LIMNOLOGY

Limnology started many centuries ago. It started in Africa in 1890 when European studies Lake Tanganyika, Niger, and Nile fishes and water characteristic.

LIMNO means lake, LOGY means study. Aquatic habitat is about 75% of the earth surface produce lower number of plants but largest animals. For example, fish which give poly unsaturated animal fat. It is the study of fresh water habitat which involves the study of physical, chemical, biological and geographical (longitude and latitude) (location characteristics of fresh water environment).

All these affect and influence the beneficial use of water and MR NIGER, survival, production, and management of the inhabitants. Limnology is divided into two:

1. Lentic which is static, water lakes and pond
2. Lotic which is flowing, streams and rivers

Water covers approximately 75% f the earth surface, aquatic habitat contribute nearly 80% of the world's animal production. Many rivers of the world lie in the tropical and sub-tropical zone.

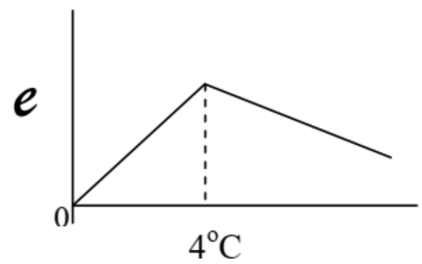
PHYSICAL LIMNOLOGY

These include temperature, light, turbidity (colour), viscosity, water density, water current (speed and direction), depth, amount of suspended/floating/sinking organisms, and physical nature of substance (atoms).

TEMPERATURE

Temperature is defined as the degree of hotness or coldness. It affects other parameters:

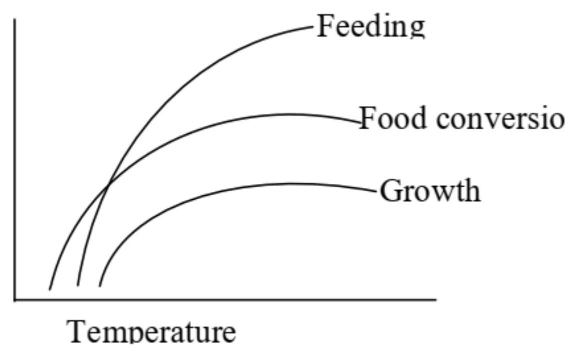
- Affect states of water (solid, liquid and gas). Water has large capacity to hold heat, specific heat capacity of water equal to unity (i.e. one). Water temperature increase, density decreases until 4°C, any further increase in temperature make density remain constant.



- temperature also affect dissolved gas, at high temperature low gas dissolved
- amount of soluble salt in water increases as temperature increases
- Affect biology of aquatic organisms. *Movement of plankton up and down in night day and season, reproduction, nutrition i.e. metabolic rate, growth: increase in temperature affect increase in growth.* It limits production in area where it varies seasonally. Fresh water and intertidal plants can be frozen into ice and be completely dormant especially in northern area when encased in ice. Hence some plant shed their perennial parts down in frozen mud when water temperature is close to 0°C, light is minimal, but nutrient is generated in high concentration. Only cold loving organisms tolerate less than 20°C (e.g. Britain in temperate) while high temperature lover 25-32°C are restricted to Tropics (Trout and Salmon). Cold water fish generally demand water of much better quality. That is why it is difficult to transfer fish geographically, except when water is heated artificially, from cold region. In warm water, fertilizer dissolved faster, herbicides act quicker, rotenone degrades faster and rate of oxygen consumption by decaying manure is greater.

Metabolism:-in high temperature, rate of metabolism is increase in fresh water organisms, hence increase growth as the organisms require more than enough food to supply energy with which to compensate the high metabolic rate. It consume more food and oxygen

Temperature (^{0}C)	Oxygen consumed mg/l
8	48
10	60
12	96
15	135
18	180



Temperate fish farmer keep eye on thermometer for effective management of fish and not to waste food.

Reproduction: - tropical fish would breed only at temperature greater than 20^{o}C. Embryo develops into fingerling slow at low temperature of less than 20^{o}C. Larva growth is optimum at 32-37^{o}C. At high temperature (30^{o}C) some aquatic organism hibernate in mud, under stones e.g. Clarias (for months), Lung fish (for years) while zooplankton lay eggs with cyst preparing for drought. Plankton comes near the surface at night and stay early hours of the day 6am, between 12mid-6am and down in the day time when temperature is high. At high temperature, photosynthetic phytoplankton manufactures more food due to high light illumination.

