COURSE CODE:	FIS305
COURSE TITLE:	Limnology
NUMBER OF UNITS:	2 Units
COURSE DURATION:	Two hours per week

COURSE DETAILS:

Course Coordinator: Dr. I.T. Omoniyi

Email: itomoniyi@yahoo.com

Office Location: Room D205, COLERM
Other Lecturers: Dr. (Mrs.) N.B. Ikenweiwe

COURSE CONTENT:

Physical and chemical properties of inland water. Properties of natural and-made lakes. Thermal properties and stratification. Hydrology and water cycle.

COURSE REQUIREMENTS:

This is a compulsory course for all students in Department of Aquaculture & Fisheries Management. In view of this, students are expected to participate in all the course activities and have minimum of 75% attendance to be eligible to write the final examination.

.

READING LIST:

References

• Balogun, J. K. (2006) Basic fisheries biology and management. Pp 88
• Lowe-McConnel (1978) Identification of freshwater fishes, in the biological basis of freshwater fish production eds Shelby D. Gerking and E. David Le Cren. Pp 305

LECTURE NOTES

LECTURE NOTE ON FIS 305
FIS 305 – LIMNOLOGY (2 UNITS)

What is Limnology?

It is simply defined as the science or study of freshwater bodies. The study involves the physical and chemical features of the freshwater (FW) and the life forms that exist in such bodies mainly the streams, rivers, lakes and reservoirs. It is a branch of Hydrobiology

Hydrobiology

Give further illustrations in the class. The Course is introductory.
Limnology (freshwaters)
Oceanography (Brackish water and Marine water)

Classification of Aquatic environment

Based on salinity or chlorinity is equivalent to the salt content in the water (i.e. Cl^- present in one litre of water) aquatic environments are described as thus:

(a) Oligohaline - water contains very low salinity usually less than 1‰
(b) Mixohaline - volume of water with highly variable salinity, it can be from 1-30‰
(c) Mesohaline - water with medium salinity ranging from 10-20‰
(d) Metahaline - water contains very high salinity usually above 30‰

Note that it is assumed that life started from aquatic environment and this view is further supported by the marine plankton (especially phytoplankton) supplying O_2 for the earth.

Hence, study of aquatic environment is vital to life on earth. Aquatic environment serves not only as habitat for its inhabiting organisms but it is a source of gaseous exchange, source of nutrients and medium for disposal of waste products of metabolism.

Also, based on the nature of habitat, aquatic environment can be divided into 3 groups for easy description:

(i) Marine water/habitat - is metahaline, very high salinity ranging from 30-40‰ (av. 35‰). Exception is found e.g. Baltic sea in Europe has salinity ranging from 7-35‰. Above this range are the Red sea and Mediterranean sea having salinity range of 40-43‰ - thus referred to as hypersaline. This is due to high evaporation in their locations. One feature of the marine water is that the relative concentrations of different salts do not vary markedly.

Salinity along the coast is usually lower than the normal range due to rivers and flood water with virtual zero salt flowing into it thereby lowers the salinity. Other examples of marine water are the oceans e.g. Atlantic, Indian, Pacific oceans etc.

(ii) Brackish water - is mixohaline ranging from 1-33‰ depending on the season e.g. Lagos lagoon in rainy season is as low as 0.9‰ and at the peak of dry season - 31.8‰. other examples are the estuaries, creeks and bays.

(iii) Freshwater - is oligohaline i.e. low salinity. In most cases, the salinity is less than 0.5‰. Examples are the rivers, streams, ponds, lakes and reservoirs which are inland waters.

Note that some inland waters may not be fresh water by having more than 1‰ e.g. the Great
salt lakes in North America have higher salinity, Lake Elmentia (East Africa) has about43‰.
Hence, not all inland waters are necessarily fresh water.

Classification of Freshwater (FW). FW is the core of this course.

FW may be considered into 2 groups based on the presence or absence of unidirectional
current.

(A) 1st Series - Lotic water is otherwisely called 'runnng water' i.e. lotic water shows
unidirectional movement. It includes spring, streams, rivulets, rivers. Rivers column of water
moving from inland areas towards the sea. They usually have slow motion during dry season.

Note that motion is expressed as rate of flow or stream velocity. Also, note that rate of flow
is equivalent to discharge rate defined as the volume of water passing an observation point in
a specific unit of time. Expressed as cubic metreSec^{-1} or cu.ftSec^{-1}. The discharge rate
increases towards the sea as the main river is joined by many tributaries. Motion may be even
i.e. water particles move parallel to one another.

In such column, water is said to exhibit laminar flow. Motion may be quite irregular hence
showing turbulence. High turbulent water has higher erosive power and high concentration of
dissolved O_2 than rivers with Laminar flow.

Lotic water is sub-divided into 3 types:

(i) Ephemeral lotic water - short living, water appears for a short time e.g. few hours or
days especially during the rainy periods e.g. run offs.

