, the more people are motivated to participate. Insufficient support and domestic duties often force women to restrict these activities and to continue production and marketing on a limited scale. There are, however, several examples of women exploring new activities and setting examples for others who are equally poor. Freedom to handle marketing and finances are critically important for women and result in a better living for the family.

Equal access to credit and participation in market development for women is needed to consolidate their position as traders. Women are often not acquainted with official credit facilities. The existing household funds are usually the only source of money for women. Self-help savings groups and rotating funds provide a good basis for the development of credit opportunities.

Examples of trade associations specialised in aquaculture products are found in China and Malaysia on several administrative levels. These associations are responsible for the purchasing, distribution, market supply, and storage of farm and fish products. The fish are purchased on the basis of a contract negotiated between the association and the producers. Payment in advance is possible; moreover the association supplies necessary inputs to the fish farms like fertilisers, seeds, and feeds. Because of their close contacts with the producers and their capacity to control supply and demand at the markets, they can be considered as an important regulating and promotional agency. Although different in many aspects, these associations have a somewhat similar role to the fish mammies in small-scale capture fisheries being practiced in Nigeria. These similarities include:

(a) interdependency between producers and traders,
(b) secure delivery and marketing,
(c) financial management to the benefit of both parties,
(d) social services in times of misfortune.

## 4.0 CONCLUSION

In this unit you learnt that the handling, processing and marketing of fish products are essential complementary functions of the production system. Marketing efficiency is essential requirement to reducing costs to the consumer. The role of women in the development of various aspects of aquaculture industry in Nigeria is being downplayed by policy makers.

## 5.0 SUMMARY

Women acquainted with fish processing and marketing readily include aquaculture products, especially if pond harvest coincides with the slack season in capture fisheries. It is imperative to regulate the distribution and marketing of perishable products like fish and shellfish. Instead of trying to introduce deliberate changes into the marketing systems which involve completely new roles for women, it is advisable to adapt local production and marketing patterns towards multi-functional trade associations.

Aquaculture products have to compete with traditional products. If aquaculture production is focused on a highly preferred product already available on the markets, it will have to compete through price. When new products are introduced, the customer often requires a period of time to accept the new product. Consumer preferences for size, external features, taste, and price must all be taken into consideration.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. What are the constraints to achieving high quality fish production in the Nigerian market?
2. What management approach would you suggest towards successful fish marketing?

## 7.0 REFERENCES/FURTHER READINGS

INFOFISH (2006). *INFOFISH International* No. 2/2006 (March/April) 40-64 pp.

F.A.O (1995). *World Agriculture Towards 2010*.(Alexandratos, N.ed) John Wiley and Sons, England.

# UNIT 2 GENERAL KNOWLEDGE AND FISHERIES MANAGEMENT

**CONTENTS**



## 15.0 INTRODUCTION

Fisheries management is the rational exploitation of fisheries resources in a way that economic benefits accrue to man and resources are protected and conserved. Fisheries management involves a lot of systematic procedure in ensuring the continuous availability of the fish resources. Fish production in Nigeria is however, mainly from three sub-sectors; namely,

(a) Industrial/commercial fisheries
(b) Artisanal fisheries and
(c) Aquaculture

**Industrial Fisheries**

This involves the use of highly mechanised techniques and fishing gears refer to as fishing trawlers or fishing vessels, most of which are imported. The skill and techniques involved in this fishery is quite high and more advanced than the artisanal fisheries. The catch per unit effort and the profit margin derived from fishing is high. At present, there are over 400 vessels operating in Nigeria. Despite the huge investment and yield, the commercial fisheries over the years contributed less than 10% of the domestic fish production in Nigeria.

**Artisanal/small Scale Fisheries**

These are fishing operations practised by small scale fishermen in the rural communities along the coast line and the boundary of inland water bodies e.g. dams, lakes, rivers etc. They make use of small-medium sized canoe usually between 3-10 metres. The small scale fishermen in Nigeria make use of simple, outdated or crude fishing gears such as fishing nets, traps of various sizes and shapes, beach seinenet, purse seine net, damming of the water etc. The labour involved in fishing is far beyond the financial return. The catch per unit effort is significantly low and the fisher folks face many social problems. Despite the social problem of small scale fisheries in Nigeria, it accounts for over 80% of the domestic fish production.

**Aquaculture**

Aquaculture has been defined in a number of ways. It has been called "the art of cultivating the natural produce of water", the raising or fattening of fish in enclosed ponds. It is the rearing of aquatic organisms under controlled or semi controlled conditions. Both fresh and marine water fishes are reared in well designed and managed ponds (enclosures). Aquaculture practices are yet to find its full feet. It has only been contributing about 5% of domestic fish production in Nigeria.

## 16.0 OBJECTIVES

At the end of this unit, you should be able to:

- understand what fisheries management is all about
- explain the various management strategies in fisheries.

## 17.0 MAIN CONTENT

## 3.1 Strategies Used in the Management of Fisheries

Successful management of an aquatic ecosystem requires fundamental information about the state, properties and dynamic interactions among the various components of the system. In Nigeria, the immediate need for food production in the form of fish flesh is paramount, especially in the face of burgeoning populations. This implies that procedures and plans must be provided to ensure continuous availability of fish resources. Management procedures often employed in commercial fisheries and small scale fishermen are similar because they involve the utilisation of the open natural waters.

Management of the resources of capture fisheries is very cumbersome because man does not have direct control over the activities and yield of the resources. However, certain resources such as fish yield assessment, fish stock assessment, determination of maximum sustainable yield (MSY), age determination, and population dynamic studies are important for management purposes. Management measures that are usually taken to increase fish production in open water bodies include;

(i) Quota system
(ii) Regulations of the fishing gears
(iii) Limitations on catch by individual fishermen
(iv) Limitations of time of fishing.
(v) Limitations on size of fish caught
(vi) Limitations on area being fished
(vii) Limitations on species caught
(viii) Open and closed seasons

### 3.1.1 Culture Fisheries

Unlike capture fisheries, culture fisheries enjoy some/high level of control over the culture medium depending on the enclosure being used. The overall objective of any management measures is to increase fish production. Some of the measures that must be taken in aquaculture include the following;

(i) Proper site selection (Good soil, topography and water)
(ii) Well designed and constructed ponds
(iii) Selection of fish species
(iv) Choice of culture system (polyculture or monoculture)
(v) Provision of good feeds
(vi) Water quality management
(vii) Proper management of health and diseases
(viii) Harvesting the fish

### 3.1.2 Culture System

Culture system refers to the medium in which the fish will be raised. Culture systems can be categorised into three major system groups: open, semiclosed and closed. Each has its special characteristics, advantages and disadvantages. The choice of the system is largely a function of the organisms to be grown and the resources and ideas of the fish farmer.

### 3.1.3 Open Systems

These are the oldest of the aquaculture system. Open system farming is the use of the natural environment as the fish farm. An open system does not require water to be pumped out of a sea or a lake, rather, the fish to be cultured are kept in the sea or lake. Examples of open system include dam beds, rafts and fish cages. Open systems are often leased from government agencies. Capital expenses are generally low and there is less management than in the other systems. However, predation and poaching could be a problem. The farmer also has less control over the environmental conditions, so the rate of growth and uniformity of the fish varies if compared to other systems.

### 3.1.4 Semiclosed Systems

Semiclosed system is the most popular method of culture for many types of organisms. Water is taken from a lake, bay, well or other natural source and is directed into a specially designed facility. Semiclosed system includes ponds, raceways, tanks etc. It offers an advantage over open systems in that they allow greater control over the growing conditions. A greater production per unit area is possible in addition to the crop being more uniform. This is because temperature, water volume and amount spent can be regulated. Prepared feeds can also be used with such less waste and aeration can be increased simply. This system is more expensive to develop and operate than open systems and it requires a more complex management scheme.

### 3.1.5 Closed System

Closed system is that culture system in which little or no water is exchanged and the water is subject to extensive treatment. These have made little impact on the commercial aquaculture industry, although some laboratory reports are very promising. Extremely high densities of fish can be raised under these conditions, if they are managed properly – the farmer has complete control over growing conditions. Weather conditions are never a problem and harvesting is simple. Food and drugs can be added efficiently into the system. All these allow the fish to grow quickly and uniformly. A problem associated with close system is the re-used water and the great density of the culture fish. Hence, the

filtration/treatment system must be very good and the water must be pumped through these systems at a fairly high speed. Diseases outbreak could be a problem in a closed system. Examples of closed system include Water Recirculatory System (WRS) and flow through systems.

## 3.2 Basic Principles in Fish Farming

Modern fish farming started in Nigeria in 1964 when an officer was seconded from British Agriculture Department to initiate fisheries investigations. Fish farming is a very lucrative business, it however requires a lot of expertise for manipulation of the various activities. Fish farming procedures involves the following:

- Site selection
- Pond construction
- Liming
- Impoundment/flooding
- Fertilisation
- Stocking
- Feeding
- Water quality management
- Management of Health and diseases
- Harvesting the fish

### 3.6.1 Site Selection

Proper selection of site is probably the most important factor in the success of a fish farm. Site selection will depend on the kind of fish farm you plan to use. For pond construction, you need to consider the following factors: soil type, quality and quantity of the water available and the requirements for filling and drainage of the pond.

### 3.2.2 Pond Construction

The vast majority of freshwater fish are raised in ponds are usually located on land with a gentle slope. They are rectangular, circular or square shaped, have well finished dikes and bottom slopes. The pond should be drainable in case of harvesting of the fish. Side slopes should be 2:1 or 3:1 which allow easy access will not encourage vegetation to grow and helps to reduce erosion problems. Depending on the site, fish pond could be: embankment ponds, excavated pond (diversion ponds) or Barrage ponds.

### 3.2.3 Liming

Liming of ponds after construction involves the addition of lime substances to pond bottom. The dosage varies depending on the lime type and pond conditions. Liming increases the pH of the pond. Lime not only kills harmful animals and plants but also eliminates pathogenic bacteria. Liming also enhances the utilisation and release of certain nutrients from the pond bottom. Some of the commonly used limes include quick lime, slaked lime and agricultural lime.

### 3.2.4 Impoundment/Flooding

Impoundment/flooding is the introduction of water into pond prior to stocking. Water level should reach about 1.5 in a pond. It is important that sufficient water is available to fill all ponds within a reasonable period of time and to maintain the same pond level. This water should be changed from time to time due to deterioration water quality parameters such as dissolved oxygen, carbon dioxide, Nitrite, Nitrate, $NH_3$, turbidity, total alkalinity, and total hardness should be checked thorough before impounding.

### 3.2.5 Fertilisation

Fertilisation of pond is the addition of fertilisers in form of organic or inorganic into the fertilisation is aimed at developing natural food organisms and saving artificial feeds. Fertilisation supplies the phytoplankton with the materials essential for photosynthesis. As the phytoplankton photosynthesise and reproduce, zooplankton, which feed on zooplankton, phytoplankton, and benthos also flourish. Organic manures include animal faeces, urine of livestock poultry, night soil, green manure, compost etc. while organic manures often used in pond fertilisation include super phosphate etc. Application rate varies for each of the manure type.

### 3.2.6 Stocking

When selecting fish species suitable for farming, various biological and economic factors are important. These includes:

- Market price and demand for such fish
- The growth rate of such species of fish
- Ability of the fish to reproduce in captivity
- Simple culture of the young fish (Larvae or Fingerlings).
- Match between available fish feeds and the food preference of the selected fish species. Stocking density of fish varies from 3-8 fish $1m^2$. A farmer could either practice any farming method such as monoculture or polyculture.

### 3.2.7 Monoculture

Monoculture is the production of the same type of fish species on the some pond. In monoculture, only one species of fish is raised in the pond. In monoculture, it is easier to give certain supplementary feeds to the fish as there is only one fish species. However, a single disease may kill all fish in the pond. Examples include Tilapia pond.

### 3.2.8 Polyculture

This refers to the production of more than on species of fish within an enclosure (pond/fish tank) during a particular production cycle. The increased production with polyculture as compared with monoculture is achieved by two effects: the better use of pond resources and the synergy between the two species such as tilapia and catfish. In addition to better use of pond resources in the pond, the feed given as supplement is also better used: the *Clarias,* for example, mainly consume the fragments of rice husks, wheat bran and other similar feed ingredients while the tilapias filter suspended and floating particles. By consuming tadpoles, frogs and wild fish, the Clarias eliminates the tilapia' competitors. While on the other hand, the tilapias consume part of the floating vegetation of the pond.

### 3.2.9 Feeding

There are 2 types of food in the pond which the fish can eat to grow: Naturally produced fish food inside the pond and supplemented fish food supplied from outside the pond to the fish. Natural foods include algae (phytoplankton) and tiny animals (zooplanktons). Supplementary feeds are often formulated using a combination of the various feed ingredients, such as fishmeal, soybean etc. Feed ingredients are prepared, mixed and palletised into sizes and shapes require by the fish. Fish should be fed 3-8 times daily with 3-5% of their body weight. Fish should be fed at the same time and in the same part of the pond. Feeding should be done in the late morning and early afternoon when dissolved oxygen levels are high so fish have enough time to recover from the high oxygen-demanding feeding activity before nigh fall. Fish should not be over fed and feeding should stop at least one day before breeding, harvesting or transporting them.

### 3.2.10 Water Quality Management

Water quality is closely related to fish growth and yield. During production, water colour is the indicator of water quality, and there are various means of controlling water quality: feeding and manuring, use of aerators, adding fresh water, and turning the pond silt. Water quality parameters such as dissolved oxygen, carbon dioxide, nitrate, ammonium nitrate, total alkalinity, total dissolved solids (TDS) should

be monitored from time to time. This is because fish have optimum level of tolerance for each of these factors.

### 3.2.11 Management of Fish Health and Diseases

High and stable fish yields can be ensured through the daily routine of pond management, which should be performed carefully, diligently, and unremittingly throughout the rearing period. The principle of fish disease control is prophylaxis: "prevention is better than treatment" in the event of an outbreak of disease, fish should be treated in the early stages. Because of complexity of their environment, fish are susceptible to viral, bacterial, fungal, and parasitic infections. An outbreak of disease jeopardizes regular aquaculture and threatens fish yields. Therefore, controlling disease is one of the most vital tasks in fish culture. Good nutrition and proper water quality (with plenty of dissolved oxygen) are the most important factors for good fish health, needed to cope with diseases.

### 3.2.12 Harvesting the Fish

The final phase in fish farming cycle is the harvest and possible sale of the fish. When most of the fish are big enough to be eaten or sold, harvesting could either be total (capturing all the fish) or partial (capturing only the matured size). Fish should not be fed at least a day before harvesting to prevent continuous digestion of food by fish which lead to excreation of waste.

## 18.0 CONCLUSION

Fisheries management is the wise use of fisheries resources to the benefit of man that involves series of systematic procedures. Of all the different production systems, the Artisanal fisheries constitute the highest source of fish in Nigeria. The various stages involved in fish farming were discussed beginning with the initial selection of site to the time of harvest.

## 19.0 SUMMARY

Capture fisheries and aquaculture should not be considered in isolation. In certain areas, some supposedly "wild harvest" fisheries are actually highly dependent on an aquaculture phase to produce young fish that are necessary to maintain current capture rates. In this unit, we have learnt that:

- Fish management and production requires high level of technicality
- Fish production in Nigeria is from three sub sectors.

- Artisanal fisheries still produce the highest domestic fish production in Nigeria
- The various culture systems with their examples, advantages and disadvantages.
- The essential principles in fish farming from site selection to harvesting the fish.

## 20.0 TUTOR-MARKED ASSIGNMENT

1. What do you understand by the following terms?
   (a) Commercial fisheries (b) Aquaculture (c) Open systems
   (d) Closed system
2. List 10 feed ingredients in aqua feed production you know
3. What are the essentials of water quality management?
4. Make a visit to a particular fish farm and list out all the features you observed on the farm.
5. State the functions of each of the features you listed in 4.

## 21.0 REFERENCES/FURTHER READINGS

James H.T. and Allan G.L. (2002). *Fish as Food: Aquaculture's Contribution. Ecological and Economic Impacts and Contributions of Fish Farming and Capture Fisheries*.

J.E. Bardach (1997). *Sustainable Aquaculture*.

*NACA* (1989). "Network of Aquaculture Centers in Asia and the Pacific" Technical manual 7. Integrated Fish Farming in China Visitation to a Fish Farm.

# UNIT 3 WILDLIFE MANAGEMENT IN NIGERIA

**CONTENTS**

## 1.0 INTRODUCTION

Wildlife management could simply be defined as application of ecological knowledge to populations of (vertebrate and invertebrate) animals and their environment in a way that strikes a balance between the needs of those populations and the needs of man. Wildlife management is essentially applied ecology, and it will advance as basic ecological knowledge becomes available and is integrated by wildlife ecologists. What is ecology? The word ecology is derived from the two Greek words *oikos* meaning 'home' and *logos* 'study of'. It was first coined by Ernst Haeckel in 1869 and it means the study of an organism in its natural home. In other words, it is the study of the inter-relationship between organisms and their environment. With increased knowledge about wildlife ecology, the programme of management gets more effective. The application of ecological knowledge involves three basic management approaches:

- Preservation by allowing nature to take its course without human intervention
- Direct manipulation of animal population by cropping, culling etc. For instance species from overpopulated areas could be transported elsewhere.
- Indirect manipulation of animal population through alteration of vegetation and habitat improvement.

## 2.0 OBJECTIVES

At the end of this unit, students are expected be able to:

- definition of Wildlife management
- importance of Wildlife management
- objectives of Wildlife management in Nigerian and
- problems facing Wildlife conservation in Nigeria.

## 11.0 MAIN CONTENT

### 3.1 Wildlife Management

Wildlife management sometime is better termed wildlife conservation, since in some cases the best technique for conserving a landscape is to leave it intact and doing so may not fit the definition of management. In such instance, there may be no management at all. Conservation has been defined in Encyclopaedia Americana (1976) as getting the maximum use of the greatest number of available natural resources that are valuable to the greatest possible number of people for the longest period of time. Encyclopaedia Britanica (1981) on the other hand defines conservation as the achievement of the highest sustainable quality of living for mankind by the rational utilisation of the environment.

In the Funk and Wagnal dictionary (1963) it is the act of keeping or protecting from loss or injury while Chapman & Reiss (1995) defines it as the management of the earths resources in a way which restores and maintains the balance between human requirements and the other species in the world. The decision as to what is best is that of man. Since we are human, we have, like other animals, a natural bias towards our own survival. Try as we might, we cannot remove our human bias from our perception in dealing with flora and fauna around us.

### 3.2 Importance of Wildlife

Wildlife is a natural resource of an overwhelming degree of usefulness. However, the value of Nigeria's wildlife has only been realised a little due to lack of awareness, inadequate funding and illegal human activities among other problems.

1. **Sources of Protein**: Wildlife represents the principal source of animal protein for the rural majority in most African countries. Wildlife, particularly forest mammals, account for between 20%-90% of total animal protein consumed in Benin Republic, Cameroon, Ghana, Cote-d-voire, Liberia and Nigeria. The supply of bush meat from the wild no doubt serves as a possible measure to bridge the gap between livestock production and human population growth. A considerable number of individuals now

make a living out of snail farming (snailry), bee honey production (apiary) and grass-cutter rearing while some others do this as a means of alleviating poverty.

However, the hunting methods are crude and wasteful. These include the use of fire, snares, traps (especially gin traps), dogs and dane guns. These methods, mostly in unskilled hands, lead to serious losses of wild animals. Many wild animals get wounded and escape only to die later and be consumed by scavengers rather than by the intended hunters. Some of the methods used are not selective and indiscriminate killing of young and pregnant females may drastically affect wild animal population and lead to the disappearance of valuable wild animal species in an area.

2. **Education and Research:** the study of the environment in which we live is being given more and more attention in formal education. In most parts of Nigeria virgin stretches of land is difficult to find and due to hunting pressure, even the protected areas now have few large wild animals. In the past such large animals were abundant in areas with natural vegetation. Today with long periods of conservation activities the protected areas provide students with first hand information about wildlife and natural vegetation. This kind of opportunity is not available to school children and students in many developed countries where natural habitats have been destroyed beyond repair, but in Africa we are privileged to have stocks of large animals to this day.

Wildlife has made significant contribution to research the world over. Research in medicine, including studies on disease immunology, frequent depends on the availability of species of wild animals. Thus, life animals (rats, primates) are being used in many medical research laboratories. Primates are widely used by virtue of their relative resemblance of man. Perhaps you have heard about the Rhesus factor which is very helpful in blood transfusion today. This was first discovered in Rhesus monkey before it was applied to man. The common toad is used in countless undergraduate practicals to demonstrate nerve muscle action.

Now come to think of it, it is not possible to maintain a great variety of wild animal species in captivity and there is a need for all wild species to be preserved for study. More so very little is known about most of the wildlife species (and their potential values) that there are possibilities of major discoveries being made in human medicine (and other areas) as a result of investigations into other animals.

3. **Sale of Live Animals and Wild Animal Products**: A large number of live animals are exported out of the country. These include monkeys, baboons, and birds for exhibition in zoos and use in laboratories. The wildlife products included the skins of reptiles (such as snakes and lizards) and mammals including leopards and antelope. Ivory, which was once one of the most precious export products from West Africa, is scarce nowadays (that the Elephant is an endangered species), but good management of elephant herds can bring back this valuable material. Live animals for sale must be captured with great care and kept in comfort and good health. This entails much higher input of labour than is required in hunting for meat and thus brings in greater income for the collector on each animal caught. Wild animals' purchased are also used as pets. Recently, monkeys are being trained to assist paralysed human beings in doing some things at home.

4. **Tourism and Foreign Exchange**: wildlife conservation areas have proved to be one of the world's greatest attractions for tourists. National parks, game reserves, zoos and museums provide ample opportunity for recreation and education of both young and old. If tourism is developed, Nigeria as a country with potential resources can earn hundreds of millions of Naira from game viewing and tourism like Kenya and Tanzania. Already the Kainji lake national park and Yankari game reserve record between 3,000 and 10,000 visitors representing over 50 nationalities annually. Tourists spending begin with fares paid for international and local air transport. This is followed by payment of hotel bills and hiring of vehicles for making local tours. Also, tourists pay for such services as game guides and interpreters and they buy locally made goods as souvenirs. Tourism accounts for more than US $ 3.5 trillion of world output that is 6 percent of world Gross Domestic Products. International tourism has long been a source of foreign exchange earning, this contributed to the economy of African countries such as Kenya, Senegal, Gambia, Tanzania and Botswana.

5. **Conservation for Posterity**: the economic argument in favour of conservation is very great but equally important is the need to preserve our National heritage (of abundant genetic resources). Our role should be that of a trustee who must ensure that he does not pass unto future generations less than what we have inherited. When economic development has provided that human population with the means of a safe and comfortable livelihood, there will be more time to think about culture and recreation. Our history and folklores are tied firmly to a background of wild

animals. These animals are as much a part of our tradition as the Benin sculpture, and our rich tradition of music, dancing and other art forms. Wild animals cannot be preserved adequately in museums and zoos but must be maintained as wild and free creatures. Our modern technology which will provide food and comfort has the power to destroy this heritage and also the power to conserve it for posterity.

6. **Traditional Medicine**: the importance of wildlife to traditional medicine cannot be over emphasised. Parts of wild animals and wild plants are being used in combination to cure various ailments in both children and adults.

## 3.3 Basic Philosophy of Wildlife Management

The work of the wildlife scientist/manager is basically that of producing the highest possible amount of wildlife, in the face of utilisation of vast area for multiple benefits, which to a greater or less extent limit wildlife production. He has to tune his work and methods to forests which must produce timber, grasslands which must furnish grazing for domestic stocks and farmland devoted to almost innumerable crops. His programme and plans must take into consideration these other uses in a way that will not seriously interfere with them. The Wildlifer, as the business manager of a great resource, must first maintain the resource and secondly, utilise it to the greatest possible advantage of the nation the public.

## 3.4 General Objectives of Wildlife Management

The aims and objectives sought will vary from place to place and probably from time to time. However, some of the common objectives of wildlife management are:

1. Preservation of species
2. Maintenance of population of useful species.
3. Stability or reducing population of certain species.
4. Limitation of wildlife utilisation to annual production capacity.

## 3.5 The Objectives of Wildlife Conservation in Nigeria

In Nigeria the main National Wildlife Management objectives are:

1. Bush-meat production to increase the animal protein available in rural and urban areas of Nigeria with particular emphasis on rural areas.
2. To promote game viewing, tourism and foreign exchange earning, including photographic safaris, sport fishing and sport hunting.
3. Preservation of national heritage
4. To encourage and promote wildlife conservation for education and research.
5. To generate employment opportunities in rural areas.
6. Finally, to promote ecological diversity and stability through preservation of gene pool and maintenance of continuity in gene pool.

From the above objectives it is clear that wildlife conservation is centred upon human benefits through wise utilisation. However, most of the above listed laudable objectives feature in our development plans from time, but were never implemented due to inadequate funds, dearth of manpower, ignorance and lack of proper awareness on the part of the planners and policy makers.

## 3.6 Problems of Wildlife Management

You are probably aware that the abundance and variety of wildlife are declining at a rapid rate and some of it is at the edge of extinction. There are a number of factors responsible for this state of affairs. These are social and ecological problems facing wildlife management in Nigeria. The problems include the following:

**1.** **Poaching**: An individual that kills wild animals in protected areas without permission or kills protected animal species outside conservation areas is a poacher. The immediate effects of wildlife poaching are decimation of game population and making wildlife shy or wary of visitors. When animals become shy, and then become more difficult for tourists to sight, the consequence of this is reduction in visitor satisfaction. Poaching has major effect on animal population when the activity reaches an organised commercial scale. Considering species such as Elephant (*Loxodonta africana*) which have relatively small numbers, reproduce slowly, and have a slow "population turnover" poaching may have adverse effect on the population.

Most of the poachers are aware that their activities are illegal. They are only taking the risks because of the income accruing to them from the sale of bush-meat. Poachers most often escape apprehension by the few and ill-equipped park protection staff.

When the poachers are arrested and prosecuted they are often sentenced to ridiculously light terms of imprisonment and/or fines. There is need to mount an effective public enlightenment campaign on the values of wildlife conservation and the negative effects of poaching rather than on the legal consequences of illegal hunting.

2. **Bush Burning**: This refers to bushfires that are set by poachers and farmers around the boundaries of protected areas. Poachers set fire in the wild to reveal wild game for easy target while farmers use fire as a tool on their farmland around protected areas. Fires originating from outside the park and those set by poachers often penetrate into and burn up protected areas particularly along the riverbeds, around the waterholes and over the shelterbelts. In other words, illegal fire is a potent element in the destruction of habitat. And habitat destruction is in turn a factor in the extinction of animal species

3. **Habitat Destruction**: This posses a great problem to the survival of wild animal populations. The existence of wildlife is intricately tied to the available vegetation. The vegetation contributes immensely to characteristics of the habitat to which specific species of animals are adapted. This is the basic reason why the species of animals in the forest are different from those of the savanna. Any functional alteration in vegetation therefore jeopardises the survival of the species associated with that vegetation. In Nigeria, habitat destruction still remains a problem. In fact, protected areas even get reduced in size to provide land for other uses.

4. **Illegal Grazing of Animals in Protected Areas**: The abundance of any wild animal species depends mainly upon the condition of the habitat and the available food supply. And reproductive success in herbivores to a large extent is hinged on the quantity and quality of available grass, herbage and shrubs. The population abundance of carnivores or predators depends largely on the availability of prey species. In Nigeria the Bororo Fulani cattle rearers bring their stock into the protected areas for grazing in contravention of the laws establishing them. The cattle population in effects competes with the wild animals for the available food supply. The Fulani herdsmen also cut down branches of trees to make more food available to their animals and thereby leaving so many trees without crown. This in a way is a form of habitat destruction. The herdsmen frequently engage in poaching activities within the protected areas.

5. **Illegal Settlement in Protected Areas**: This is a situation where individuals establish illegal settlements within the park to carry out various offences such as illegal fishing and poaching

6. **Dearth of Trained Personnel**: Since wildlife management is a relatively new discipline very few candidates apply to take the course in the Federal College of Wildlife Management and in the few universities that offer the course in Nigeria. Thus, there are very few wildlife experts in the field. A considerable number of the few graduates are outside the country on international appointments.

7. **Inadequate Finance**: The amount of fund released for the development of wildlife management is meager. This has translated into lack of field equipments; camping materials for game guards; field vehicles, and retarded development of tourist facilities.

8. **Lack of Awareness of the Public About The Benefits Of Conservation**: The level of awareness of the public about the importance of wildlife conservation is very low. This gives room for a situation where some people and even those in government do not see the reason why public fund should be allocated to it. This also reduces the support of local communities for conservation effort leading to conflicts between the management of protected areas and local inhabitants. However, recent initiatives have been targeted at reducing such conflicts around national parks in the country.

9. **Public Apathy:** This is a situation where the citizens despite awareness are not ready to stand as a pressure group against any policy or action that may hinder the development of wildlife conservation in and outside protected areas. For instance, in some developed countries there ate NGOs that are focused on the welfare of animals. And we are told that no conservation effort would be successful without the functional cooperation of the general public. Endangered species are still freely sold in the market. In other words, wildlife laws and regulations are 'irrelevant' outside protected areas!

10. **Political Instability**: Instability in governance leads to frequent changes in policies, laws and regulations, and conservation programmes. Policy and conservation programmes are sometimes terminated at points at which they are about to be yielding dividends, all in the name of change in government.

## 3.7Categories and Management Objectives of Protected Areas

1. **Scientific Reserve/Strict Nature Reserve**. To protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring and education, and for the maintenance of genetic resources in an evolutionary state.

2. **National Park**. To protect relatively large natural and scenic areas of national or international significance for scientific, educational and recreational use, under management by the highest competent authority of a nation.

3. **Natural Monument/Natural Landmark**. To protect and preserve nationally significant natural features because of their specific interest or unique characteristics.

4. **Managed Nature Reserve/Wildlife Sanctuary**. To ensure the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment when these require specific human manipulation for their perpetuation.

5. **Protected Landscapes.** To maintain nationally significant natural landscapes characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism.

6. **Resource Reserve**. To protect the natural resources of the area for future use and prevent or contain development activities that could affect those resources.

7. **Natural Biotic Area/Anthropological Reserve**. To allow the way of life of societies living in harmony with the environment to continue undisturbed by modern technology.

8. **Multiple-Use Management Area/Managed Resource Area**. To provide for the sustained production of water, timber, wildlife, pasture and outdoor recreation, with the conservation of nature primarily oriented to the support of these economic activities.

9. **Biosphere Reserve**. To conserve for present and future use the diversity and integrity of representative biotic communities of plants and animals within natural ecosystems and to safeguard the

genetic diversity of species on which their continuing evolution depends.

10. **World Heritage Site**. To protect the natural features for which the areas was considered to be of world heritage value and to provide information for worldwide public enlightenment.

The IUCN publication *Managing Protected Areas in the Tropics* (1986) gives much useful information on approaches to the management of these different protected area categories.

**Table 3.1: Protected Areas Gazetted and Proposed In Nigeria**

| No | PROTECTED AREA | AREA (ha) | LOCATION | YEAR GAZETTED |
|---|---|---|---|---|
| 1. | Kainji Lake National Park | 534,082 | 9° 40¹ – 10°10¹N & 3 ° 30¹ - 5 ° 51¹ E | 1975 |
| 2. | Gashaka-Gumti National Park | 636,300 | 6 ° 10¹N – 8⁰20¹N& 11⁰10¹N - 12⁰10¹E | 1977 |
| 3. | Chad Basin National Park | 228,000 | 13° 20¹N & 14°00¹E | 1978 |
| 4. | Cross River National Park | | | |
| | (a) Northern sector (Boshi/Okwangwo) | 72,000 | 6° 20¹N & 9°15¹E | 1991 |
| | (b) Southern section (Oban Hills) | 374,255 | 7° 45¹N & 4°07¹E | 1991 |
| 5. | Old Oyo National Park | 251,200 | 8° 44¹N & 3° 44¹E | 1991 |
| 6. | Yankari Game Reserve(GR) | 224,000 | 9° 30'N –10°00'N & 10°00' - 11°00'E | 1957 |
| 7. | Orle River Game Reserve | 110,000 | 6° 50'N & 6° 36'E | 1960 |
| 8. | Kwale Game Reserve | 1,340 | 5° 43'N & 6° 27¹E | 1960 |
| 9. | Gilli Gilli Game Reserve | 36,300 | 6°05'N & 5°20'E | 1960 |
| 10 | Falgore Game Reserve | 92,000 | 11°00 – 11° 20'N & 8 ° 33' - 8 ° 45'E | 1969 |
| 11 | Kambari Game Reserve | 41,400 | 8 ° 48'N & 10 °38'E | 1969 |
| 12 | Dagida Game Reserve | 29,400 | 9 °42'N & 5 °31'E | 1971 |
| 13 | Alawa Game Reserve | 29,600 | 10⁰ 20'N & 6⁰ 38'E | 1971 |
| 14 | Kwiambana Game Reserve | 261,400 | 10⁰ 50' - 11⁰ 50'N & 6⁰ 00' - 7⁰ 00'E | 1971 |
| 15 | Pandam Wildlife Sanctuary | 22,400 | 8⁰ 31' – 8⁰ 40' N & 7⁰ 50' - 9⁰ 00'E | 1972 |
| 16 | Pai River Game Reserve | 248,600 | 8⁰ 09'N & 2⁰ 50'E | 1972 |
| 17 | Wase Game Sanctuary | 186,500 | 9⁰ 40'N & 10⁰ 00¹E | 1972 |
| 18 | Ibi Game Reserve | 153,000 | 8⁰ 20'N & 10⁰ 38'E | 1972 |
| 19 | Nasarawa Game Reserve | 190,000 | 8⁰ 32'N & 7⁰ 43'E | 1972 |
| 20 | Lame-Burra Game Reserve | 205,767 | 10⁰ 27'N & 9⁰ 15'E | 1972 |
| 21 | Wase Rock Bird Sanctuary | 93 | 9⁰ 04'N & 9⁰ 58'E | 1972 |
| 22 | Opara Game Reserve | 248,600 | 8⁰ 09'N & 2⁰ 50'E | 1973 |
| 23 | Kashimbila Game Reserve | 139,600 | 6⁰ 40'N - 8⁰ 20'N & 11⁰ 10' - 12⁰ 10'E | 1977 |
| 24 | Sambisa Game Reserve | 68,600 | 11⁰ 00 - 11⁰ 30' & 13⁰ 30' 14⁰ 30'E | 1978 |
| 25 | Hadejia Baturiya Wetlands GR | 29,700 | 12⁰ 27'N & 10⁰ 17'E | 1976 |

| | | | | |
|---|---|---|---|---|
| 26 | Okomu Wildlife Sanctuary | 11,200 | $6^0$ 21' N & $5^0$ 13'E | 1985 |
| 27 | Kamuku National Park | 120,000 | $10^0$ 48'N & $6^0$ 18'E | |
| 28 | Anambra Game Reserve | 35,400 | $7^0$ 16'N & $7^0$ 24$^1$E | |
| 29 | Ifon Game Reserve | 28,200 | $6^0$ 59' - $7^0$ 13'N & $5^0$ 43' - $5^0$ 53'E | |
| 30 | Meko Game Reserve | 96,610 | $7^0$ 27'N & $2^0$ 51'E | |
| 31 | Ebbe Ikempe Game Reserve | 11,730 | $8^0$ 15'N & $6^0$ 00'E | |
| 32 | Jos Wildlife Park | 800 | $9^0$ 55'N & $8^0$ 45'E | |
| 33 | Omo Biosphere Reserve | 460 | $6^0$ 30'N & $4^0$ 15'E | 1949 |
| 34 | Lekki Nature Reserve | 78 | $6^0$ 27'N & $3^0$ 23'E | |
| 35 | Taylor Creek Game Reserve | | $5^0$ 02'N & $6^0$ 25'E | |
| 36 | Udi/Nsukka Game Reserve | | $6^0$ 35'N & $7^0$ 15'E | |
| 37 | Dagona Waterfowl Sanctuary | | $12^0$ 40'N & $10^0$45'E | |
| 38 | Stubbs Creek Game Reserve | | $8^0$ 09'N & $4^0$ 29'E | |

**Source: Adapted from Inahoro, 1991**

## 12.0 CONCLUSION

You have learnt that wildlife management is the application of ecological knowledge in the management of wildlife populations including endangered animals. You were also exposed to the importance of wildlife that includes serving as sources of protein, education and research, sale of live animals and wild animal products, tourisms and conservation. Finally the different problems of wildlife management were enumerated.

## 13.0 SUMMARY

Wildlife management is the wise use of the plants and animals around us in a sustainable manner. The objectives of wildlife management include preservation of species, bush meat production, promotion of conservation education, generation of employment and preservation of National heritage. The importance of wildlife is evident in bush meat production, medical research, traditional medicine, tourism and recreation. The constraints of wildlife conservation in Nigeria includes lack of public awareness, inadequate finance, political instability, public apathy, illegal grazing of animals in protected areas, poaching or illegal hunting, illegal settlement inside reserves, bush burning, and lack of trained personnel.

## 14.0 TUTOR-MARKED ASSIGNMENT

Write an essay on the relevance of wildlife conservation to development of the Nigerian economy.

## 7.0 REFERENCES/FURTHER READINGS

Afolayan, T.A (1987). *Man's Inhumanity to Nature: the Overexploitation of Wildlife Resource*. Inaugural lecture series 3, Federal University of Technology Akure, 1987. 35 pp.

Ajayi, S. S. (1971). *Wildlife as a Source of Protein in Nigeria: Some Priorities for Development*. Wildlife Bulletin of Nigeria. No. 2, 1974. "The Nigerian Field" vol. XXXVI, No. 3, July, 1971. pp. 115-127.

Ajayi, S.S. (1972). Wildlife and Tourism in Tanzania: possibilities in *Nigerian Journal of Forestry* vol. 2, No 1. pp 34-39.

Ajayi. S.S. (1979). *Utilisation of forest wildlife in West Africa* FO.MISC 79/26 December 1979 FAO, Rome.

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife* Ilorin Kwara State: SAOLOG Printing Productions, 1982. 80pp.

Chambers Enyclopaedia (1970). *International Learning System Corporation Ltd. London.* New Revised Edition Vol. 4 1970 pp 812-813.

Chapman, J.L. and Reiss, M.J. (1995). *Ecology: principle and applications*. United Kingdom: Cambridge University Press 1995. p. 275.

Eltringham, S. K. (1984). *Wildlife Resources and Economic Development*. New-York: John and Wiley and Sons Ltd.

*Encyclopaedia Americana* (1967). Bol 7 New York, 1967. page 546.

*Encyclopaedia Brintannica* (1981). Vol. 5. Helen Hemingway, Benton. 1974. p39.

Funk, I.K. and Wagnal, M. (1963). *New Standard Dictionary of the English Language*. New York: Funk and Wagnal's Publishing Company Inc., 1963 p. 561.

*Nigerian Trade Summary* (1976). June edition. Federal office of statistics.

Omitoyin, B. O. & Alarape, A. A. (2003). *West African Fish and Wildlife. Ibadan Distance Learning Series*. University of Ibadan: Distance Learning Centre. 72pp.

Oosting, H.J. (1956). *The Study of Plant Communities*. 2nd Edition. San Francisco: W.H. Freeman and Co.

Poore, D. and Sayer, J. (1991). *The IUCN forest conservation Programme: The Management of Tropical Moist Forest Lands* – Ecological Guidelines. 2nd Edition. International Union for Conservation of Nature, United Kingdom. P.49.

Sharma, B.M. (1986). *Introductory Ecology*. Ibadan: Abiprint Publishing Company limited. 109pp.

Steele, R.C (1974). *Forestry and Wildlife Conservation in the Temperate Zone*. 10th Commonwealth Forestry Conference, September, 1974 33 pp.

Swynnerton, G.H., Mence, A.J., Moore-Gilbert, S.M. and Goddard, J. (1966). *Ngorongoro's Animal life*. Edited by S.A. Ole Saibull. Booklet N0. 4. Arusha, Tanzania: Tanzania Litho Limited, 42pp.

WTO (1994). *Compendium of Tourism Statistics, World Tourism Organization*, 10th Edition, 1984-1988.

## UNIT 4 PRINCIPLES OF WILDLIFE MANAGEMENT

**CONTENTS**

## 11.0 INTRODUCTION

Wildlife management is the art of making land produce sustained annual crops of wild games for food and recreational use. Wildlife management is the science and art of transforming the attributes and interactions of habitats, wild animal populations and man in other to achieve specific human goals through the wildlife resource. Though the principles of wildlife management are scientific, there are opportunities for integration with other technologies. Wildlife management is based on ecological principles. And ecology is the relation of an organism to the environment in addition to other living organisms that co-inhabit the same basic resources of soil, water vegetation and atmosphere. These principles may be used in combination. The aim of the wildlife expert is to identify the factors limiting the abundance of wild animals, the control of which could produce more wildlife for benefit of humans.

It is important to study the individual species in relation to others, since the increased one species may be detrimental to another one. Those species that have declined should be propagated under controlled conditions and released into their preferred habitats. Likewise species from over-populated areas should be transported elsewhere.

## 12.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify some principles of wildlife management
- explain the ideas behind each principle.

## 13.0 MAIN CONTENT

### 3.1 Control Principles of Wildlife Management Hunting

Wild animals are important food items. If cropped without limitation there is no doubt that the population decreases continuously. This has led to the complete elimination of some species in the world. Thus, there is need to put a check on the hunting of wild animals. When restriction of hunting in protected areas lead to increased wildlife population densities above the available resources in the area (carrying capacity) what follows is destruction of vegetation as well as starvation and diseases. Such situations are usually kept in check by controlled hunting for meat as well as for recreation (sport hunting).

The limitation of hunting is usually very important to ensure survival of breeding stocks of animal species. It also prevents the populations of animals rising to a point detrimental to the environment and ultimately their very existence. Hunting may not be allowed all the year round. The period when hunting is permitted is called the Open Season while Close Season refers to the interval when hunting license is not issued. A licensed hunter operates under certain guidelines which include the following:

a. The species, sex and age of animal to be hunted.
b. The area where hunting could be done.
c. The time of the day when hunting could be carried out (generally night hunting with the use of headlamp is not allowed).
d. The type of weapons allowed.
e. The bag-limit (maximum number of animals that could be killed by an individual hunter).
f. The use of fire is illegal.
g. The use of traps (especially gin trap) is totally prohibited.