(ii) Intermittent lotic water - Are streams or even rivers which flows seasonally i.e.
seasonal rivers. Live longer than ephemeral. Give your local example e.g. Alaata river

(iii) Perennial lotic water - permanently flowing rivers e.g. R.Ogun, Niger river etc.

Each of these lotic water can be divided into zones as Rapid zone - shallow, fast current and
firm bottom and the Pool zone which is deeper, slower current and soft substratum. Illustrate
all these with further examples.

(b) 2nd Series - Lentic waters - Have multidirectional currents. Can move in any
direction and hence referred to as 'standing' waters. Examples are swamps, ponds, lakes,
man-made lakes/reservoirs. A lentic water has basically three zones:

Littoral zone - shallow parts of the water with light penetrating to the bottom
Limnetic zone - Ends where the light penetration is effective. It is the open part of the water.
Profundal zone - This is the bottom and deep part of the water which is beyond the part of
effective light penetration. It is called the dark region of the water and usually no green
plants survive in the zone. Give the diagram during lecture hours.
It has to be noted that the boundaries between these zones are not rigidly defined. For
example, seasonal rivers may be lotic in the rainy season and turns lentic in dry season.
Rivers can be turned into artificial lakes e.g. through human factor or
geographical/geological factors. For example Oxbow lake, volcanoes forming crater lakes,
tectonic lakes or Graben lakes formed by movement of the deeper portion of the earth (i.e.
upward e.g. Caspian sea; downwarp e.g. L. Tangayika, L. Baikal (deepest). Thus, the
classification of the freshwater bodies is not rigid and can be changed by any of these factors.
Importance of FW: FW habitat is very small and confined. Usually surrounded by land and
thus the organisms are localized. FW provides the cheapest and most convenient source of
water for domestic and industrial uses to man, useful for waste disposal system especially in
advanced countries. FW is also important for agriculture e.g. irrigation and raising fish for
human consumption.
Important features of comparison between lotic and lentic waters will be fully discussed in
class. For instance, in lotic water, the flow is often turbulent but in standing water the flow if
any is rather gentle: stratification is rare and unimportant in lotic water in view of the
turbulent flow but this is important in lentic water even though convection currents
sometimes mix up the layers/strata. In running water, plankton are poorly developed because
most of them are eliminated by floods and turbidity e.g. rotifers and diatoms. The benthic
flora and fauna are richer in species and adapted to movement of the water. Whereas in
standing water, the fauna and flora are well developed. Etc

EUTROPHICATION IN FRESHWATER

Note, the word trophic is a Greek word which means nourishment. The word is often used to

refer to the nature of organic nutrients and its concentration thus it is used to qualify the
fertility of water body. Eutrophication of lakes may be considered as high or excessive
enrichment of water body which may be desirable or not. If it is desirable, the increase is
looked upon as a fertilizing enrichment but more frequently the results are undesirable and
thus eutrophication receives the connotation of pollution. Types of eutrophication include:
natural eutrophication which is a gradual process of enrichment and it is part of ageing
process; and artificial/cultural eutrophication which occurs after discharge of industrial and
domestic effluents land the run-offs from agricultural and which has been 'dressed' with
nitrate and phosphate artificial fertilizers.
When a lake is young, it typically has a very low concentration of dissolved nutrients,
because of this, gross production in the water body is limited and it is a typical oligotrophic
lake. As time proceeds, the nutrient materials accumulate in the lake either as substrate
dissolved in the river or as solid sediments carried by the river. As nutrient level rises, its role
in limiting production decline and thus allowing productivity to increase.
Based on this concept, there are 3 types of trophic lakes, though some degrees of
intermediate conditions can exist. The lake with relatively rich plant nutrients and low O_2
tension are termed eutrophic while the lakes with low plant nutrients and are highly
oxygenated are termed oligotrophic. Brown water lakes where high concentration of humid
acid inhibit bacterial decay and recycling of nutrients occur are termed dystrophic lakes.
Eutrophic and oligotrophic lakes are distinguished by the bathymetric characteristics. Find
these out during the lectures.
Causes of eutrophication include: (i) urbanization where water bodies are polluted by wastes
from industries, referred to as industrial pollution e.g. Ogunpa river in Ibadan (ii) water useorganic
wastes accompany water being used either in the homes, schools, hospitals and from
other sources (iii) Rainfall-the dusts/floods of debris that settle down inside water bodies
after each rainfall act as pollutants in water

(iv) Municipal sewage - In some urban cities, man turned water bodies to refuse deposition
centres and these refuses, pollute such water bodies e.g. Ogun River in Abeokuta.
(v) Sewage system - Soak-away faeces are dumped into water bodies which could lead to
pollution of such water bodies etc.