### 3.2 Refuge

These are protected areas where animals could hide against hunting predation and disturbance. Many of these refuges are now being used to sustain and protect endangered species of animals. This principle is also been used extensively as an immediate protection for transplanted native species and other exotic (non-native) species.

### 3.3 Captive Breeding/Artificial Stocking

This involves the propagation of animal species (birds inclusive) that have decline in number under controlled conditions in captivity after which they are released back into their preferred habitats. When an animal is bred, reared and returned back into a region where it was formally represented, that is called Re-introduction. That is the bringing of individuals of a native animal species. On the other hand, when the animal concerned is non-native, then it is termed Introduction. However, it should be noted that such animals are less able to compete and survive after liberation than the wild stock that have always been in the field. This in part is a consequence of genetic selection except in a situation where the individual involved was directly from another wild area. Protection and creation of refuge is therefore pertinent to the survival of introduced or re-introduced species.

## 3.4 Control of Vermin

This is the control of wild animal damage. Wild animals may be responsible for the destruction of valuables, farm crops, wood, forest, trees, stored products, textiles, aircrafts, etc. **'**Bird strike' refers to a situation where individual(s) of migratory species of bird is(are) responsible for plane crash. When there is wildlife damage problem, carry out assessment of the situation by answering the following question:

1. When was the damage done/carried out (Time; period)?
2. What was the extent of the damage?
3. What was the quantity (in tonnes) of the items damage?
4. What part of the item/product/crop was damaged?
5. What is the cost of establishing what has been damaged? How much would have been realised if the damage had not occurred?
6. What is the economic value of the animal species responsible for the damage?

**Note:** It is difficult to estimate the economic value of wildlife resource. However, effort is being made to find indirect means of arriving at this.

## 3.5 Habitat Improvement

The manipulation of the environment by man for his needs is the worst prevalent factor affecting wildlife habitat and consequently wildlife

populations. Habitat improvement is basically concerned with the following objectives:

1. To maintain good quality habitat as in a natural ecosystem.
2. To produce quality habitat where it has deteriorated or to provide alternatives where a particular habitat component (such as water, food and shelter) is lacking.

The goal of habitat improvement is the production of food and cover for particular species or group of species. To achieve this goal, the following methods are adopted

A. Propagation this could be done by:

i. Seeding.
ii. Grafting.
iii. Cutting.
iv. Transplanting.

For Propagation to be successful the following has to be considered:

i. Site selection.
ii. Site preparation.
iii. Planting depth.
iv. Soil moisture.

B. Release of desirable species through destruction of undesirable competing species. This may be done using the methods below.

i. Mechanical method.
ii. Manual method.
iii. Chemical spray (this, however, is being discouraged considering pollution).
iv. Prescribed burning .
Very often these methods are used in combination to meet specific needs.

C. Protection: this is the protection of habitat from illegal farming, illegal fire and erosion.

## 3.6 Prescribed Fire Controlled Burning

This is the intentional use of fire by management staff to influence vegetation. Fire is a natural occurrence in the savannah. Fire removes

old unpalatable growth while promoting new flush of grasses. It is also used to control bush and encroachment of range land by woody species and destroy parasites. There are two types of fire. A cool fire (otherwise known as early burning) is an early dry season fire, set when grasses are sill green and have high moisture content. A cool fire is usually mild, and as such does not consume the whole vegetation. A hot fire (late burning) occurs towards the end of the dry season, when the grass cover is completely dry and has low moisture content. This type of fire rapidly consumes dead woods. It is very severe and devastating on vegetation.

## 1. Fire as a Tool in Habitat Management

Fire can be caused by some natural phenomena and by man consciously or inadvertently through his actions. Most of the semi-natural savannah owes their origin to fire. Fire is also necessary for maintaining them in their savannah state. Their structural complexity and species composition are also influenced by the severity of the annual fires. Fire is an important tool in the management or range lands and livestock, and in the control of the ecto-parasites of livestock. It is equally important in wildlife management.

It should be pointed out that even though effects of the fires caused by lightning, volcanic eruptions and sparks from rock boulders may be significant in natural ecosystems, they are relatively milder in their destructive effects and spread than the man causing fires. Man deliberately sets fire to vegetation to prepare land for cultivation, to flush out animals during hunting expeditions, to remove old unpalatable growth while promoting new flush, to control bush and encroachment of range land by woody species and to destroy parasites. You should know that fire is a good servant but a bad master. Therefore, the use of fire must be adopted with adequate consideration of fire break.

## 2. The Range of Fire Effects

According to Rogers (1979) fire can affect the following environmental variables either directly or indirectly:

### l. Soils by

a. Affecting numbers and rate of activity of soil organisms.
b. Removing or changing rates of organic matter formation and accumulation in the soil.
c. Affecting surface compactness.
d. Affecting soil water retention properties.
e. Affecting amounts and availability of essential nutrients.

f. Removing soil surface horizons through surface run off and sheet erosion.

**2. Land Surface by**

a. Affecting degree and rate of surface erosion by effects on soil and vegetation cover.
b. Effects on environment water.

**3. Water by**

a. Changing rates of transpiration and evaporation.
b. Changing rates of permeability and subsurface flow.
c. Affecting amount and rate of sedimentation.
d. Changing stream and river structure, through bank and surrounding vegetation destruction.

**4. Vegetation**, both directly and indirectly through the habitat effects mentioned above e.g.

a. Changing direction and speed of vegetation succession.
b. Affecting plant biomass, structure and shape.
c. Affecting plant phenology.
d. Affecting plant quality in terms of nutrient content and availability.

**5. Animals by**

a. Changing the shape or amount of vegetation cover.
b. Changing in plant palatability and availability.
c. Indirectly altering water availability.
d. Causing death or injury (especially lower orders of animals).

He further stated that many of these effects are related and interacting, thus the study of fire ecology and implementing its management is extremely complex.

## 3. Types of Fire Regime

Daubenmire (1974) recognized three main types of fires considering the portion of the vegetation that is consumed by the fire. There are ground fires, surface fires and crown fires. Ground fires are usually flameless and can penetrate to subterranean depths. They are mostly common in places where the soil is overlaid with thick layers of organic matter. Surface fires feature above the ground surface and their flames usually consume the litter, living herbs and shrubs. They also scorch the basis of

any tree along their route. Crown fires are those fires that burn to the crowns of trees and shrubs. Fires are also classified on the basis of the time of the year when they occur.

A cool fire (other wise known as early burning) is an early dry season fire, set when the grasses are still green and have high moisture content. A cool fire is usually mild, and as such does not consume all the vegetation. Early burning fires move close to the ground, shooting up to grass tops as they are encountered. Temperatures rarely reach 300$^{o}$C and are minimal at 2 m. below ground level. Tree tops escape damage as do the denser shrubs and greener shade loving grasses. Dead wood is slowly consumed. Small tracks, watercourses, valleys and ridges can act as barriers to these fires, and a heavy dewfall can extinguish them. Thus, they rarely cover very large areas. A hot fire (late burning) occurs towards the end of the dry season, when the grass cover is completely dry and has low moisture content. According to Rogers (1979), this kind of fire moves rapidly at 1.2m above ground level, temperature can reach 600$^{o}$C or more, and temperature effects can reach down to 5cm below ground level. Tree tops are scorched and leaves killed, shrubs and seedling are engulfed. Dead wood is rapidly consumed, small barriers as mentioned above, can be jumped and such fires can cover large areas in a short space of time. Late burning in addition to its severity is also devastating on vegetation.

Cool and hot fires are no necessarily determined by calendar months. The severity (temperatures) of any of the different types of fires, and the degree of their impact on an ecosystem, are dependent on some factors, among which are the onset and termination of rains (the weather condition at the time of burning), soil moisture, wind direction and velocity, the topography, plant species – stage of maturity and water content, and the kind, amount, dryness and the disposition of the fuel that has accumulated since the last fire.

## 4. Fire and the Savannah Vegetation

The Savannah vegetation owes its existence to a number of factors operating singly, severally or in different combinations in a particular area. These factors include climate, soil, topography and human influences. The use of fire is seen to be the most prominent and perhaps the most potent factor in the production of derived savannah. Late burning is however, very important in the continued maintenance of the derived savannah. Fire among other factors, is known to influence the structure of plant communities. It also influences the species composition of plant communities.

## 5. A Fire Regime for Wildlife Management

Prior to the selection of a fire regime and land use, policy statement is inevitable. Fire regimes (no burning, late burning and early burning) are selected for various reasons. For wildlife management a major objective is the provision of suitable habitat for the game resource. The wildlife manager aims to provide a sufficient grass cover of nutrient value. As conservationists we are also interested in the combination of other less noticeable species, such as forest duiker, requiring different more specialised habitats. Therefore, there is a need for the maintenance of a variety of habitat. Resource use may bring difficulties, for instance, a non-burnt 2m high grass cover is not conducive to game viewing or hunting and these considerations of land use may affect the fire policy. Unbridled fires in vegetation are known to have a number of adverse effects on the population of wild animals. According to Egunbjobi (1979) they are:

1. Destruction of their habitat.
2. Removal of food resources – mainly for herbivores
3. Destruction of young and eggs.
4. Exposure of predators.

Fire is also said to affect their breeding potentials as well as the movements and distribution of wild animals in their habitat. However, the following, among others, are the beneficial effects prescribed burning can have on wild animals:

a. Prescribed fire can be used to attract animals to certain parts of their habitat. This helps to enhance game viewing in a conservation area.
b. Fire when managed, is also a useful tool in the prevention of wild fire in conservation areas. This is done using rotational burning in blocks of land.

## 3.7 Ranching and Domestication

Ranching is a form of wildlife exploitation. It implies a greater degree of control over the animal population by confining it behind fences or by determining its composition through selective removal of certain age or classes. Such population would no longer be truly wild and would have much in common with ranched cattle. To this, complete domestication is the next logical step. No animal is considered domesticated until it breeds readily in captivity and its owner has some control over its reproduction.

It is necessary to distinguish between domesticated animals and those that are merely tamed. The fact that an animal can be tamed is no guarantee that it will be a suitable domestic animal. Tameness has been

defined as the elimination of the tendency to flee in the presence of man. In the prehistoric times, all the present day domesticated animals were wild. The objective of domestication includes the use as pets, source of food, beast of burden and hunting partner.

The choice of an animal species for domestication is based on its ecological potential and the acceptability of its meat by the society. In Nigeria, various efforts have been expended on the domestication of the African giant rat (*Cricetomys gambianus*), grass cutter (*Thryonomys swinderianus*) and Guinea fowl (*Numida meleagris galeata*). For a successful domestication of any wildlife species adequate information on the susceptibility and resistance to disease, reproduction and growth rate is inevitable. And studies in meat production, carcass qualities and grazing behaviour are essential. It is argued that wildlife is superior to domestic animals in terms of lean meat production (per unit live weight), productivity (growth rate and reproduction), adaptation to local environment and pre-immunity against local diseases. Wildlife domestication is a significant factor in the conservation of endangered species of wildlife in that it reduces pressures on wild stock. Since it is impossible to make a sharp distinction between ranching and domestication, domestication could therefore be described in terms of levels (depth). Thus with respect to wild animals bred by man under artificial conditions three main types of husbandry techniques are identifies, vis:

1. Ranching (Extensive Management).
2. Farming on fenced range (Semi-intensive Management).
3. Pen rearing (Intensive Management).

## 3.8 Local Community Participation

This is often defined as involvement of all segments of a community in a wildlife conservation activity. It may be defined as a community support programme geared towards mobilising local capacity to become social actor in decision making and observation of activities that are relevant to their livelihood. It is the involvement of individuals or group of individuals who have direct interest in the use and management of a natural resource base. This could include the local community resources users, developers, extension workers, industries, indigenous and non-governmental organizations (NGOs). Functionally, it involves local populations in the design, implementation and evaluation of projects. Local community participation is expected to lead to stewardship of the resources. Sustainable wildlife conservation must involve the widest possible participation of stakeholders. Stakeholders are therefore all individuals or group of individuals that are directly or indirectly affected by a conservation project or programme including all those that are

negatively or positively affected. Community participation is a process of partnership right from the planning stage through decision-making, implementation, monitoring and evaluation of the resource base. In fact, it is common knowledge now that no conservation effort can be sustainable without the cooperation of the surrounding communities. Local participation can be classified into passive and active participation. A successful collaborative approach to wildlife conservation must have the elements of compensation schemes, income generation project, substitution of traditional techniques and management practices, appreciation of local culture, and finally, environmental education programme. The following are examples of community involvement programmes.

1. Support Zone Development Programme (SZDP), Cross River National Park, Nigeria.
2. Game Harvesting Project in Kedia, Botswana.
3. Luangwa Integrated Rural Development Project (LIRDP) in Zambia.
4. Administrative Management by Design (ADMADE) in Zambia.
5. Communal Area Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe.

## 3.9 Park Protection/Law Enforcement

This is a tool of wildlife management. To produce a sustained annual crop of wild animals for recreational, use there is need for protection, regulation and law enforcement. The work of protection should be handled by a team of knowledgeable, well trained and disciplined law enforcement staff or personnel, such as game (park) guards, rangers, chief park ranger (chief park warden), whose duties include the following:

a. Patrol of the area to protect it from encroachment.
b. Checking of licenses or permits.
c. Protect the park from illegal hunting and poaching (Anti-poaching patrol).
d. Ensuring that there is no aquatic ecosystem pollution.
e. Checking logging in the park.
f. Involvement in conservation education.
g. Prosecution of arrested offenders in the law court.

A Ranger as a law enforcement staff should be well trained to understand the peculiarities of his work and so know what to do when dealing with three distinct kinds of violators as follows:

1. The accidental violator who has no intent to violate the law and has made a mistake.

2. The opportunist violator who leaves home with no intention to violate the law but "the birds are so abundant in the adjacent closed area" that he is carried away and goes after them.
3. The criminal who leaves the home with full intent to violate the law.

Each of these classes must be handled in a different manner. The officer must ask, "Will my handling of this case aid conservation and stimulate the interest of this individual and his respect for law and the department?" The law enforcement staff must make on the spot decisions such as "will I arrest or warm the man?"

The law enforcement personnel should be knowledgeable about the creed that stresses the human relations of law enforcement – which stipulates thus, to save the unfortunate offenders from unnecessary humiliation, inconvenience and distress; to have no compromise for crime and resolutely seek the violator but with judgement charitable to the minor offenders; never to arrest if a citation will suffice; never to cite if a warning would be better; never to scold or reprimand, but rather to respect and inform.

## 14.0 CONCLUSION

You learnt that wild animals are important food item with great potentials. Good wildlife management must be based on solid biological information and must be of benefit to plants and other animals not just one species of wildlife. It must include management of humans because of our activities. It must put animals at a level that we can live with. The unit also enumerated the various methods of controlling wildlife.

## 5.0 SUMMARY

Wildlife conservation implies the wise use of the game animal populations. Proper control of methods of hunting ensures that their numbers remain high. The restriction of various types of weapons and hunting methods, imposition of closed seasons to hunters, and creation of reserves, lead to eventual increase in animal numbers. Other principles on which Wildlife management is based include controlled burning, control of vermin, habitat improvement, ranching and domestication, community participation and law enforcement. Prescribed fire is a tool in habitat management while unbridled fire has deleterious effects on vegetation. There are two broad types of fire, namely-cool fire and Hot Fire. Fire is important to the maintenance of savannah vegetation. Burning operations can be used to prevent wildfires in protected areas. Habitat improvement is aimed at the production of food land cover for wild animals. This may be done

through propagation, elimination of competing species of plants and protection of the habitat.

## 6.0 TUTOR-MARKED ASSIGNMENT

What is wildlife management? Discuss in details five wildlife principles of your choice.

## 7.0 REFERENCES/FURTHER READINGS

Ajayi, S.S (1975). *Domestication of the African Giant rat* (*Cricetomys gambianus*, Waterhouse). Ibadan: Department of Forest Resources Management. 44pp.

Arikpo, E.E. (1996). Wildlife Management, Problems and Prospects in the National Parks. Proceedings of Workshop on the Rain Forest of South Eastern Nigeria and South Western Cameroon. 20-24th October, 1996. Obot, E. and Barker, J. Eds. Pp141-147.

Ayodele, I. A., Ebin, C. O. and Alarape, A. A. (1999). *Essentials of Wild Life Management*, Ibadan: Jachin Publishers, 88pp.

Daubenmire, R. F. (1974). *Plants and Environment.* New York: John Wiley and Sons Inc. 320 pp.

Egunjobi, J. K. (1979). *An Appraisal of the Savannah Burning Problem, in Wildlife Management in Savannah Woodland.* London: Taylor and Francis Ltd, 1979. pp. 160-165.

Eltringham, S.K. (1984). *Wildlife Resources and Economic Development.* John Wiley and Sons Ltd. New-York, 1984. 325pp.

Fatubarin, A. (1984). *The Fire Factor in Tropical Ecosystems*. *Obeche,* No. 18 and 19, June, 1984.

Rogers, W. A. (1979). The Implications of Woodland Burning for Wildlife Management, In Wildlife Management Savannah Woodland, London: Taylor and Francis Ltd. 1979. Pp. 151-159.

Sharma, B. M. (1986). Introductory Ecology. Ibadan: Abiprint Publishing Company Ltd. 109 pp.

Nchor, A.A. (1996). Integrating Local Communities in the Management of Cross River National Park. Proceedings of Workshop on the Rain Forest of South Eastern Nigeria and South Western

Cameroon. 20-24th October, 1996. Obot, E. and Barker, J. Eds. Pp135-140.

Orhiere, S.S. (1996). Managing the Rainforest, Community Participation, and Biodiversity Conservation. Proceedings of Workshop on the Rain Forest of South Eastern Nigeria and South Western Cameroon. 20-24th October, 1996. Obot, E. and Barker, J. Eds. Pp128-134.

Wood-Gush, D.G.M. (1983). *Elements of Ethology*. Chapman and Hall London, New-York. 1983.

## UNIT 5 ORDERS OF NIGERIAN MAMMALS

### CONTENTS

## 1.0 INTRODUCTION

The first step when looking at an unidentified mammal is to find out its name. For most mammals, it should be possible to identify the mammal to the species, although for several similar closely related species it may only be possible to determine the genus. Identification is accomplished by using keys. Each key consists of a number of paired alternatives, one of which is correct for the mammal being identified. The methods of identification and descriptions of each species follow a standard format. Samples of these would be given in this and the following units. Measurements and descriptions are essential for identification. Common names are many and varied. In some instances a single animal species has two or more common names. Sometimes some common names are used for several species. This is the reason why the scientific name is emphasised.

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- know the external features of members of the mammalian orders in Nigeria
- know the scientific names of common species of wildlife in Nigeria
- understand the essentials of identification of Mammals.

## 3.0 MAIN CONTENT

### 3.1 Mammals

Most of the larger land animals are mammals. Mammals have hair on their bodies and in most kinds this forms a thick coat all over. In some mammals, thick hair grows only in a few parts of the body. Mammals

have constant body temperatures. They give birth to the offspring which are fed on milk in the early part of their lives. A young mammal is weaned when it can feed itself and no longer depends on its mother's milk. The gestation period of a mammal is the time taken from fertilisation of the female egg till parturition.

## 3.2 Measurements for Mammals

As stated above, body measurement is an essential part of identification of mammals. Thus, there is a standard for the measurements for mammals to ensure uniformity (see table 5.1 below).

**Table: 5.1. Standard measurements for mammals (linear measurements in millimeters, weight in grams, unless otherwise stated)**

| Abbreviation | Measurement | Details |
|---|---|---|
| HB | Head and body | From tip of nose to base of tail |
| T | Tail | From base of tail to tip of tail, excluding terminal hairs |
| HF | Hindfoot | From heel to tip of longest toe, excluding nail or claw |
| E | Ear | From notch to tip, excluding terminal hairs |
| TLS | Total length of skull | From anterior part of skull (nasal bone or incisor teeth) to most posterior part of skull. |
| CI | Condylo-incisive | From most anterior part of incisor teeth to condyles at back of skull; similar to TLS except that the most anterior part of the skull is the incisor teeth, not the nasal bone; shrews only. |
| FA | Forearm | Total length of radius bone or forearm; bats only |
| SH | Shoulder height | From ground level to highest point of shoulder; large mammals only, e.g. some carnivores, antelopes, elephants, etc. |

| | | |
|---|---|---|
| TL | Total length | From tip of nose to end of tails; used when difficult to distinguish HB from T; manatee only. |
| HL | Horn length | From base of horn to tip of horn along the front edge; bovidae only |
| WT | Weight | Total weight of animal |
| Nd | No data | No information on this measurement |

Source: Happold, 1987.

## 3.7 Mammalian Orders

There are thirteen mammalian orders represented in Nigeria. They are: Tubulidentata, Carnivora, Rodentia, Chiroptera, Insectivora, Lagomorpha, Perisssodactyla, Artiodactyla, Pholidota, Sirenia, Primates, Hyracoidea and Proboscidea (Note that the last letter in the names of order ens in 'a' except in the case of primates). The following key leads to the identification of these orders.