LIFE FORMS IN FW ENVIRONMENT

In summary, life forms belong to both plant and Animal kingdoms. Can be schemed as:
1. PLANTS
2. ANIMALS

Note that protochordates and echinoderms do not occur in FW. Cirripedia in crustacean class
does not occur in FW. However, other many vertebrates e.g. fish, amphibians reptiles
(snakes) and birds which depend on water and mammals do occur in FW. It has been noted
that m any fauna and floral varieties occur more in marine than in FW. These aquatic
organisms are divided into different groups based on their micro-habitats. These include:
(a) Neustron - organisms resting on water surfaces e.g. *Gerris*
(b) Plankton - Live suspended in the water. Sometimes called drifters or floaters because
they cannot control their movement but influenced by water current e.g. the phytoplankton
(plant-origin) and zooplankton (animal-origin). Each member of plankton is called plankter.
(c) Nekton - organism which can control their movement and swim in the water. They are
macro-organisms e.g.
Crustaceans, molluscs, fishes. Plankton and Nekton are grouped together as pelagic or
limnetic organisms because they live within the water column i.e. below the surface of water
and above the bottom.

Phytoplankton
Bryophytes
Bryophytes
Zooplankton
CPoroelteonztoearnastes e.g. Hydra
Annelida (but no polychaetes, *Nereis* occur)
Arachnid
Molluscs and Insect

(d) Benthos - organisms which live in or on the bottom of the water.
Apart from all these, some organisms live attached to plants e.g. *Hydra*. This is called
periphyton. Some are attached to rocks inside the water called Aufwuch.
Present diagram in class to show this distribution into the micro-habitats.

Discuss the classification of plankton under the two types: Phytoplankton are plant-origin
while animal-origin are collectively called Zooplankton.
Phytoplankton are divided into 5 groups as:
i. Diatomaceae
ii. Myxophyceae
iii. Dinophyceae
iv. Euglenoceae
v. Chlorophyceae
Zooplankton are divided into
i. Rotifera
ii. Cladocera
iii. Copepoda
iv. Coelenterata
v. Protozoa
Note that some nauplius larvae (crustacean larvae), insect larvae and pupae and fish larvae
may be occasional in occurrence and hence referred to as adventitious plankton. Attend class
for the discussion on the characteristic features of the organisms.

Features of biological success of planktonic organisms

i. Members have very high surface area to volume ratio. This leads to an increase in
frictional force which decreases the rate of sinking of the organism.
ii. Cyclomorphosis is a process whereby planktonic organisms exhibit changes in length
of their appendages (spines) with the density of water e.g. *Ceratium* shortens its spines
during winter when density is high as it needs less energy to keep afloat. During summer
when density is low, *Ceratium* elongates its spine to prevent sinking.
iii. Many of them possess spines which increase the surface area to the small volume e.g.
Keratella, Lecane, Trichocera
iv. Secretion of oil droplets e.g. *Noticula.* Oil droplets decrease gravity of the organisms
since it is lighter than water.
v. Planktonic organisms exhibit patchiness whereby they are not evenly distributed to
reduce pressure from predators.
vi. Plankton shows seasonality in abundance. This depends on change in water current,
water level, transparency and amount of nutrients available i.e. conductivity.
vii. Most of the animal plankton are transparent which provide protection from the
predators.
viii. Planktonic organisms show diurnal ventral migration. Explain this with the three

theories of limnologists.
Nekton - Are fishes and crustaceans mainly. So also molluscs. This is your core course
throughout the programme.
Benthos - Occur at the bottom of water, include bacteria and fungi, protozoan, leeches,
oligochaetes, planarians, ostracods, crabs and prawns, coleopterans. They are many snails.
Periphyton include *Hydra* which attach to plants, water mites and rotifers.
Neustron - stay at surface of the water. These are mainly arthropods - *Gyrinus, Gerris* (Pond
skater), adult mosquito (temporarily).

PLANTS

a. Floating plants - float freely on water e.g. *Pistia, Lemna Salvinia*
b. Submerged Vegetation - Plants completely under water e.g. *Ceratophyllu, Utricularia*
c. Rooted vegetation - Have roots at the bottom but leaves appear on the surface of water
e.g. grasses and sedges

Discuss the relationship among the FW organisms. The relationship is mainly on feeding and
hence called trophic relationship. Illustrate this in class.
These organisms also affect physic-chemical parameters of the water. The full discussion of
this effect starts with phytoplankton which forms the base of the food. Higher plants tend to
cover the water and therefore reduced illumination. Nekton activities in the system affect the
gases and stir up the bottom when feeding thus turbidity will increase.
Secondly, we discuss how physico-chemical properties or features of FW can influence
biotic aspect (i.e. the life forms). This situation in the water body becomes dynamic until
stability may nearly be reached but it is never attained.

CAUTION!!!

References and textbooks would be recommended during introductory lecture. Inter-net
lectures are incomplete for your excellent performance in my examination. Therefore, attend
my class regularly and punctually for your good.