## 3.8 Key to the Order of Mammals in Nigeria (Happold, 1987)

1. Wings present (it belongs to the order)→ Bats (Order Chiroptera)
   Wings absent (proceed to step)→ 2

2. Forelimbs modified into flippers for swimming: hindlimbs modified to form 'fluke' totally aquatic Sea cows, manatee (Order Sirenia) Limbs well developed, not modified into flippers or flukes; terrestrial, or if partially aquatic, capable of movement on land. 3

3. Nose and upper lip elongated to form trunk; upper incisors elongated to form tusks; very large size Elephant (Order Proboscidea) Nose and upper lip not elongated; upper incisors not elongated to form large tusks; size varies from very small to large 4

4. Hairs on dorsal surface modified into scales Pangolins (Order Pholidota) Hairs not modified into scales 5

5. Digits of limbs (especially forelimbs) elongated and ending in flattened nails (not claws or hooves); opposable thumbs; eyes in front of skull to give binocular vision. Apes,

Monkey(Order Primates) Digits of limbs not elongated, ending in claws or hooves; thumb, if present, not opposable; eyes at side of head, no binocular vision 6

6. Hairless with elongated snout; long erect pointed ears; no incisor and canine teeth; feeds entirely on ants and termites Aardvark(Order Tubulidentata) Not this combination of characteristics 7

7. One pair of upper incisors and one pair of lower incisors, very well developed for plucking and gnawing (if second pair of upper incisors present, there are very small and hidden behind first pair); size very small to medium, weight never more than about 20kg. 8

Upper and lower incisors not as above: varied in size 9

8. One pair of upper incisors; ears small and held close to head; eyes small; tail long or short with small scales, and or bristles or short hairs, tuft of hairs at tip in some species, limbs mostly sort in relation to body; movement by scampering, trotting, climbing, and jumping; live on ground or in trees, may burrow and rest underground Rodents (Order Rodentia)

Two pairs of upper incisors, second pair very small and hidden behind first pair; ears long or very long, usually held erect; eyes large; tail short and fluffy; climbs long in relation to body; movement by fast running; live on ground, do not burrow Hares(Order Lagomorpha)

9. Carnivorous or Insectivorous mammals; canine or incisor teeth long and pointed to catch and hold prey; cheek teeth with many pointed cusps to chew prey; four or five digits on each limb, ending in claws; tail usually long and covered with hair or sparse bristles 10

Herbivorous mammals: canine and incisor teeth generally small and wide, used for grazing and browsing; upper canines and incisors absent in some species, but in others upper and lower canines or incisors modified into small tusks which are used for obtaining food; cheek teeth wide and flattened for grinding grasses, leaves, and fruits, two, three, or four digits on each limb, ending in hooves or hairs (not claws); tail usually short with sparse hairs, and with tuft of hairs at tip in some species, tail hairless or absent in some species 11

10. Snout elongated, with mobile nasal region; long vibrissae; pelage soft and dense; tail wide at base tapering to tip, with sparse bristles; limbs short with small claws; terrestrial or semi-aquatic. Or snout not elongated; dorsal hairs modified into spines; body capable of being rolled into a ball with spines pointing outwards. Mostly very small or small, and nocturnal. HB 30-280; WT 2 – 1000g Shrews, hedgehogs (Order Insectivora)

    Snout not particularly elongated, nasal region not mobile; vibrissae present, but not especially long; pelage soft, with distinctive spots and patterns in some species; claws well developed, retractile in some species; limbs usually fairly long for fast movement; tail long in most species, well furred or bushy; some species diurnal and may live in groups or packs, other nocturnal and solitary. Size medium to large, HB 300-2500, WT 1–250kg Carnivores (Order Carnivora)

11. Medium-sized mammals with short compact limbs; tail absent; three digits on each limb ending in soft pads with small flattened claws; small rounded ears; upper outer incisors form small triangular-shape tusks; dorsal gland on center of back surrounded by hair contrasting in colour with rest of pelage; live in rocky habitats, or in tall rainforest trees. HB 400– 500, WT about 4kg.
    Hyraxes (Order Hyracoidea)

    Not this combination of characteristics
    12

12. Weight of body rest on three digits; horns of compacted hair on nasal region, no horns on head between ears; upper incisor teeth present; almost hairless; very large. WT up to 1300 kg

    Odd-toed Ungulate (Order Perissodactyla)

    Weight of body rests on two or four digits, ending in hooves; no horn of compacted hair on nasal region; horns of bone on head between ears in some species (usually males only); upper incisor teeth absent in most species, although present in pigs and hippopotamuses; pelage soft or coarse, with distinctive colour pattern in some species (hair absent in some species, e.g. hippopotamuses, or rather sparse in others, e.g., pigs). Size medium to large, from HB 60–70 cm and WT 11–14 kg. (e.g. small duikers) to HB 400 cm. and WT 3000kg (e.g., hippopotamuses)
    Even-toed ungulates (Order Artiodactyla)

The following formula is an easy way to remember the order of Nigerian mammals.

| **TRIP$^4$** | | **C$^2$LASH** | |
|---|---|---|---|
| T: | Tubulidentata | $C_1$: | Carnivora |
| R: | Rodentia | $C_2$: | Chiroptera |
| I: | Insectivora | L: | Lagomorpha |
| $P_1$: | Perissodactyla | A: | Artiodactyla |
| $P_2$: | Pholidota | S: | Sirenia |
| $P_3$: | Primates | H: | Hyracoidea |
| $P_4$: | Proboscidea | | |

The Scientific names of some Nigerian mammals are listed in table 5.2.

**Table 5.2: Scientific Names of Some Nigerian Mammals**

| **ORDER**<br>**Family** | **Common Name** | **Scientific Name** |
|---|---|---|
| **ISECTIVORA** | | |
| Tenrecidae | Giant otter-shrew | *Potamogale velax* |
| Erinaceidae | Fair toed hedge hog | *Erinaceus albiventris* |
| Soricidae | African giant shrew | *Crocidura flavescense* |
| **CHIROPTERA** | Straw coloured fruit bat | *Eidolon helvum* |
| Pteropodidae | Franquet's fruit bat | *Epomops franqueti* |
| | Bate's slit faced bat | *Nyecteris arge* |
| Nyecteridae | Hairy slit faced bat | *N. hispida* |
| | Mauritian tomb bat | *Taphozous mauritianus* |
| Emballonuridae | Large mouse tailed bat | *Rhinopoma microphyllum* |
| Rhinopomatidae | Yellow winged bat | *Lavia frons* |
| Megadermatidae | Abyssinia horse shoe bat | *Rhinolophus fumigabus* |
| Rhinolophidae | Noack's African leaf nosed | *Hipposideros rubber* |
| Hipposideridae | bat | *Pipistrellus nanus* |
| Vespertilionidae | Banana bat | *Tadarida nigeriae* |
| Molosidae | Nigerian free tailed bat | |
| **PRIMATES** | | |
| Lorisidae | Angwantibo | *Arctocebus colabarensis* |
| Galagidae | Dwarf Galago | *Galagoides demidovii* |
| Cercopithecidae | Anubis baboon | *Papio anubis* |
| | Mona Monkdy (a.ka. fine | *Cercopithecus mona* |
| | boy) | *C. nictitans* |
| | White nose monkey | *C. tantalus* |
| Pongidae | Tanalus monkey | *Pan troglodytes* |
| | Chimpanzee | *Gorilla gorilla* |
| | Gorilla | |
| **PHOLIDOTA** | Tree pangolin | *Manis tricuspis* |
| Manidae | Long tailed pangolin | *M. longicaudata* |
| **LAGOMORPHA** | Crawshay's hare | *Lepus crawshayi* |
| Leporidae | | |

| | | |
|---|---|---|
| **RODENTIA** | Beecroft's flying squirrel | *Anomalurus beecrofti* |
| Anomaluridae | Gambian sun squirrel | *Heliosciurus gambianus* |
| Sciuridae | Gambian giant rat | *Cricetomys gambianus* |
| Cricetidae | Black rat | *Rattus rattus* |
| Muridae | Common African dormouse | *Graphinrus murinus* |
| Muscaradimidae | Lesser Egyptian jerboa | *Jaculus jaculus* |
| Dipodidae | Crested porcupine | *Hystrix cristata* |
| Hystricidae | Brush tailed porcupine | *Atherurus africanus* |
| | Greater cane rat | *Thryonomys swinderianus* |
| Thryonomidae | Ochre mole-rat | *Cryptomys ochraceocinereus* |
| Bathyergidae | | |
| | | |
| **CARNIVORA** | Side striped jackal | *Canis adustus* |
| Canidae | Hunting dog | *Lycaon pictus* |
| | Cape clawless otter | *Aonis capensis* |
| Mustellidae | African civet | *Viverra civetta* |
| Viverridae | Benin genet | *Genetta bini* |
| | Forest genet | *G. poensis* |
| | Two-spotted palm civet | *Nandinia binotata* |
| | Marsh mongoose | *Atilax paludinosus* |
| | Spotted (laughing) hyaena | *Crocuta crocuta* |
| Hyaenidae | African wild cat | *Felix libyca* |
| Felidae | Serval | *F. serval* |
| | Lion | *Panthera leo* |
| | Leopard | *P. pardus* |
| | | |
| **TUBULIDENTATA** | Aardvark | *Orycteropus afer* |
| Orycteropodidae | | |
| | | |
| **PROBOSCIDEA** | African elephant | *Loxodonta africana* |
| Elephantidae | | |
| | | |
| **HYRACOIDEA** | Western tree hyrax | *Dendrohyrax dorsalis* |
| Procaviidae | Western rock hyrax | *Procavia ruficeps* |
| | | |
| **ARTIODACTYLA** | Warthog | *Phacochoerus aethiopicus* |
| Suidae | Red river hog | *Potamochoerus porcus* |
| | Giant forest hog | *Hylochoerus mernertzhageni* |
| | Hippopotamus | *Hippopotamus amphibious* |
| Hippopotamidae | Pygmy hippopotamus | *Choeropsis liberiensis* |
| | Water chevrotain | *Hyemoschus aquaticus* |
| Tragulidae | Giraffe | *Giraffa camelopardalis* |
| Giraffidae | African buffalo | *Syncerus caffer* |
| Bovidae | Bush buck | *Tragelaphus scriptus* |
| | Water buck | *Kobus elipsiprymnus* |
| | Giant eland | *Taurotragus derbianus* |
| | Maxwell's duiker | *Cephalophus maxwelli* |
| | Red flanked duiker | *C. rufilatus* |
| | Crowned duiker | *Sylvicapra grimmia* |
| | Kob | *Kobus kob* |
| | Roan antelope | *Hippotragus equinus* |
| | Hartebeest | *Alcelaphus buselaphus* |
| | Oribi | *Ourebia ourebi* |
| **PERISSODACTYLA** | | |

| | | |
|---|---|---|
| Rhinocerotidae | Black rhinoceros | *Diceros bicornis* |

**Source: Happold, 1987 and Ayodele, *et. al*., 1999.**

## 4.0 CONCLUSION

## 15.0 SUMMARY

The methods of identification and descriptions of each species follow a standard format. Identification is accomplished by using keys. Measurements and descriptions are essential for identification. The Nigerian mammals fall under thirteen orders (Tubulidentata, Carnivora, Rodentia, Chiroptera, Insectivora, Lagomorpha, Perissodactyla, Artiodactyla, Pholidota, Sirenia, Primates, Hyracoidea and Proboscidea).

## 6.0 TUTOR-MARKED ASSIGNMENT

1. List all the mammalian orders that are represented in Nigeria.
2. Provide the scientific names and common names of common wild animal species in Nigeria.

## 7.0 REFERENCE/FURTHER READINGS

Ayodele, I. A.. Ebin, C. O. and Alarape, A. A. (1999**)**. *Essentials of Wild Life Management.* Ibadan: Jachin Publishers, 88pp.

Happold, D. C. D. (1987). *The Mammals of Nigeria***.** Oxford: Clarendon Press, 402pp.

# MODULE 4 CLASSIFICATION, EVOLUTION, MORPHOLOGY AND BASIC STRUCTURE OF PRINCIPAL SPECIES OF WILDLIFE IN WEST AFRICA

# UNIT 1 ORDER RODENTIA

## CONTENTS



## 1.0 INTRODUCTION

The rodents are the largest order of Nigerian mammals having nine families, 37 genera and 55 species. They can easily be identified through their dental formula and the characteristics of the teeth. Rodents vary in body size, colour, and size of tail and limbs, and hair texture. They occur (often in large numbers) in most habitats.

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- differentiate between families of rodents
- know the characteristics of the families under the Order Rodentia.

## 3.0 MAIN CONTENT

## 3.1 Order Rodentia

The dentition of rodents can be represented in the following formula:

$$\frac{1\ 0\ 0\ 3}{1\ 0\ 0\ 3} = 16 \quad \text{to} \quad \frac{1\ 0\ 2\ 3}{1\ 0\ 1\ 3} = 22$$

The characteristics of their teeth are as follows:

1. The two upper and lower incisors are chisel-like and are used for gnawing and biting; they grow and are worn out continuously throughout life.

2. Behind the incisor teeth there is a gap resulting from the absence of canine teeth (diastema).

3. The cheek teeth (3/3 or 4/4 or 5/4) at the back of the mouth are for grinding and chewing and gradually wear away during life so their appearance changes with age.

4. The structure and number of cheek teeth distinguish each family (and some species), and are very useful for identification.

5. The jaw musculature and the form of zygomatic arch are also used to distinguish the three main groups of rodents (Sciuromorpha represented by the squirrels, beavers and marmots; Caviomorpha represented by the Guinea pigs and including porcupines; and Myomorpha, the mice and rats) (Happold, 1987).

Rodents vary in size from the small pigmy mouse (10g) to the large crested porcupine (*Hystrix cristata*), which weighs from 15 – 20 kg. There is a great variation in external form, colour, size of tail and limbs and hair texture between families and species. They live in most habitats from the rainforest of the South to the semi-arid regions of the extreme North; the majority of the rodents are ground-living, some are arboreal and one species is fossorial (e.g. Giant rat). None is aquatic although some species prefer damp, swampy habitat and none is capable of true flight although the 'flying-squirrels' (family Anomaluridae) can glide from tree to tree. As an order, the rodents are extremely successful. They are often very numerous but their total biomass is small

in relation to that of a few larger herbivores (e.g. a kob that is approximately 60kg. has about the same biomass as about 1620 Dalton's mice weighing 37g each). They consume a variety of seeds, grasses and insects and they form a major part of the diet of many aerial and terrestrial animals (Happold, 1987).

Many species are important to man; some may become pests of crops and food stuffs e.g. Multimammate mouse, the Nile rat, the Savannah Gerbil, Greater Cane rat, some are potential carriers of human diseases (Multimammate mouse, Black rat, Norway rat) and others are important sources of meat in some part of the country (e.g. Gambian giant rat (*Cricetomys gambianus*) and the Greater cane rat (*Thryonomys swinderianus*).

### 3.1.1 Key to the Order Rodentia (in Nigeria)

1. One pair of upper incisors
2. Ears small and held close to head; eyes small, tail long or short with small scales and/or bristles or short hairs, tuft of hairs at the tip of tail in some species.
3. Limbs mostly short in relation to body
4. Movement by scampering, trotting, climbing and jumping; live on ground or in trees; may borrow and rest underground (Happold, 1987).

### 3.1.2 Key to the Families of Rodentia (Hoppold, 1987)

1. Hairs on upper part of body, modified into spines - Hystricidae.
   Hairs not modified into spines 2

2. Specialized for fossorial life (reduced tail, very small eyes, very large incisor teeth projecting forward and large fore teeth Bathyergidae
   Not specialized for fossorial life 3

3. Tail bushy with long hairs from base to tip 4
   Tail not bushy or with slight tufts of hairs at the tip. 6

4. Patagium present - Anomaluridae
   Patagium absent 5
5. Small (HB 150mm or less, WT 50g or less); fur grayish; cheek teeth 4/4 Muscardinidae
   Medium to large (HB 150 or more, WT 50g or more); fur brown or rufous (reddish) brown often with other colour markings; cheek teeth 4/4 or 5/5 Sciuridae

6. Hind feet very long about 55% of HB (head Body); specialized for saltatorial locomotion; tail very long about 180% of HB with terminal tufts Dipodidae
   Hind feet not elongated 25% or less of HB; not specialized for saltatorial locomotion; tail length variable (40 – 160% of HB) 7

7. Large HB (450 - 584mm), WT. 5 - 7kg; tail very short (40% of HB): upper incisors deeply grooved; cheek teeth 4/4 Thryonomidae

   Small to medium (HB up to 400 mm) WT up to 1.5kg; tail at least 60% of HB (except Steatomys) upper incisors not grooved or only slightly grooved, cheek teeth 3/3 Cricetidae and Muridae

Note: **Fossorial –** Burrowing, living underground.

**Patagium** – Membrane of thin living skin between digits and body forming the wing of bats and between the forelimbs and hind limbs forming the gliding membrane in flying squirrel.

**Saltatorial** – Having the ability to hop or jump on hind limbs usually associated with extremely long hind limbs, reduction of fore limbs and walking on the tip of toe(s) of hind limbs.

**Zygomatic Arch** – An arch of bone on the skull ventral to the eye which supports and protects the eyeball.

## 3.2 Common Rodents in Nigeria

Rodents got their name from the Latin word ‘rodens’, meaning gnawing and are, therefore, animals which gnaw, or grate away with the front teeth substances like wood, tree back, nutshells, cassava tubers, etc. Rodents are easily distinguished by the large, chisel stayed incisor teeth and by the absence of canines

### 3.2.1 Flying Squirrel

Flying squirrels are medium-sized arboreal rodents, easily identified by the flap of skin, or patagium, on either side of the body between the fore and hind limbs. When the limbs are extended, the patagium forms a tightly stretched membrane which increases the surface area of the body and enables flying squirrels to glide from tree to tree. These creatures do not really fly. In fact the flying squirrel glides, and is not capable of upward movement through the air. There are two species of flying squirrel in Nigerian, namely: *Anomalurus beecrofti* and *A. derbianus*.

*Anomalurus derbianus*: This is the largest of the Nigeria flying squirrel. The following are the average measurements. HB 306 (283-379), T 284 (227-327), HF 56 (51 – 64), E 40 (36-47), WT nd (Rosevear, 1969). The flight membrane (patagium) extends from fore limb to hind limb, are from hind limb to base of tail. Dorsal pelage is long, dense and soft, greyish–brown or blackish brown flecked with pale yellow or buff (pale yellow brown); ventral pelage white. Fur on patagium shorter and sparser than on back; ventral surface of membrane almost hairless. Head roundish, large eyes surrounded by blackish hair; dark patch of fur between ear and eyes, and above ears, no white spot on crown of head. Long limbs ending in strong curved claws. Tail long, narrow at base widening to long-haired brush at tip; pointed backwardly –projecting scales on ventral surface of tail at basal end. It eats fruits, flowers, and probably leaves and bark.

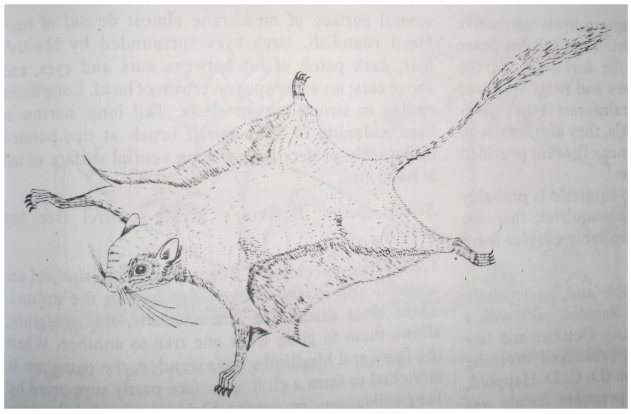


**Fig. 1.1. Derby's Flying Squirrel (*Anomalurus derbianus*)**

### 3.2.2 Geoffroy's Ground Squirrel (Xerus erythropus)

The following are the average measurements of the Ground squirrel. HB 255 (223-290), T 219 (185-262), HF 62 (58-69), E 16 (14-19), TLS 60.8 (51.7-65.7) (Rosevear, 1969). The ground squirrel is heavily built with sparse coarse pelage. Dorsal pelage is brownish-yellow to sandy-orange, lightly speckled, hairs brown, usually with black tips and a pale subapical band. Ventral surface is covered with sparse white hair. There is conspicuous white side-stripe, and white lines above and below each eye. The tail is bushy and similar to dorsal pelage, each hair with sub-apical black band and long white tip. The ground squirrel is exceptional in that it runs entirely on the ground and lives in burrows. It has very powerful legs for digging. They are unable to climb trees. They prefer grasslands, especially where there are small clearings, and open bush-scrub habitats in the North of Nigeria. Ground squirrels feed mostly on palm nuts, seeds, bulbs, small insects and sometimes on Agriculture root crops. They often have so many food-stores around their burrows.

Sometimes, the seeds in the food stores germinate instead of being consumed. They make a variety of vocal sounds including alarm call. When alert, the tail is held over the back, and flicked back and forth with the hairs erect; when frightened the squirrel runs with the tail in line with the body. The tail is almost dragged on the ground with the hairs flat when the squirrel is completely at ease.

**Fig. 1.2. Ground Squirrel (*Xerus erythropus*)**

### 3.2.3 Black Rat (Rattus Rattus)

This is a large dark, fairly slender rat. Dorsal pelage dark-grey to grey-brown, with black elongated gaurd hairs extending beyond pelage, or dull grey. Hairs long and rather coarse. Ears large and hairless. Fore and hind feet relatively large, upper surfaces covered with brownish hairs. Tail thin and very long, covered with small scale and very small dark bristles. Black rats are introduced species yet extremely prolific, have 5-10 young in a litter and a female may have up to six litters per year.

**Fig. 1.3. Black rat (*Rattus rattus*).**

### 3.2.4 Gambian Giant Rat (Cricetomys Gambianus)

A large, thick–set rodent often called pouched rat, pelage greyish to greyish brown, tending to dark grey in southern localities. Flanks paler merging into whitish ventral pelage. Upper lips, chin, throat and chest whitish. Body hair coarse and rough. Elongated face, pointed nasal region, very long vibrissae (Whiskers), relatively small eyes, and large fleshy ears. Tail long and thick, basal half brown, terminal half white. It feeds on fruits, vegetables, seeds, yams, maize, oil palm nuts, and other local crops. Litters contain 3-5 young; eyes open at about 20-23 days

and weaning occurs at about 4 weeks. Attains adult size in about 5-6 months.

**Fig. 1.4. Gambian giant rat (*Cricetomys gambianus*).**

### 3.2.5 Crested Porcupine (Hystrix Cristata)

A large rodent with the dorsal and lateral hairs, especially on posterior part of back, modified into stout smooth quills. Each quill (about 30cm) with alternating wide black and narrow white bands, and white point tip. Head, neck, and limbs covered with coarse bristles (up to 50mm). Crest of long, wiry hairs (up to 45cm), mostly white with black base, on week and shoulders. Crest and quills erectile. Head rounded and blunt, with small eyes and ears. Limbs relatively short with strong digits and claws. Tail short, usually not visible, covered with short weak quills, quills at tip of tail elongated, widening to an open 'cup' which rattles when tail is shaken. The crested porcupine looks larger than it really is because of its erectile crest and quills. Quills from some localities, are reddish, especially on the white band and tip.

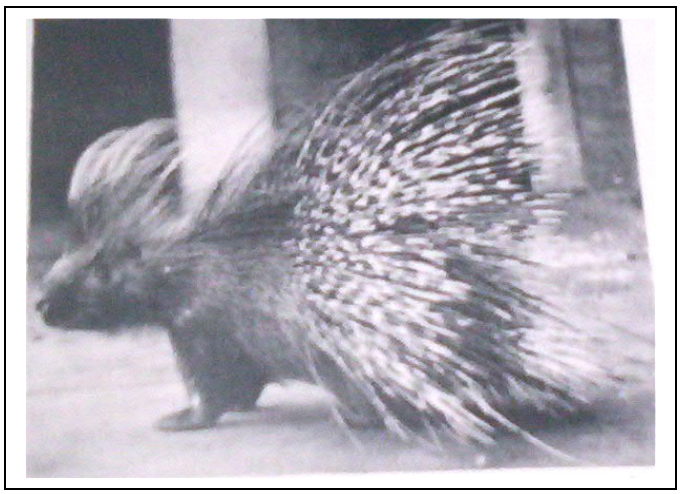


**Fig. 1.5. Crested porcupine (*Hystrix cristata*)**

### 3.2.6 Grass Cutter (Thryonomys Swinderianus)

The grass cutter sometimes called greater cane-rat is the second largest species of rodent in Nigeria after the crested porcupine. Dorsal pelage

deep brown to rufous brown, flecked with yellow and black. Dorsal hairs thick and coarse, mostly brown with yellow band at terminal end (usually) black tip. Flanks similar to dorsal pelage, merging into greyish – white ventral pelage. Body thickset, head broad with short flattened muzzle, small eyes and ears. Upper incisor teeth wide and strong, each with three grooves on anterior surface. Limbs short and powerful, well developed pads and claws on feet. Tail short (about 40% of HB), covered with small hairs. Litter size between 2-6 young (average 4). The young are precocious, fully furred, capable of running, and have their eyes open at birth. Attains sexual maturity at about 5 months.

**Fig. 1.6. Grass Cutter (*Thryonomys swinderianus*)**

## 4.0 CONCLUSION

You have learnt that rodents make up the largest order of mammals in Nigeria with 9 families and 55 genera. They have 2 incisors in the upper jaw used for gnawing. The unit also introduced the general features used in their identification.

## 5.0 SUMMARY

The rodents are the largest order of Nigerian Mammals having nine families, 37 genera, and 55 species. They vary in size from small to large species. They live in most habitats. The majority of them are ground–living. Some are arboreal, and one species is fossorial. They consume a variety of seeds, grasses, and insects, and they form a major part of the diet of many aerial and terrestrial predators. Some become pests of crops and food stores while others are important sources of bush meat in some parts of the country.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Write an essay on rodents indicating their distinguishing characteristics as a mammalian order.

2. List the families of rodents that you know giving an example of each of them.

## 7.0 REFERENCES/FURTHER READINGS

Ajayi. S.S. (1975). *Domestication of the African Giant Rat.* (*Cricetomys gambianus* Waterhouse). Department of Forest Resources Management, University of Ibadan, Ibadan. 44pp.

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife Ilorin Kwara State:* SAOLOG Printing Productions, 1982. 80pp.

Ewer, R. F. (1966). *Juvenile Behaviour in the African Ground Squirrel*, *Xerus erythropus (*E. Geoff*) Z. Tierpsychol.* 23, 190-216.

Happold, D. C. D. (1987). *The Mammals of Nigeria.* Oxford: Clarendon Press, 402 pp.

Rosevear, D. R. (1969). *The Rodents of West Africa. British Museum* (Natural History), London.

Thistleton, G.F. (1968). *Nature study of Africa, Mammals*. Evans Brothers Limited, Ibadan. 108pp.

Webb, G.C. (1957). *A Guide to West Africa Mammals*. Ibadan University Press, Nigeria. 40pp.

# UNIT 2 ORDER CARNIVORA AND PERISSODACTYLA

**CONTENTS**

## 22.0 INTRODUCTION

The carnivora is an order of flesh eating mammals and includes the jackals, foxes, otters, weasels, civets, genets, mongooses, hyaenas, and cats (e.g. Lion and Leopard.).. Two different kinds of hyenas live in West Africa, the striped hyena and the spotted hyaena. The striped hyena lives in the open country and grasslands to the north-east of Nigeria bordering Lake Chad. The spotted hyaena is more common than the striped hyaena and may be found in any area covered by grass. The lion is the largest of the West African cats and lives in the grasslands, feeding mostly on antelopes which it catches and kills. Lions are not common in West Africa, though some may still be found in the less densely populated regions of the north. The leopard is smaller than the lion and is more common. It occurs both in the forest and in grasslands.

The perissodactyla are called the ‘odd-toed’ ungulates in that the weight of the body rest on one toe (the third) as in zebras, horses and asses or on three toes (the second, third and fourth) as in the rhinoceroses. They are completely different from the order artiodactyla in which the weight of the body rest on two (the third and fourth) or four toes (second to fifth). The perissodactyla also vary in having upper incisor teeth and are non-ruminants.

The two African families are in the order Equidae (zebras, horses, and asses.) and Rhinocerotidae (represented in Nigeria only by the Black rhinoceros, *Diceros bicornis*).

## 23.0 OBJECTIVES

At the end of this unit, you should be able to:

- know the families of animals in the order carnivore and perissodactyla
- describe the external features of species in the two orders.

## 24.0 MAIN CONTENT

## 3.1 Carnivora

The carnivora is the largest order of flesh eating mammals in Nigeria and includes the jackals, foxes, otters, weasels, civets, genets, mongooses, hyaenas, and cats. They range in size from the Libyan striped-weasel (1kg) to the Lion (130kg or more), and show a variety of colours and markings. Most carnivores are terrestrial and the majority are nocturnal, resting in burrows, caves, thickets, or trees during the day. Genets and palm civets are arboreal while otters are aquatic. All species in the order are predators which catch and kill their prey.

All carnivores have good sense of smell, sight and hearing. Their eyes tend to be large and usually have a reflective layer (the Tapetum Incidum) at the back of the eyes which enhances their vision at night. Most carnivores are intelligent mammals with great agility and co-ordination, and most are strong and powerful in relation to their size. Five families, 22 genera and 33 species of carnivora are recorded from Nigeria.

### 3.1.1 Key to the Families of Carnivore in Nigeria (Happold, 1987)

The families of carnivora are distinguished principally by the characteristics of their teeth and skull. Therefore, a key based entirely on external features may not be completely reliable.

1. Head broad with blunt flattened nasal region; outer surfaces of ears black or partly black, claws retractile (except Acinonxy)

2. Large, SH about 70cm; broad head with pointed muzzle; forelimbs longer than hind-limbs so back slopes towards tail; pelage spotted or stripped; four digits on each foot Hyaenidae
   Small to medium; SH not more than 50cm (except Lycaon); fore and hind-limbs more or less equal in length; pelage not spotted on striped (Lycaon has large irregular blotches); four or five digits on each foot
   3

3. Small to medium; HB 45-65cm, SH 25-45cm; pelage uniform in colour with or without side-stripe, elongated muzzle and pointed

erect ears, tail bushy and not tapering; or large, HB 110-120cm, SH 75-80cm, pelage with large irregular black, brown and sandy-yellow patches
Canidae

Not as above 4

4. Small to medium; pelage with large or small spots or blotches, tail dark or with alternating dark and pale rings, pointed ears; or pelage uniform beige [light yellow brown], brown or dark brown, sometimes with speckled appearance and transverse stripes. Tail bushy and perhaps tapering towards tip, ears usually rounded
Viverridae

Small to medium; dorsal pelage and flanks with black and white longitudinal lines; or dorsal pelage and flanks white with black ventral pelage; pelage dark brown with throat and chest white, glistening and water repellent
Mustellidae

### 3.1.3 Common Carnivores in Nigeria

The characteristic features of the common members of the order carnivora are the following. Four well-known species discribed in the order Carnivora (Carnivores) are the Hyaena (*Crocuta crocuta*), Lion (*Panthera leo*), the Leopard (*Panthera pardus*) and the Cheetah (*Acinonyx jubatus*).

### 3.1.3 Hyaena (Crocuta Croscuta)

**Identification:** A large heavily-built dog-like carnivore. Pelage prey to grey-brown with irregular roundish brown spots on dorsal surface, flanks and legs. Hair coarse and woolly, sometimes with small rufous grey crest on dorsal surface of neck and shoulders. Head very large and broad with short muzzle, and rounded ears; no spots on head, chin, and throat. Fore limbs longer than limb-limbs so back slopes downwards to base of tail. Limbs strong, usually darker than body; digits with short non-retractile claws. Tail short, sparsely covered with hair except for brown-black tuft on tip; tail often held vertically or forwards over back when animal is excited.

Hyaenas are scavenger (primarily so) and predators which feed on a variety of small and large prey. Spotted hyaenas live in packs or clans which vary greatly in number and may include as many as 25 animals. Females are usually larger than males and are the dominant members of

a clan, which is an unusual situation in mammals. They are mostly nocturnal but may be active during early morning or late afternoon.

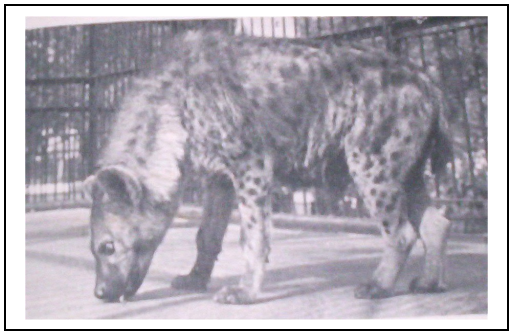


**Fig. 2.1. Hyaena (*Crocuta crocuta*)**

### 3.1.4 Lion (Panthera Leo)

**Identification:** A large powerful cat without spots or distinctive colour makings. Pelage short, beige to sandy-brown; ventral pelage usually paler. Head large and broad short muzzle with clearly defined vibrissae, and small rounded ears with black markings on outer surface. Patterns of vibrissae very variable and may be used to identify individual animals. In males, long fur on top of head, neck, shoulders, and chest forms a dense mane, usually darker than rest of body. Limbs short and thickset, with large paws and retractile claws. Tail long with black tuft at tip. Lions which are less than one year old have numerous small dark beige spots on pelage.

**Fig. 2.2. Lion (*Panthera leo*).**

The lion is the largest of the West African cats and lives in the grasslands. Lions live together in groups (called pride) of 2-25 individuals. Larger pride often split up into smaller sub-groups which later rejoin. A pride is typically composed of one adult male, several females and their young. Each pride lives and hunts in a home range where strange lions are not tolerated. The presence of a pride and the boundaries of its home range are advertised by roaring, and by urination and defaecation on tree trunks and bushes where the scent is likely to be perceived by other lions.

Hunting is usually performed by the females either single or in small groups. Lions are mostly nocturnal, although they may sometimes travel and hunt during the day. Males are usually dominant to females, and females are dominant to young. The very mobile tail moves from side to side when the lion is angry. Lions have good senses of smell, sight and hearing. They produce a loud characteristic roar. Lions breed only once in every two years producing 1-6 young in each litter.

### 3.1.5 Leopard (Panthera pardus)

**Identification:** A large heavily-built cat; dorsal pelage buff (pale yellow-brown), beige (light yellow-brown) or yellowish brown with numerous irregular spots. Spots on dorsal pelage and flanks arranged in 'rosettes' each consisting of a buff or beige central part, sometimes with a small black spot, and an outer ring of two to six black round or elongated spots. Ventral pelage usually with scattered black spots. Spots on head, neck and limbs irregular in size and shape, not arranged in rosettes. The patterning of rosettes and spots could be used to distinguish individual animals. Head is broad with short muzzle and small low-set ears. Limbs thick and short, with large paws and retractile claws. Skin of body, especially on lower flanks and vertical surface loose giving a sagging, floppy appearance. Tail long with large black spots.

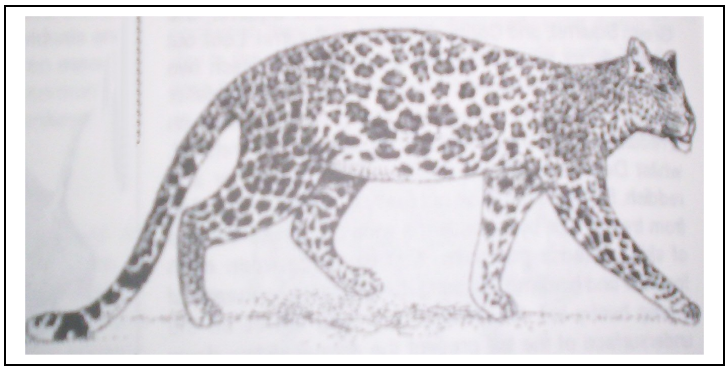


**Fig. 2.3. Leopard *(Panthera pardus)***

Leopards are nocturnal animals and tend to remain in habitats where they are difficult, if not impossible, to see. They are solitary animals except when the mother is caring for her young (spanning about over year). They usually hunt in the night and drag their prey into a tree where it can be protected from scavengers and kept to provide food for several days. Leopards provide a characteristics rasping cough, similar to the noise of sewing a rough piece of wood. Urine marking probably also indicates the presence of individuals and the boundaries of their hour ranges. They produce litter of 2-3 young which could be at most times of the year.

### 3.1.6 Cheetah (Acininyx jubatus)

**Identification**: The cheetah is one of the most beautiful and graceful of the African cats. Large, slimly-built with long thin legs, hollow back, and long tail usually curved upward slightly at the tip. Dorsal pelage sandy or beige with many small black spots as in the serval. Ventral pelage similar in colour to dorsal pelage or paler; spots absent or obscure. Head relatively small, rounded and lightly spotted; distinctive black line from inner corner of each eye to mouth. Limbs slender and spotted; digits with non-retractile claws. Tail very long, spotted except for terminal end where spots merge to form black band and black tip.

The Cheetah is the fastest land animal in the world and can run up to 120km per hour over a short distance. Cheetahs are mostly diurnal; they usually hunt in early morning or late afternoon and they rest in shaded or secluded places at night and during mid-day. They usually live singly or in pairs, although after the offspring are weaned and still living with their parents, they maintain small family groups led by the male. There are 3-4 young per litter and they become totally independent at about 15-18 months of age.

**Fig. 2. 4. Cheetah *(Acinonyx jubatus)***

## 3.7Order Perissodactyla

The perissodactyla are called the ‘odd-toed’ ungulates in that the weight of the body rest on either one (the third) digit as in zebras, horses and asses or on the (the second, third and fourth) as in the rhinoceroses. They are completely dissimilar to the order artiodactyla in which the weight of the body rest on two (the third and fourth) digit or four (second to fifth) digits. The perissodactyla also vary in having upper incisor teeth and a simple stomach without rumination of food (i.e. they are non-ruminants).

There are two African families in this order, namely:

1. Equidae (zebras, horses, and asses.)
2. Rhinocerotidae (this is represented in Nigeria only by the Black rhinoceros, *Diceros bicornis*)

### 3.2.1 Black Rhinoceros (*Diceros bicornis*)

**Identification:** Enormous heavily built mammals (weight 900-1300kg) with barrel shaped bodies. Skin grey, naked, often encrusted with mud. Head massive and heavy; eyes small; ears trumpet-shaped and erect; large round nostrils and rounded fleshy lips. Two horns, composed of hardened hair, curve upwards and forwards from snout, anterior to the eyes; anterior horn long, thick and square at base, tapering to point; posterior horn similar but shorter. Limbs thickset with flat, almost circular, feet; three broad nails on each foot. Limbs of West African subspecies (*longipes*) longer and thinner than in other subspecies. Tail short and thin.

Black rhinos are rather solitary animals inhabiting dry wooded savannahs. They are usually seen singly or in pairs, and it is rare to see more than five individuals together. Males only associate with females for mating and most pairs or groups are mothers with young. They have extremely poor eye sight thus relying mainly on their sense of smell and hearing. They are mostly nocturnal but they also feed and drink during the day. They are entirely herbivorous, browsing on leaves, twigs and shoots of trees, and bushes. The black rhino is more dangerous than the white rhino, especially in places where they are frequently disturbed. They like to wallow in the mud to cool the body (due to absence of sweat glands in the skin). A single calf is born after 18 months gestation and the mother takes care of it for two years or more. Maturity is attained at 5-7 years, and females may produce young every 3-4 years.

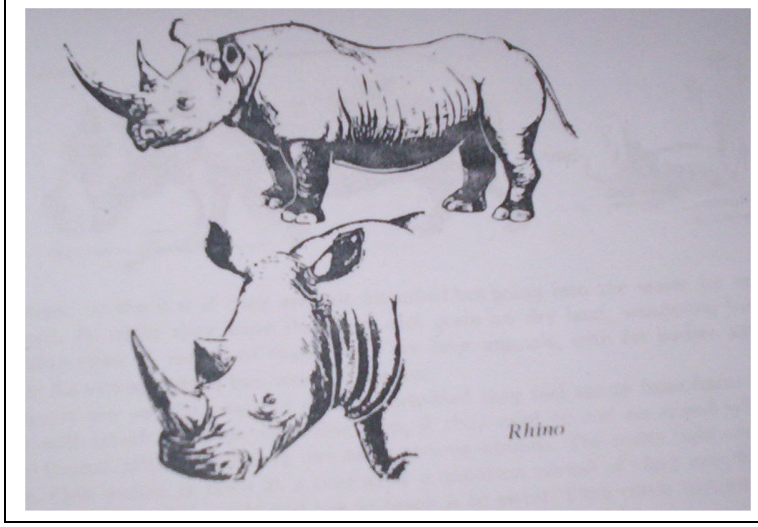


**Fig. 2.5. Black rhinoceros (*Diceros bicornis*)**

## 25.0 CONCLUSION

You have learnt that the Order Carnivora contained 5 families, 22 genera and 33 species in Nigeria. The unit discussed identication keys to the families of Carnivora and the characteristics of the common types found in Nigeria. You also learnt that the Order Perissodactyla has 2 families namely Equidae and Rhinocerotidae. The Order contained animals with odd-toe that are generally large size with relatively simple stomach. They are hindgut fermenters (digest plant cellulose in their intestines and not stomach).

## 26.0 SUMMARY

This unit gives short descriptions of some of our most important members of the order carnivora and perissodactyla. The characteristic features of the common members of these orders (with which they are grouped into families) are given. Within each family there are many species and each species has a familiar name. Three well-known species discribed in the order Carnivora (Carnivores) are The Hyaena (*Crocuta crocuta*), the Lion (*Panthera leo*), the Leopard (*Panthera pardus*) and the Cheetah (*Acinonyx jubatus*). A well-known member of the order perissodactyla, black rhinoceros (*Diceros bicornis*) is also described.

## 27.0 TUTOR-MARKED ASSIGNMENT

1. Describe in details two members of the order carnivora.
2. Mention the families of animals in the order perissodactyla and give a description of a species of your choice.

## 28.0 REFERENCES/FURTHER READINGS

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife Ilorin Kwara State*: SAOLOG Printing Productions, 1982. 80pp.

Dunn, A. (1999). *Crashaka Gumti National Park, A Guide Book.* National Park Service Nigeria. 80pp.

Happold, D.C.D. (1987). *The Mammals of Nigeria*. Oxford: Clarendon Press. 402pp.

Thistleton, G.F. (1968). *Nature study of Africa, Mammals*. Evans Brothers Limited, Ibadan. 108pp.

Webb, G.C. (1957). *A Guide to West Africa Mammals*. Ibadan University Press, Nigeria. 40pp.

## UNIT 3 ORDER ARTIODACTYLA

**CONTENTS**

## 1.0 INTRODUCTION

The Artiodactyla are called 'even – toed' ungulates. This is because the body weight rests only on two (third and fourth) or one four digits (second to fifth) of each foot. They occur throughout the country and exhibit great diversity in size and structure. They are herbivores, which feed on grasses and herbs (grazers) or shrubs and trees (browsers). Two out of the three sub-orders under this order are represented in Nigeria. These are:

a. Suiformes that comprises the pigs (family suidae) abd hippopotamuses (family Hippopotamidae).
b. Ruminantia which includes the Giraffe (family Giraffidae), the water chevrotain (family Tragulidae), and the African Buffalo and Antelopes (family Bovidae).

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- know the families of animals in the order artiodactyla
- describe the external features of species in the order.

## 15.0 MAIN CONTENT

### 3.1 Order Artiodatyla

Members of this order occur throughout the country and exhibit great diversity in size and structure. They usually form large biomass. All are herbivores feeding on grasses (grazers) or shrubs and trees (browsers). Due to their generally large size and abundance they may have marked effect on local vegetation. The members of this important order, unfortunately, are now uncommon as a result of overhunting, poaching and destruction of their natural habitat. They are sub-divided into three sub-orders but only two of these (Suiformes and Ruminantia) are found

in Nigeria. The members of the sub-order suiformes are non-ruminants having simple stomachs while the ruminantia are ruminants having complicated digestive systems. The stomach is three chambered (Tragulidae) or four chambered (Happold, 1987).

### 3.1.1 Key to the Families of Artiodactyla in Nigeria (Happold, 1987)

1. Upper incisors present; horns absent; non – ruminant 2

   Upper incisors absent; horns present (except in Tragulidae and females of some Bovidae); ruminants 3

2. Muzzle broad; body without hairs; thickset limbs; two central and two lateral digits support weight of body; aquatic or semi-aquatic Hippopotamidae

   Muzzle elongated ending in flat disc around nostrils; body with few or many bristles, usually with mane on dorsal surface; two central digits on each foot support weight of body; two lateral digits do not support weight; terrestrial Suidae

3. Horms absent in both sexes; upper canine teeth elongated to form small tusks; three chambered stomach; small size (WT not more than 16kg) Tragulidae

   Horns present (except in females of some species – see table 1); upper canines absent; four – chambered stomach; size small to very large 4

4. Very large (WT up to 1180kg); neck and legs extremely elongated; horns very short and covered with skin and hair; two digits only on each foot; pelage with pattern of large dark blotches Giraffidae
   Small to large; neck and legs not particularly elongated; horns (if present) not covered with skin and hair; two central digits support weight of body, two lateral digits do not touch ground; pelage varied, but without pattern of large dark blotches Bovidae

**Table1: the suborders and families of Artiodacyla in Nigerian**

| Suborder/ Family | Digits on each foot* | No of stomach chambers | Ruminates | Horns | Teeth characteristics | No of species in Nigeria |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Suiformes** Suidae (pigs) | 2+2 | 2 | No | No | Upper and lower canines form tusks | 3 |
| **Hippopotamidae** (hippopotamuses) | 4 | 3 | No | No | Lower canines form tusks | 2 |
| **Ruminantia** tragulidae (chevrotain) | 2 + 2 | 3 | Yes | No | Upper canines form tusks | 1 |
| Giraffidae (giraffe) | 2 | 4 | Yes | Yes (covered by hair) | No upper incisors, no tusks | 1 |
| Bovidae (buffalo, antelopes) | 2 + 2 | 4 | Yes | Yes, but absent in females of some species | No upper incisors, no tusks | 25 |

* 2+2 = two digits touch ground; two digits higher up on back of foot do not touch ground.

Source: Happold, 1973.

### 3.1.2 Common Artiodactyls in Nigeria

The characteristic features of the common members of the order artiodactyla are the following. Four well-known species discribed in the order Carnivora (Carnivores) are the Hyaena (*Crocuta crocuta*), Lion (*Panthera leo*), the Leopard (*Panthera pardus*) and the Cheetah (*Acinonyx jubatus*).

### 3.1.3 Warthog (*Phacochoerus aethiopicus*)

**Identification:** The warthog is a large pig with an enormous head and well developed tusks. Males larger and heavier than females. Skin grey, with sparse scattered bristles; more of elongated bristles on dorsal surface of neck and shoulders. Head large relative to body, with flattened nose, long muzzle, large roundish warts on side of head below eyes and on side of muzzle. Curved tusks (elongated canine teeth) extend upwards and outwards from side of mouth, often forming a semi-circle. Ears and eyes small. Body elongated; legs short, each ending in four digits with small hoofs. Tail long and hairless, with tuft of coarse bristles at tip, tail usually held up vertically when running and walking.

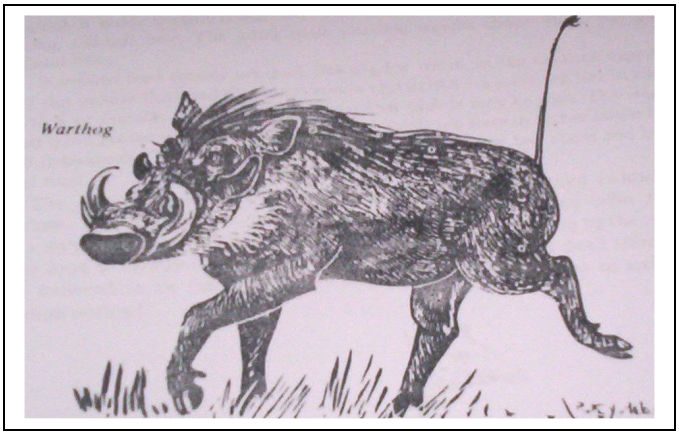



**Fig.3.1. Warthog (*Phacochoerus aethiopicus*).**

Warthogs live in the savannah habitat having preference for flood plains, riverine forests, and other places close to water. They have poor eyesight, good hearing and outstanding sense of smell. They live in small family groups consisting of females with their young; mature males are usually solitary. Group size ranges from 1-9. The warthog is strictly diurnal. They breed throughout the year.

### 3.1.4 Hippopotamus (*Hippopotamus amphibius*)

**Identification:** The hippopotamus is an enormous semi-aquatic mammal with a large head, solid barrel shaped body and short thickset legs. Skin brownish grey, turning to pink at muzzle, around eyes and on throat; hairless except on muzzle and inner surface of ears. Head large and broad; mouth with large gape capable of opening to at least $90^0$. Slit like nostrils on upper surface of muzzle; orbit protrude above the line of head, often only nostrils, eyes and ears are visible when hippopotamuses are in the water. Lower canine well developed to form small tusks, usually invisible unless the mouth is open. Limbs short; feet large and flat, each ending in four wide digits. Tail relatively short, with small terminal tuft of bristles.

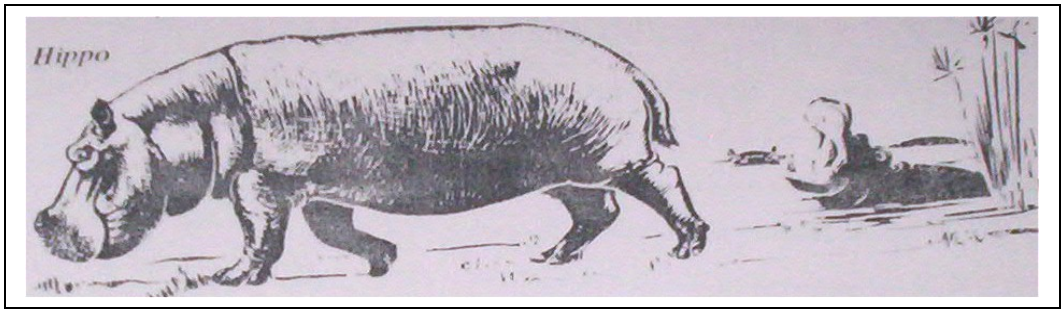



**Fig.3.2. Hippopotamus (*Hippopotamus amphibius*)**

Hippopotamus are large animals weighing 2 to 3,000kg on average. Hippos are mainly aquatic animals. During the day, they remain almost submerged in water thus preventing the skin (that lack sweat gland)

from drying out. They live in 'schools' which contain males, females and young. In Nigeria, each school usually contains 2-13 individuals. However, schools of 50-100 individuals have been recorded in East Africa. They feed exclusively on land. At night when the environment is cool, they move out of water to feed on grasses and herbs. They produce a single young every 2 years or so, after a gestation period of 230 days; and the young attain maturity at 4-5 years or later.

### 3.1.5 Giraffe (*Giraffa camelopardalis*)

**Identification:** Large size, relatively small body, long legs, very long neck, and sloping back. Dorsal pelage, flanks and neck beige or sandy with large bold chestnut-brown patches; ventral pelage paler with or without faint light brown patches. Pattern of patches is unique to each individual. Head elongated with large fleshy lips, and two short stumpy horns covered with skin and hair. Limbs long and slender with small brown irregular patches on upper half and without patches on lower half. Limbs terminate with two hooved digits. Tail short, with tuft of long dark hairs at tip.

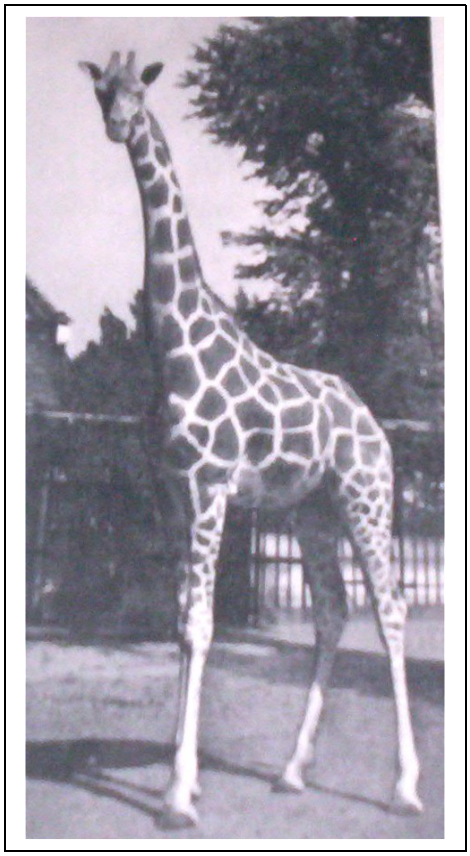


**Fig. 3.3. Giraffe (*Giraffa camelopardalis*)**

The giraffe is the tallest of all living mammals. The neck and legs are extremely long, and small horns covered with skin and hairs protrude from the top of the skull. Giraffe live in small groups or herds

containing fever than 10 individuals although past records show herds of 40-50 individuals.

### 3.1.6 African Buffalo (*Syncerus caffer*)

**Identification:** Body large and barrel-shaped; legs thickset; tail long with tuft hairs at tip. Males usually larger and heavier than female. A large heavily-built herbivore resembling domestic cattle. Body hair sparse, pelage colour black, brown, rufous (or reddish) brown to light brown; individuals of different colours occur in a single population. Head with wide forehead, hairless muzzle, and large outwardly projecting ears with fringe of hairs on lower edge. Horns in both sexes, heavy and flattened, with a broad boss covering most of the top of the head; horns extend outwards, upwards and slightly backwards, curling inwards at tip.

**Fig. 3.4. African Buffalo (*Syncerus caffer*)**

Buffaloes are entirely herbivorous. They live in herds which vary in size. The size and composition of herds change frequently; large herds split into smaller herds which may rejoin later. Large herds usually contain males, females, and young or only young males. Buffaloes are diurnals and nocturnal but rest under shade during the day. The gestation period is about 300 days and the young are born singly. More young are born in the middle of the dry season (January) than at other times.

### 3.1.7 Bush Buck (*Tragelaphus scriptus*)

**Identification:** A medium-sized antelope with short, dense, rufous to bright chestnut pelage, boldly patterned with white stripes and spots. Six to seven vertical white stripes and two horizontal stripes on each side of body; white spot on each cheek and above each foot; two white patches on lower part of neck, and white spots on upper parts of hind limbs.

Head with darkish band from muzzle to crown; ears large and mobile with dark band on inner surface and fringe of white hairs on front edge. Horns in males only, extending slightly backwards and outwards with half to one spiral, turning forwards at tip. Underside of tail white. The West African bushbuck is sometimes called the 'Harnessed Antelope' because the bold white marking hook like a harness.

Bushbuck usually live single or in pairs and only occasionally are three or four individuals seen together. A single young is born after a gestation period of about 120days. After parturition mothers hide their young.

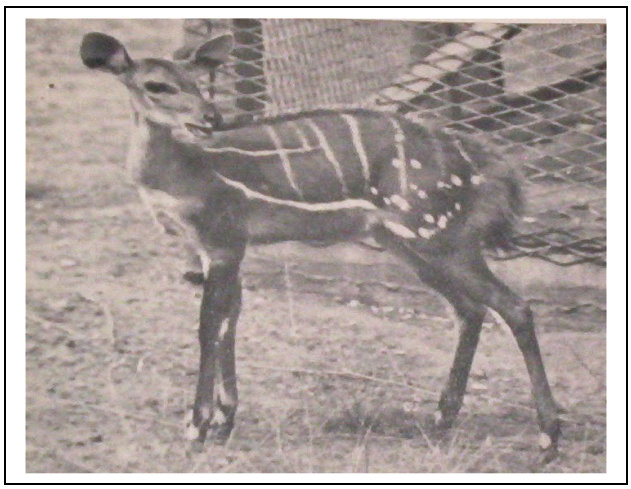


**Fig.3.5 A Female Bush Buck (*Tragelaphus scriptus*).**

### 3.1.8 Giant Eland (*Taurotragus derbianus*)

**Identification:** A very large (680kg) heavily-built antelope with long spiral horns. Pelage rufous to rufous-grey, with 12-14 white vertical stripes on each side of body. Small crest of black hairs on mid-dorsal line from back of head to middle of back. Head large with white lips, large broad rounded ears, and bright rufous patch on head. Long straight horns in both sexes, diverging slightly outwards with two or three well-developed spirals. Dewlap of varying size on vertical surface of neck. Black patches on posterior surface of forelimbs and on all limbs close to hoofs. Tail long with well developed black terminal tuft.

**Fig. 3.6. Giant Eland (*Taurotragus derbianus*)**

Giant Eland are timid, nocturnal animals. They feed at night and usually rest in the shade during the day. They have excellent senses of smell and hearing. Giant eland live in herds. Herd size ranges between 3 and 20, but herds of 20-100 individuals have been observed in the field. One young is born after a gestation period of about 270 days.

### 3.1.9 Maxwell's Duiker (*Cephalophus maxwelli*)

**Identification:** A small lightly-built duiker with slate-grey to grey-brown pelage; paler on neck, chest, and ventral surface. No white pelage on neck, chest, vertical surface, buttocks and anal region. Head pointed with dark muzzle, whitish-grey stripes; small dark head tuft. Slit-like opening of sub-orbital gland very conspicuous below each eye. Horns in both sexes, small and pointed. Tail dark and bushy, fringed with white hairs. The pedal gland in the foot lies in a sac at the end of a narrow canal.

**Fig.3.7. Maxwell's Duiker (*Cephalophus maxwelli*)**

Maxwell's duikers are wary and nocturnal although they are partly diurnal in activity. Duiker often rubs secretions from the suborbital gland on twigs and low growing branches in order to mark territories. Sometimes mutual marking of two individuals occur (usually between male and females). Maxwell's duikers live singly or in pairs in home ranges that do not overlap. One young is born after a gestation period of about 120 days. Young are capable of standing and walking within a few hours of birth. Maturity is attained at about three years. Breeding is probably once a year.

### 3.1.10 Kob (Kobus kob)

**Identification:** A medium-sized antelope with short golden-brown pelage. Ventral pelage white. Head golden-brown with black muzzle, whitish patch around each eye, white on lips and chin; large laterally placed ears, white on inner surface, brown on outer surface. Horns in males only, long and S-shaped in side view, extending upwards, then backward, and finally upward, again at tip, wider at tips than at base; heavily ringed at base. White patch on throat. Limbs similar in colour to body, black on front edge of forelimbs. Tail thin; dark on upper surface, white on under surface, with terminal tuft.

Kob are active during the day and night and do not necessarily seek shade during the hottest part of the day. Kobs are exclusively grazers. Kobs are frequently seen in herds. Male and females are seen singly but the majority live in herds which ranges between 2 and 32 in number. Some adult males establish individual territories during the breeding season and mate with any adult female which enter these territories. Herds of females and young are allowed inside the territorial boundaries while single males and bachelor herds are excluded. Young are born single after a gestation period of 180 days, ending in most months of the year.

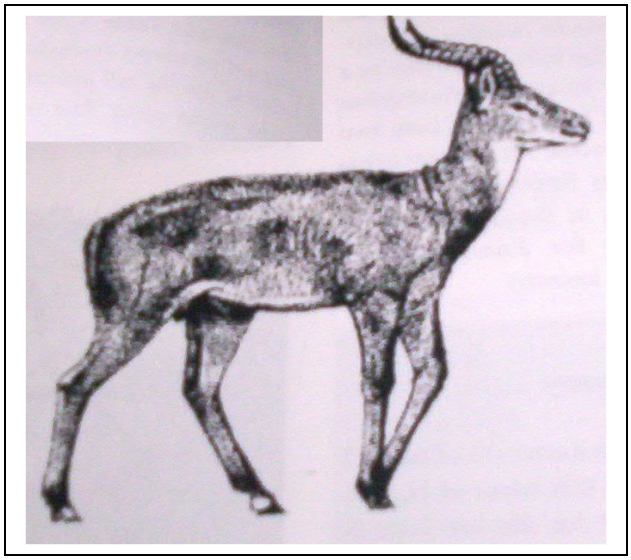


**Fig. 3.8. A Male Kob (*Kobus kob*).**

### 3.1.11 Roan Antelope (*Hippotragus equinus*)

**Identification:** The Roan Antelope is probably the most magnificent antelope of the Nigerian savannahs. Body large (227-272kg), heavily-built with heavy forequarters, thick deep-set neck, and long, relatively thin limbs. Dorsal pelage beige or dark tan with short chestnut-brown mane on neck. Ventral pelage white, with black on chest in some individuals. Head large, mostly black or dark with white lips and chin, white stripe in front of each eye from base of horns to cheek; short white stripe between eye and base of ear. Ears long and thin, white on inner surface, dark tuftof hairs on tip. Horns on both sexes, long, heavily ringed on basal half, rising upwards and backwards in smooth scimitar-shaped curve; horns in males larger than in females. Tail with long black terminal tuft.

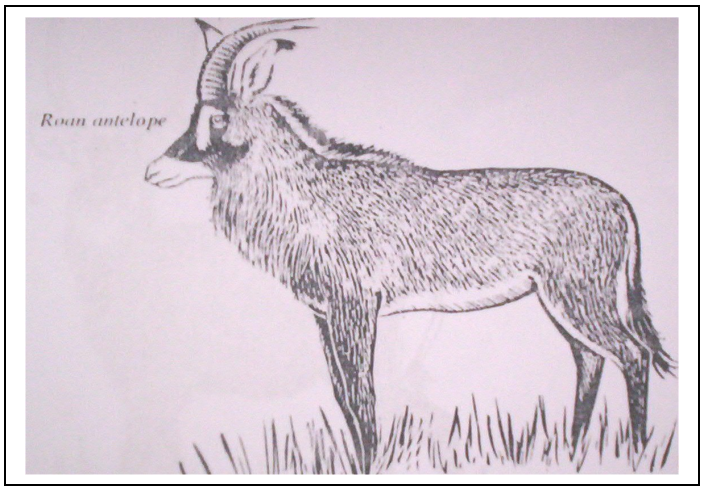



**Fig. 3.9. Roan Antelope (*Hippotragus equinus*).**

Roan Antelope live in savanna woodland up to 15km from water. They are browsers and grazers. Solitary individuals are frequently seen, and herds of up to 20 animals have been observed in the field. The litter size is one after a gestation period of about 270 days.

## 16.0 CONCLUSION

This unit discussed the even-toed ungulates. They are herbivores that feed on grass and herbs or shrubs/tress. Two sub-orders (Suiformes and Ruminantia) are present in Nigeria. The unit also discussed key to the families and features of the common ones that occur in the country.

## 17.0 SUMMARY

The artiodactyla are called 'even–toed' ungulates. This is because the body weight rests only on two digits (third and fourth) or on four digits (second to fifth) of each foot. They occur throughout the country and exhibit great diversity in size and structure. They usually form large biomass. All are herbivores feeding on grasses (grazers) or shrubs and trees (browses). The members of this important order, unfortunately, are now uncommon as a result of overhunting, poaching and destruction of their environment. They are sub-divided into three-orders but only two of these (Suiformes and Ruminantia) are found in Nigeria. There are thirty-two species of Artiodactyla in Nigeria. Important members of this order are Warthog, Hippopotamus, Giraffe, Buffalo, Eland, Duikers, Kob and bush-buck.

## 18.0 TUTOR-MARKED ASSIGNMENT

1. The members of the order Artiodactyla are also known as 'even-toed ungulates', why?
2. List the sub-orders under Artiodactyla
3. The family Giraffidae is under the sub-order……
4. Mention the families of animals in the order artiodactyla and give a description of a species of your choice

## 7.0 REFERENCES/FURTHER READINGS

Ajayi, S. S. and Milligan, K. R. N. (1975). *The Wildlife of Nigeria: A Guide to Yankari and Borgu Game Reserves*. Department of

Forest Resources Management, University of Ibadan, Ibadan. 40pp.

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife Ilorin Kwara State*: SAOLOG Printing Productions, 1982. 80pp.

Dunn, A. (1999). Crashaka Gumti National Park, A Guide Book. National Park Service Nigeria. 80pp.

Happold, D.C.D. (1987). *The Mammals of Nigeria*. Oxford : Clarendon Press. 402pp.

Happold, D.C.D. (1973). *Large Mammals of West Africa*. London: Longman.

Omitoyin, B. O. and Alarape, A. A. (2003). *West African Fish and Wildlife. Ibadan Distance Learning Series*. University of Ibadan: Distance Learning Centre. 72pp.

Thistleton, G.F. (1968). *Nature Study of Africa, Mammals*. Evans Brothers Limited, Ibadan. 108pp.

Webb, G.C. (1957). *A Guide to West Africa Mammals*. Ibadan University Press, Nigeria. 40pp.

## UNIT 4 PRIMATES AND PROBOSCIDEA

### CONTENTS

## 16.0 INTRODUCTION

The order primates contain over 700 species of animals. Although there is variation in there sizes, colour, shapes, intelligence and habits, there are features common to all primates. This order includes the families Losrisidae (Pottos and Angwantibo); Galagidae (Galagos); Cercopithecidae (Tantalus, Patas, Colobus monkeys, Drill and Baboon); and Pongidae (Gorilla and Chimpanzee). The members of the order proboscidea are the elephants. Elephants are probably the best known of all African mammals. Their vast size and bulk (reaching 11ft and 7 tonnes) seem almost improbable and a large herd of elephant is a magnificent sight not easily forgotten. There are two living species; the African elephant (*Loxodonta africana*) and the Indian elephant (*Elephas maximus*) are the only survivors of an order that was extremely successful from about 26 million to 1 million years ago.

## 17.0 OBJECTIVES

At the end of this unit, you should be able to:

- know the families of animals in the order primates and proboscidea
- describe the external features of species in the two orders.

## 18.0 MAIN CONTENT

### 3.1 Order Primates

The primates are probably the most highly developed order of mammals. They have relatively large complex brains, binocular vision, nails instead of claws on most digits, an opposable first digit enabling them to grasp objects with the hand or the foot. Primates are adaptable intelligent mammals. Most species live in stable cohesive social groups. They have a variety of vocal sounds, expressions and actions/movements with which they communicate with other members of the same species. They are mainly arboreal species inhabiting the rainforests. There are four families represented in Nigeria. These are:

1. Lorisidae }

2. Galagidae prosimians).
3. Cercopithecidae (true monkeys) and
4. Pongidae (e.g Gorilla and Chimpanzee)

### 3.1.1 Key to the Families of Primates in Nigerian

1. Size very large, HB up to 220cm; tail absent; no ischial callosities on buttocks; arms longer than legs Pongidae

   Size medium to small, HB less than 100cm, ischial callosities on buttocks present or absent; legs as long or longer than arms 2

2. Size medium, HB usually 40-100cm; ischial callosities present; eyes relatively small; post-orbital bar forms a plate on side of skull separating orbit from temporal fossa; mostly diurnalCercopithecidae

   Size small, HB usually 10-39cm, no ischial callosities; eyes relatively large; post-orbital bar does not form a bony plate on side of skull; mostly nocturnal 3

3. Fore- and hind – limbs approximately equal in length; T much shorter than HB and barely visible; small ears mostly hidden by fur Lorisidae

   Hindlimbs longer than forelimbs; T longer than HB; large ears projecting outwards, from side of head Galagidae

### 3.1.2 Common Primates in Nigeria

The characteristic features of the common members of the order primates are the following. Three well-known species described in the order Anubis baboon (*Papio anubis*), Chimpanzee (*Pan troglodytes*) and Gorilla (*Gorilla gorilla*).

### 3.1.3 Anubis Baboon (*Papio anubis*)

**Identification:** A large heavily–built monkey, with the back sloping downwards from shoulders to base of tail. Pelage coarse and dense, olive-brown, often speckled because of alternating dark and light bands of hairs. Hair on neck, shoulders, and chest of adult males elongated to form a mane. Head large with small eyes, and dull black-skinned muzzle and lips. Ears small, usually hidden by the pelage. Fore- and hind-limbs

more or less equal in length, hands and feet black. Large hairless buttocks in adults; buttocks of females become very swollen and red during oestrus. Tail fairly long, sparsely covered with hair, often held horizontally and bending downwards at the tip. Males are significantly larger than females.

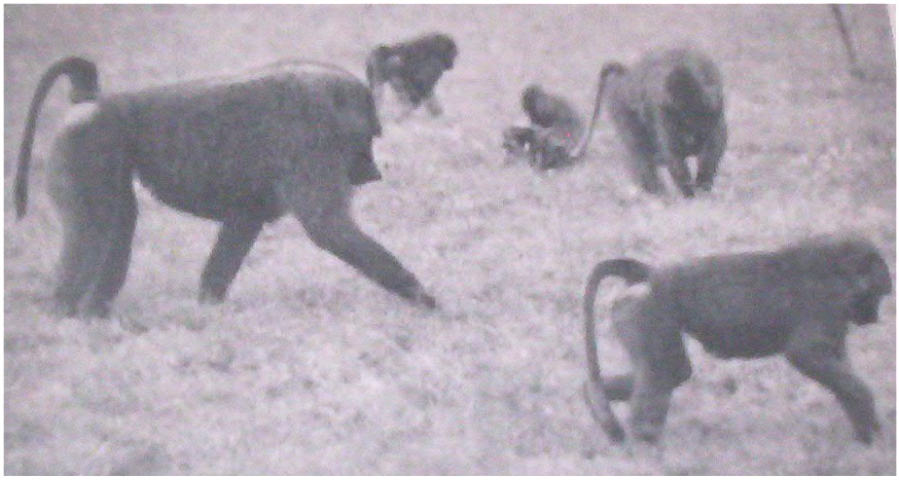


**Fig. 4.1. Anubis baboon (*Papio anubis*). Source: Thistleton, 1968.**

Anubis baboons are found in wooded savannahs and on rocky inselbergs. They feed on a wide variety of fruits, bulbs, roots, shoots, insects and small vertebrates. Despite their large size, baboons are able to climb trees quickly with age, and scramble up and down rocky slopes with great agility. At night baboons rest on topmost branches of tress. Baboons live in groups – troops. A troop, which may number as many as forty individuals or more, is composed of females and their young, adolescents of both sexes, and a number of adult males.

There is well developed social hierarchy amongst the troops of baboon which is based on dominance relationship between individuals. The young are born single and are carried by the mother close to her chest. Later the young may be carried on the back near the tail. Baboons produce a variety of sounds although most characteristic is a dog-like bark associated with alarm and danger.

### 3.1.4 Chimpanzee (*Pan troglodytes*)

**Identification:** This description is in respect of forest chimpanzee, *Pan troglodytes verus*. A large robust ape. face pale, with dark mask around eyes and large pale ears. Small nostrils opening above a large forwardly projecting upper lip; nostrils closer to eyes than to mouth. Top of head rounded without sagittal crest. Body and legs with sparse black hairs, turning grey on some parts of the body in old individuals. Hands hairless, with long fingers. Walks and runs with weight on sole of foot

and on middle phalanges of fingers. When standing upright, forelimbs do not reach level of knees. Buttocks hairless, pale, and especially of occipital and nuchal crests.

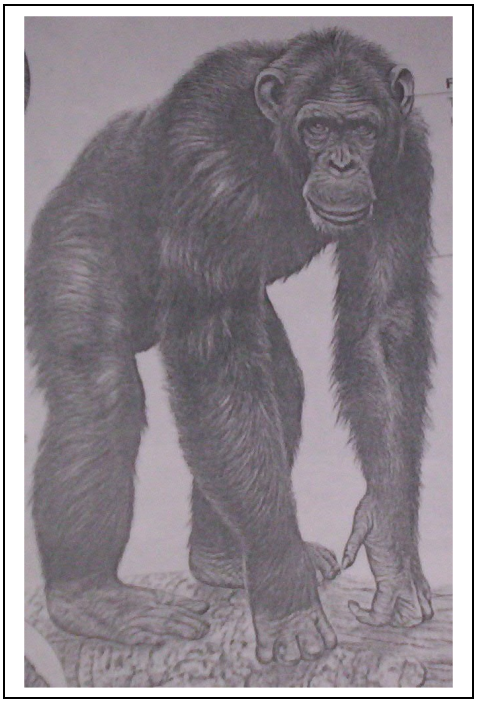


**Fig. 4.2. Chimpanzee (*Pan troglodytes*).**

Chimpanzees are arboreal and terrestrial. They normally walk and run on all four limbs but can do same on the hind limbs for short distances. At night they make nest in trees using twigs and branches to form a simple platform. Each nest is normally used for only one night. Chimpanzees live in groups of 2-25 individuals. The groups may be of the following types:

- Adult male and female groups
- Male groups
- Female and young groups
- Mixed groups of all ages and sexes.

They have a wide variety of vocal sounds, postures, expressions and activities with which information is passed between individuals and groups. Chimpanzees are probably the most intelligent of all primates. They feed on fruits and nuts and sometimes on leaves and insects. Sticks and twigs at times are used to procure food. They usually have one young after a gestation period of 236 days. Adult size and maturity is attained in 7 – 9 years.

### 3.1.5 Gorilla (*Gorilla gorilla*)

**Identification:** The Gorilla is the largest of all the primates. The female is considerably smaller than males. Head large and black, face hairless with prominent supraorbital ridge. Large round nostrils closer to mouth than to eyes. Ears small, mostly hidden by pelage. Crown of head conical due to development of bony occipital crest on head, nuchal crest on neck, and their associated muscles. Body thickset and robust, chest deep and barrel-like, back sloping downwards towards pelvic region. Forearms long, thickset and powerful; hands broad with short fingers. Hindlimbs thickset, shorter than forelimbs. Pelage typically black, short, dense, and soft; hairs longer on forearms, chest and shoulders, especially in males. Adult males may have white or silver hairs on back forming a 'saddle'. Locomotion is similar to that of chimpanzee.

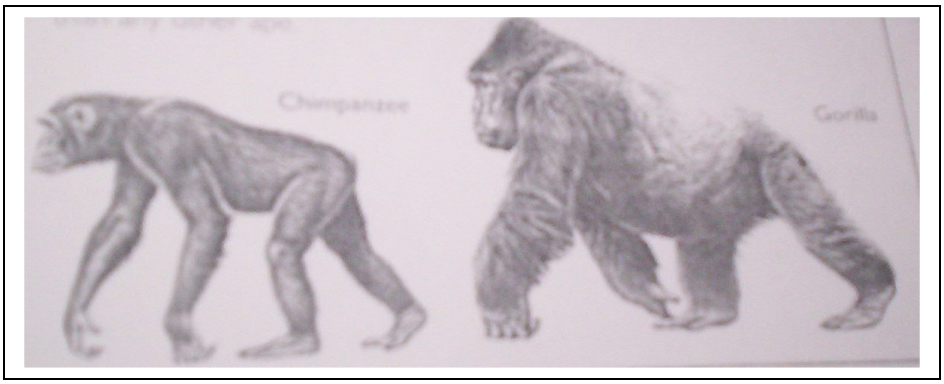



**Fig. 4.3. The Gorilla (*Gorilla gorilla*) and Chimpanzee in walking posture.**

Gorillas live in lowland and montane rainforests. They are mostly terrestrial, although they also climb trees with caution. At night they sleep in nests, similar to those of chimpanzees, on the ground or in trees. They are entirely herbivores, feeding on fruits, stems, leaves, and bark of trees. Gorilla groups ranging between 5 and 30 individuals are composed of one or more males, several females and sub-adult males, and young. Solitary males are fairly common. Each group is led by a dominant male who never-the-less allows other males, to remain in the groups. There is a well-developed communication between members of the group through facial expressions, postures and vocalisation. However, gorillas are generally much quieter animals than the noisy chimpanzees. Sometimes males may stand bipedally and show an intimidation display of chest-beating and roaring. Gorillas have a gestation period of 255 days, and normally have a simple young at parturition. Sexual maturity is attained at about 8 years.

## 3.2 Order Proboscidea

Elephant possess many unique and specialised characteristics. The nose and upper lip are elongated to form mobile and extremely sensitive trunk which is used for breathing, gathering food, squirting water,

communication between individuals by touch, posture and for combat. On either side of the trunk the third upper incisor tooth is elongated to form a tusk made entirely of enamel (but the female Indian elephant has no tusk). The size of the tusks varies greatly depending on sex, age, rate of growth and locality (Happold, 1987). The tusks are extremely hard and are used to gather food, strip barks from trees, carry and support objects and for defense. Inside the mouth, the large check teeth are modified to cope with the enormous quantity of food that have to be chewed. During its life an elephant has six check teeth on each side of upper and lower jaws. However, only one pair of check teeth is used at a time and as each tooth wears down it moves forward in the jaw and is replaced by a new tooth from behind. Each canine tooth is about 30cm long and about 10cm wide and is composed of horizontal base of enamel and dentine, which forms a stronger grinding surface (Laws, 1996).

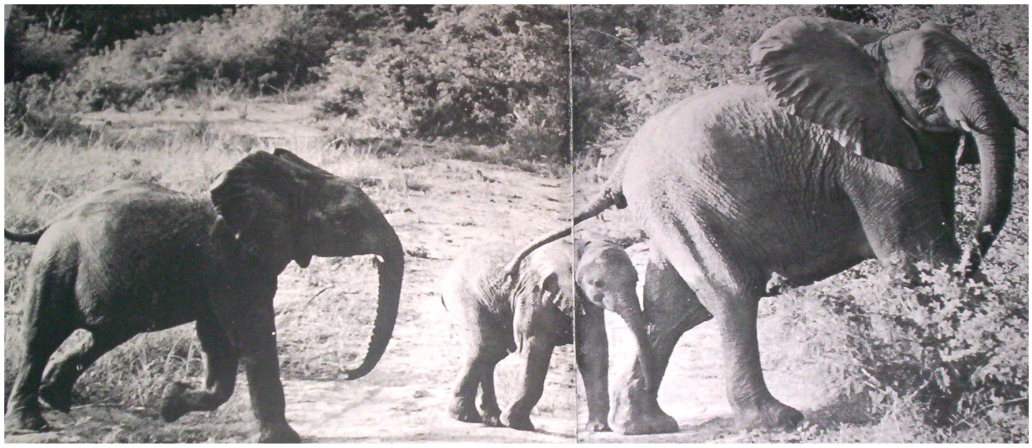


**Fig. 4.4. The Elephant (*Loxodonta africana*) (Source: Ajayi and Milligan, 1975).**

The large domed-head has small eyes and large ears, which can be flapped forward and backward. The skin is thick and wrinkled without sweat glands and with sparse coarse bristles. The limbs are necessarily thickset to support the weight of the body, and the feet are flat and almost circular in outline with four or five flattened nails. The tail is short with a tuft of black bristles. Due to their large size and food requirement elephants play a significant role in the ecosystem. They are entirely herbivorous eating a wide range of grasses, leaves and fruits. Elephants spend 12 to 16 hours foraging and eating each day. An adult elephant consumes 180–270kg of vegetation each day (Happold, 1987). Elephants break branches, rip bark from trees with their tusks and even knock down whole trees. The sheer volume of food required and the destructive method by which they obtain food can result in considerable changes in the structure and species composition of the habitat when elephant becomes too numerous. In several regions of Eastern Africa where elephant population are too large there has been widespread

alteration of the environment making it unsuitable for the elephant as well as for many other species of birds and mammals.

Elephants need to consume large amount of food everyday due to their inefficient digestive system. They produce copious amount of dung each day that contain a lot of undigested stems, seeds and other vegetable materials. Elephants swallow their food without much chewing and most of the breakdown is by fermentation in the gut. This process results in the production of lots of gasses and is thought to be responsible for the 'rumbling sounds', which can quite often be heard when elephants are nearby. The dung act as an excellent environment for germination of seeds, which pass unharmed through the elephant's digestive system. In this way the seeds are dispersed away from the parent plant and given rich moist 'compost' for germination (Happold, 1987).

Elephant usually live in groups or herds. Herd size varies depending on population density, location and season. Herds are composed either of females, immatures and juveniles or only males. Herds split and join so that very large herds are usually temporary aggregation of smaller herds. Herds also break up into smaller ones during food scarcity. At puberty males leave the mother and young herds to join the bachelor herd of males. Males join the female herd for mating (Happold, 1987).

An elephant delivers a single offspring after a period of 22 months (approximately two years). The offspring (calf) suckles for about 2 years and matures at 14-20 years depending on the environment. Elephants continue to grow even after sexual maturity; females (cows) reach adult size at 20 – 25 years but bulls (males) continue to grow and increase in weight until 30 – 35 years (laws and Parker 1968). Female elephants can produce one calf in every 4 years, although more typically the time interval between calves is 6 – 10 year. The slow rate of breeding and growth in elephants means that many years are required to increase population numbers (Happold, 1987). The only species in Nigeria is the African elephant, *Loxodonta africana*. Then there are the forest sub-species, *L. african cyclotis* and the savanna sub-species, *L. africana oxyotis*. The distinctive characteristics of the two sub-species are as shown in the following table.

**Table 4.1: distinctive feature of the forest and the savannah sub-species of elephants**

| | Features | L African cyclotis | L. African oxyotis |
|---|---|---|---|
| 1 | Tusks | Thinner, lighter and comparatively straighter (point downward) | Thicker, heavier and generally curving forward |
| 2 | Trunk | Dense covering of | Sparse bristles |

| | | | |
|---|---|---|---|
| | and Head | bristles on head and upper part of trunk | |
| 3 | Ears | Comparatively small and rounded at base (about 90cm from top up to base). | Comparatively large and pointed at base (about 150cm from top to base). |
| 4 | Size | Smaller in size and weight | Larger in size and weights |

**Source: Happold, 1987.**

## 19.0 CONCLUSION

You learnt that the Order Primates is the most highly developed order of mammals with large complex brains, binocular vision, nails and enabling hands for grasping objects. The unit discussed identification keys to the families found in Nigeria and their characteristics. The unit also discussed the Order Proboscidae and their characteristics.

## 5.0 SUMMARY

The primates are the most adaptable intelligent group of mammals having relatively large complex brains, binocular vision and nails instead of claws on most digits. They have opposable first digit enabling them to grasp objects with the hand or the foot. Most species live in stable cohesive social groups equipped with an assortment of vocal sounds, expressions and actions/movements with which they communicate within the group. The four families represented in Nigeria are Lorisidae, Galagidae, Cercopithecidae (true monkeys) and Pongidae (e.g. Gorilla and Chimpanzee).
The elephant is a popular African mammal with vast size. The two living species of Elephant are the African Elephant (*Loxodonta africana*) and the Indian Elephant (*Elephas maximus*). The distinctive features of the Elephant are the tusk, the trunk and the size (of the ears and body). Elephants usually live in groups (called herds). The forest sub-species cyclotis with downward pointing thinner and lighter tusks is smaller in size than the savannah sub-species (cycloits) with forward pointing thicker and heavier tusks

## 6.0 TUTOR-MARKEDASSIGNMENT

1 a. Describe in details a member of the order proboscidea.
b. Enumerate the distinctive features of the sub-species under this order.
2. List the families in the order primates and give the description of a species of your choice.

## 7.0 REFERENCES/FURTHER READINGS

Ajayi, S. S. and Milligan, K. R. N. (1975). *The Wildlife of Nigeria: A Guide to Yankari and Borgu Game Reserves*. Department of Forest Resources Management, University of Ibadan, Ibadan. 40pp.

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife Ilorin Kwara State*: SAOLOG Printing Productions, 1982. 80pp.

Dunn, A. (1999). *Crashaka Gumti National Park, A Guide Book. National Park Service Nigeria*. 80pp.

Happold, D.C.D. (1987). *The Mammals of Nigeria*. Oxford: Clarendon Press, 402pp.

Laws, R.M (1966). *Age Criteria for the African Elephant*, *Loxodonta africana. E. Afr. Wildl. J.*4, 1 – 37.

Laws, R.M and Parker, I.S. C. (1968). *Recent Studies on Elephant Populations in East Africa Symp. Zool. Soc. Lond*. 21, 319 - 59.

Thistleton, G.F. (1968). *Nature study of Africa, Mammals*. Evans Brothers Limited, Ibadan. 108pp.

Webb, G.C. (1957). *A Guide to West Africa Mammals*. Ibadan University Press, Nigeria. 40pp.

# UNIT 5 INSECTIVORA, CHIROPTERA, PHOLIDOTA, LAGOMORPHA, REPTILES AND BIRDS

## CONTENTS

## 1.0 INTRODUCTION

The unit discusses the order Insectivora (insect-eating mammals), the bats, order Chiroptera (which are the only mammals possessing the ability to fly), the pangolins, order Pholidota (mammals with overlapping reptilian-like scales), and the hares and rabbits that belong to the order Lagomorpha. A few common reptiles and birds are also discussed.

## 2.0 OBJECTIVES

At the end of this unit, you should be able to:

- be able to identify species of animals in orders Insectivora, Chiroptera, Pholidota and Lagomorpha
- know the external features of species in these orders
- have a general knowledge about birds and reptiles.

## 3.0 MAIN CONTENT

### 3.1 Order Insectivora

The insectivores are primitive insect-eating mammals which occur in most parts of the world other than Australia and South America. They are small (less than 1kg in weight) with short limbs, four or five unspecialised digits on each foot, an elongated nasal region, and characteristic teeth adapted for holding and crushing invertebrate prey. The following families are represented in Nigeria.

- Soricidae (shrews have soft dense pelage). They are the commonest insectivores in Nigeria
- Tenrecidae (Otter-shrews, have soft dense pelage)
- Erinaceidae (Hedgehogs, have thickened hairs which form spines on the dorsal surface of the body).

The majority of the insectivores are shrews. They are mostly solitary. It is rare to see more than two individuals together outside the breeding season.

### 3.1.1 Key to the Families of Insectivora in Nigerian

1. Dorsal surface and flanks covered with spine Erinaceidae
   Dorsal surface and flanks not covered with spines 2

2. HB 200-300; CI about 60; tail laterally flattened; aquatic habit enrecidae
   HB not more than 150; CI not more than 40; tail cylindrical, not laterally flattened; terrestrial habits Soricidae

### 3.1.2 African Giant Shrew (*Crocidura flavescens*)

**Identification:** One of the two largest shrews in Nigeria; only the black giant shrew is (usually) slightly larger. Dorsal and ventral pelage dark smoky-grey to ginger-brown in Southern Nigeria; pale grey in Northern Nigeria. Tail thick at base tapering towards tip, relatively long with scattered white hairs; about 70% HB. Very strong musky secretions give a distinctive and rather unpleasant smell. Skull large and heavy, flat in profile.

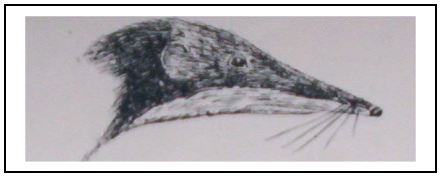


**Fig. 5.1. Head of the Shrew show the Pointed nose.**

**Fig.5 2. Elephant Shrew.**

African giant shrews are rarely found in the rainforest and natural savannah. In other words, they are common in man-made habitats and less common in natural habitats. The litter size is usually four young.

## 3.2 Order Chiroptera

Chiroptera means ‘hand-winged’. Bats are the only mammals possessing the ability of flight. Their wings consist of a fold of skin which stretches from the fingers along the arms and sides of the body to the

hind legs. The wing is a membrane of naked living skin supported by the elongated second, third, fourth and fifth digits of the forelimbs. The hind limbs, in contrast to the forelimbs, are short with well-developed claws which are mainly used to suspend the body head downwards when at rest. The bodies of many bats are so small and light.

Bats are almost exclusively nocturnal. They fly at night in search of food, leaving their place of rest in the evening and returning home as the sun rises. They either live in large colonies or they may live alone in small families. In Nigeria, they are found in all vegetation zones. There are two main suborders under chiroptera. They are:

(i) Micro-chiroptera (insectivorous bats)
(ii) Mega-Chiroptera (fruit-eating bats)

The fruit bats are fairly large and can cause serious damage to commercial fruit crops. The insect-eating bats are generally smaller than the fruit bats.

### 3.2.1 Key to the Suborders of Chiroptera

1. Second finger terminating in claw; ear couch forms complete ring around external ear opening; tragus absent; tail absent or very small; interfemoral membrane poorly developed; no nose-leaves or fleshy outgrowths on nasal region or forehead; large eyes; cheek teeth simple without well-developed cusps Megachiroptera

2. Second finger without terminal claw; inner and outer margins of ear couch arise at different points and are not joined at base; tragus usually present; tail is long in most species with well-developed interfemoral membrane (except family Megadermatidae); nose-leaves or fleshy outgrowths present in some families; eyes mostly small and obscure; cheek teeth with well-developed cusps Microchiroptera

### 3.2.2 Straw-coloured Fruit-bat (*Eidolon helvum*)

**Identification**: Dorsal pelage dull yellow or brownish-yellow; hairs dark at base with dull yellow tips; ventral pelage paler. Head is large with naked muzzle and lips; large eyes. No white basal ear-tufts, no white facial markings and no white epaulets. Wings large and dark; dorsal pelage extends along upper border of humerus. Palate with four undivided ridges, two narrow and two wide, followed by four divided but well-defined ridges which extend to outer margins of palate.

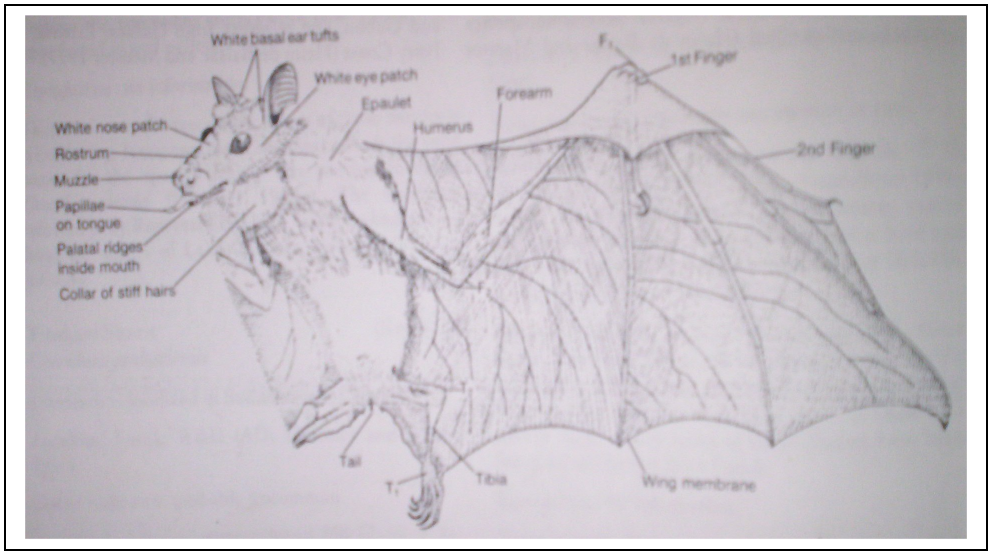



**Fig. 5.3. Identification characteristics of fruit bats (Source: Happold, 1987).**

Straw-coloured fruit bats are probably the most popular of Nigerian bats because they live in large colonies of up to half a million individuals. They eat a wide variety of fruits and also leaves, nectar, and sap. They breed once in a year.

## 3.3 Order Pholidota

Pangolins (Scaly Ant-eaters) are mammals with overlapping reptilian-like scales (made from hairs cemented together) on the back sides, tail and top of head. The under side is soft and bears a few hairs. They occur throughout West Africa. When disturbed, pangolins curl up into a tight ball (like the hedgehog) completely protected by the scales, and strong muscles of the abdomen and sides of the body prevent them from being uncurled by a potential predator.

Pangolins have long slender snouts. Inside the mouth there are no teeth, but the tongue is very long, narrow and sticky, and can be protruded to a length almost equal to that of the body. The tongue is used to obtain the food, which consists of ants and mostly termites. The legs are short and some of the toes are clawed. The forelimbs in particular are very powerful and are used to break open the nests of ants and termites, and to rip bark from trees. The ground living pangolins tend to be large with massive scales and thick non-prehensile tails. The tree living pangolins tend to be smaller with more delicate scales and long, thin prehensile tails (i.e. the tree living pangolins can hang from a branch by its tail). Pangolins are usually solitary and nocturnal.

### 3.3.1 Tree Pangolin (*Manis tricuspis*)

**Identification**: Top of head, back, sides of body and tail with small pale overlapping scales; 19-23 rows of body scales; width of scales in middle of back 12-13; lateral scales smaller. Each scale with three cusps or points on posterior edge, central cusp large and pointed, lateral cusps small and poorly defined especially in old individuals. Head with pointed, naked muzzle; eyes small; ears very small. Limbs short and thickset, with long strong curved claws. Ventral surface with sparse whitish-grey or pale brown hairs. Tail long and prehensile, about 150% of HB, slightly flattened horizontally with scales on upper and lower surfaces.

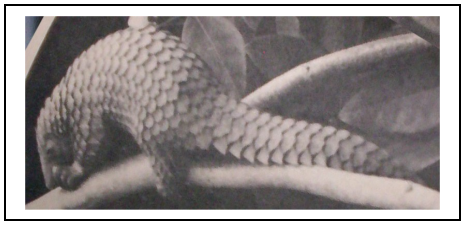


**Fig. 5.4. The Pangolin**

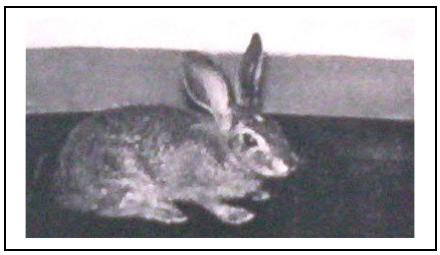


**Fig. 5.5. The Hare**

Tree pangolins live in primary and secondary forests. They spend most of their time in trees. Occasionally they descend to the ground to feed or to reach another tree, but are not well adapted for terrestrial locomotion. Tree pangolins are solitary but sometimes live in pairs, and young remain with their mothers for about four months. A single offspring is born after a gestation period of six months. At birth, the scales are soft and the eyes are open like in grass cutters.

## 3.4 Order Lagomorpha

Hares should not be confused with rabbits, especially as the latter are not usually found in Africa. In Nigeria, the order Lagomorpha is represented only by two species of hares (*Lepus capensis* and *Lepus crawshayi*). They are small animals with long silky ears, soft dense pelage, short fluffy tails, and long powerful hindlimbs. Their teeth are akin to those of rodents, but there are two notable differences, vis:

- There are four upper incisors, a large anterior pair and a smaller posterior pair.
- There are six check teeth on each side of the skull.

The large anterior upper incisors, like those rodents, are unusual since they continue to grow throughout the life of the animal. However, they

don't overgrow because they are worn down as fast as they grow. Hares have a total of teeth, more than that in any rodent.

Dental formula $\frac{2\ 0\ 3\ 3}{1\ 0\ 3\ 3} = 30.$

They live in grassland savannas and in derived savanna habitats in the rainforest zone. They are mainly herbivores, living on fresh grasses and herbs.

### 3.4.1 Crawshay's Hare (*Lepus crawshayi*)

**Identification**: Generally similar in size and form to domestic rabbits. Dorsal pelage rufous-brown flecked with black; hairs with four conspicuous bands-pale rufous at base followed by black, whitish-yellow, and black at tip. Dense white or pale rufous underfur. Flanks paler with fewer black-tipped hairs. Ventral pelage creamy-white. Dorsal pelage of neck bright rufous. Head similar to back, sometimes with white patch on forehead; chin white; throat pale rufous-brown. Eyes large and brown. Nostrils large, more or less directly above incisor teeth. Ears long and slender covered with short dense brownish-black hairs, fringed with greyish-white hairs on front edge and (in some individuals) rufous hairs on tip. Upper incisor teeth angled to each other, with well-defined groove on anterior surface filled with dentine. Hindlimb, long and strong. Tail short and fluffy, black on dorsal surface, white on lateral and ventral surfaces.
Crawshay's hares are entirely herbivorous. They tend to be solitary. One or two young are born after a gestation period of 5-6 weeks.

## 3.5 Reptiles and Birds

Nigeria has interesting diversities of species of reptiles and birds. The reptiles are a smaller, but very important class of land animals. Reptiles are covered with scales, not hair and most of them lay eggs. The young can fend for themselves as soon as they hatch and seldom receive any parental care. Reptiles are "cold-blooded" animals since their body temperature changes with that of the environment, air or water in which they live. Although some reptiles (the crocodiles and some snakes) live in water, they must always come to land to lay their eggs. Snakes are generally considered to be deadly animals to be killed at sight. This fear is unfortunate since many snakes are in fact not poisonous. Sometimes legless lizards are mistaken for snakes! The Nigerian parks have rich birdlife that can easily be seen or their calls heard during any short drive. Birds have exceptionally good eyesight and huge eyes relative to their size. A few common reptiles and birds are discussed here.

### 3.5.1 Nile Monitor Lizard (*Varanus niloticus*)

The Nile monitor lizard is the largest of all African lizards. It has a characteristic stout body, powerful limbs with sharply clawed feet, and long tail flattened for swimming. It is a largely aquatic reptile which spends the early hours of each day basking in the sun, and only after attaining optimal body temperature does it go hunting for food, It feeds on crabs, frogs, fish, smaller reptiles and birds. It has preference for reptile eggs and will excavate the nests of crocodiles where feasible. It also feeds on carrion and smaller prey may be swallowed whole.

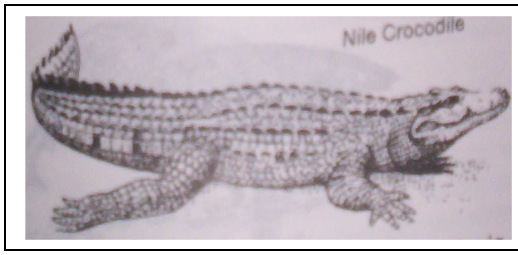



**Fig. 5.7. The Nile Crocodile**


**Fig. 5.6. The Nile Monitor Lizard.**

### 3.5.2 Nile Crocodile (*Crocodilus niloticus*)

Crocodiles are members of the family Crocodylidae. Crocodiles, the largest African reptile, are common in rivers. Where prey is abundant, crocodiles can attain a length of up to 6m and when fully grown can weigh up to 990kg. It has powerful feet and claws to clamber up the riverbank with surprising speed. The female also uses her claws to dig a nest hole for her eggs. The muscular tail propels and steers the crocodile through water. It is a weapon too: one whop-like blow can knock even a large animal to the ground. The nostrils set on a raised part of the snout, enable the crocodile to breathe when the rest of its body is submerged. A flap seals the nostrils to keep out water during dives. The eyes, like the nostrils, project above the head, so that the crocodile can keep a lookout for prey while almost fully submerged in the water. Crocodile is one of Africa's most fearsome predators.

With its massive jaws, the Nile crocodile poses a deadly threat to other animals as it lurks beneath the surface of the water, waiting to snap them up. The simple teeth rip huge chunks out of prey. The teeth grow continuously, and after about two years the worn teeth are forced out by sharp new ones beneath them.

The crocodile cannot chew its food due to its long stabbing teeth that lack cutting or grinding edges and again it has no tongue with which it could manipulate the food in the mouth cavity. Instead, it simply rips chunks off the carcass and swallows them whole. If the animal is too large to be consumed immediately, the remainder is stored underwater, or edged between rocks or submerged wood.

Unlike mammals and birds, reptiles are unable to regulate their body temperature internally. Therefore, crocodiles generally spend each morning basking in the sun to raise the body temperature. As the ambient temperature rises during the day the crocodile opens its month to let heat escape and may also look for shade or dive into the water where it is cooler. Crocodiles produce 25-100 young at the end of gestation period of 95-100 days. The young reach sexual maturity in 7-15 years.

### 3.5.3 Bush Fowl (*Francolinus bicalcaratus*)

The bush fowl belongs to the family Phasianidae. It is also known as francolin. There are about 12 different species of francolin in West Africa but this species is the only one that is common or widespread. It has brownish plumage but a closer look reveals a beautiful patterning of the feathers, those of the under parts with markings that are distinctive for this species. There are usually two spurs above the hind toe of old males. It is distributed throughout West Africa except in thickly forested parts. These ground living birds spend most of their time moving in small parties through grass, farms and the like in search of food. If disturbed they take to the wing with a whirring low flight, often calling hoarsely at the same time. Breeding occurs in the dry season when five to six eggs are laid in a natural hollow in the ground.

### 3.5.4 Ostrich (*Struthio cainelus*)

The Ostrich is a member of the order Ratities (consisting of flightless birds) and the only living representatives of the sub-order Struthiotes, family Struthionidae. They are endemic to Africa, but occur in captivity in many countries of the World. It is valued for its feathers, meat, leathers as well as a tourist attraction.

The Ostrich is the largest living bird, with the male attaining heights up to 3m and weighing more than 150kg. The head and about two-thirds of

the long neck are covered with short, hair-like degenerate feathers (filoplume) making the head and neck appear naked. The East African male ostrich has a red or pink neck, while the South African male ostrich has a blue neck resulting from the


**Fig.5. 8. The Ostrich.**

**Fig. 5.9. The Bush-Fowl**.

presence of male hormone, testosterone, and the prevalent environmental conditions. The male ostrich has black body feathers, and white wing and tail feathers called rectrices, while the female has a dull brown colouration. This sexual dimorphism is on account of the presence or otherwise of oestrogen (a female hormone). Not all the bones of the skeleton of the Ostrich is hollow, the lower legs have a thick cortex, thus making the bird to be heavy. In fact too heavy to fly but can run very fast, thus facilitating escape from enemies. With their powerful legs they can maintain speeds of up to 70km/h and deliver a kick that can injure a lion. They posses two toes (a strongly clawed 3$^{rd}$ digit and a weaker, smaller, clawless 4$^{th}$ digit). The 1$^{st}$ and 2$^{nd}$ digits are absent.

Ostriches have good eyesight and hearing. They have huge eyes relative to body size. The Ostrich has the largest eye of any land animal (albeit relative to body size) even larger than that of the elephant, and it is perfect for spotting danger in the open grassland where they live.

The Ostrich reaches sexual maturity after two years, the females attaining maturity earlier than the males. The cock generally lives and mates with a "head hen" and 2 "auxilliary hens". The hens lay eggs (numbering between 8 and 14) in the nest built by the cock while only the head hen and the cock incubate the eggs in turn and raise the chicks. The cock incubates the eggs from late afternoon till early morning while the hen takes its turn during the day.
The egg of the ostrich is the largest egg of any living bird, weighing 1 to 1.78kg, measuring between 12cm by 10cm and 16cm by 12cm, and has a volume equal to that of 24 hen's eggs! The egg is creamy white in colour and has a tough shell with an average thickness of 1.97mm.

Ostriches are primarily grazers, but often supplement their diet with succulent fruits, insects and lizards. They are gregarious, gathering into large flocks of up to 600 birds.

## 4.0 CONCLUSION

In this unit you discussed the Order Insectivora, Chiroptera, Pholidota, Lagomorpha, Reptiles and Birds. The unit discussed the keys to the families of insectivora and the suborder of chiroptera and their characteristics.

## 20.0 SUMMARY

The insectivores are primitive insect-eating mammals. They are small animals with short limbs, four or five digits on each foot, an elongated nasal region, and characteristic teeth adapted for holding and crushing invertebrate prey. The families represented in Nigeria are Soricidae (shrews have soft dense pelage), Tenrecidae (Otter-shrews, have soft dense pelage), Erinaceidae (Hedgehogs).

Bats (order Chiroptera) are the only mammals possessing the ability to fly. Their wings consist of a fold of skin which stretches from the fingers along the arms and sides of the body to the hind legs. The hind limbs, in contrast to the forelimbs, are short with well-developed claws. The bodies of many bats are so small and light. They are found in all vegetation zones in Nigeria. There two main suborders of chiroptera are Micro-chiroptera (insectivorous bats) and Mega-Chiroptera (fruit-eating bats).

Hares are different from rabbits. Rabbits are not usually found in Africa. In Nigeria, the order Lagomorpha is represented only by two species of hares (*Lepus capensis* and *Lepus crawshayi*). These are small animals with long silky ears, soft dense pelage, short fluffy tails, and long powerful hindlimbs. Their teeth are akin to those of rodents, but differ

in having four upper incisors posterior pair and six cheek teeth on each side of the skull.

Pangolins are mammals with overlapping reptilian-like scales on the back sides, tail and top of head. The under side is soft and bears a few hairs. They have long slender snouts. Inside the mouth there are no teeth, but a very long, narrow and sticky tongue. The legs are short and some of the toes are clawed.

The reptiles are a smaller class of land animals. They are covered with scales, not hair and most of them lay eggs. They are "cold-blooded" animals. Nigeria is endowed with a rich birdlife that can easily be seen or their calls heard during any short drive. The bodies of birds are covered with feathers. Birds have exceptionally good eyesight and huge eyes relative to their body size.

## 6.0 TUTOR-MARKED ASSIGNMENT

1. Describe in details a member of the order Lagomorpha.
2. Mention the sub-orders of animals in the order Chiroptera and give a description of a species of your choice.
3. Write an essay on the characteristic features and biology of the Ostrich.
4. Mention 5 species enumerated in this unit and give their common names.

## 7.0 REFERENCE/FURTHER READINGS

Ayeni, S.O., Afolayan T.A. and Ajayi, S.S. (1982). *Introductory Handbook on Nigerian Wildlife Ilorin Kwara* State: SAOLOG Printing Productions, 1982. 80pp.

Bruun, B. (1974). *The Dell Encyclopedia of Birds*.

Dunn, A. (1999). *Gashaka Gumti National Park, A Guide Book.* National Park Service Nigeria. 80pp.

Elgood, J. H. (1979). *Birds of the West African Town and Garden.* Longman Group Ltd., London. 66pages.

Grzimek, (1974). *The Grzimek's Animal life Encyclopedia*. Nostrand Reinhold Company, New York. Vol. 5.

Happold, D.C.D. (1987). *The Mammals of Nigeria*. Oxford: Clarendon Press. 402pp.

Happold, D.C.D. (1973). *Large Mammals of West Africa*. London: Longman.

Nason, A. (1992). Discovering Birds: An Introduction to the Birds of Nigeria. Pisces Publications, Oxford. 100pp.

Thistleton, G.F. (1968). *Nature Study of Africa, Mammals*. Evans Brothers Limited, Ibadan. 108pp.

Webb, G.C. (1957). *A Guide to West Africa Mammals*. Ibadan University Press, Nigeria. 40pp.