Thermal stratification and mixing:- at high temperature (upper part), water is divided into 1,2, or 3, upper part warmer, lower part colder and temperature decreases with depth, dividing water into epilimnion, hypolimnion and middle metalimnion with a sharp change in temperature called Thermocline. At high temperature water become lighter, less dense and mixing (upwelling is increase). Even at different part of a river e.g. edges are warmer, lighter, cooler and denser towards middle, because of shallow depth at the edge with low volume i.e. horizontal zonation.

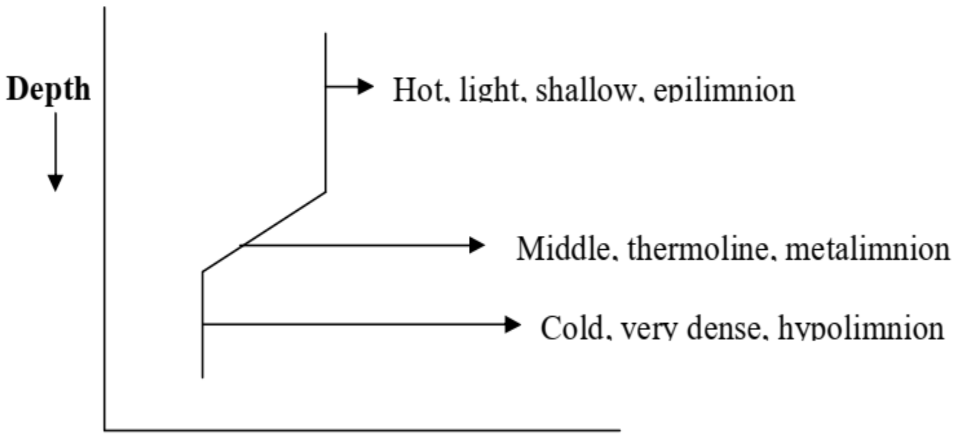
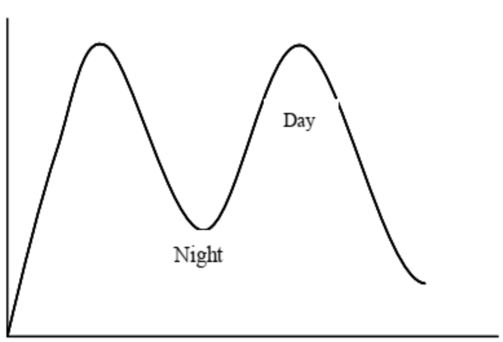


Fig: Thermal/ water stratification

VARIATIONS IN TEMPERATURE

Partial variation in temperature:- thermal stations located around running water affect water temperature as the heat released warms up the lower reactions

.**Diurnal variation**:- during the day time, water is warm but is cool at night and early hours of morning before sunrise. Highest temperature reading is observed during the hours of 2-3 in the afternoon.



Seasonal variation:- in rains, low temperature, cool rain water on the surface cools down the water. Storms accompanying rain also mix water hence cool water. It is important to note that temperature decreases with depth except in Deep Ocean where there is geothermal heat. December to January, low temperature in the Northern parts e.g. Chad and Sokoto. Seasonal temperature change is increasing in higher latitude. Temperature at tropic is almost constant through out the year e.g.

	Latitude	**Min. °C**	**Max. °C**	**Range °C**
L. Victoria (Kenya& Uganda)	1°S	23.8	25.4	1.3
Lagos lagoon	6°N	30	35	5
L. Tanganyika	7.5°N	23.3	29.5	6.2
Upper Ogun	8.5°N	20	30	10
L. Chad	15°N	20	30	10
R. Sokoto	13°N	18	30	12
Black Sea	43°N	8	20	12
L. Windermere	54°N	5	21.1	16.1

WATER STRATIFICATION (THERMAL)

Lentic water is divided into three layers, epilimnion, hypolimnion and metalimnion (in between) due to temperature difference distinct and may not mix though mixing occur within each layer.

Epilimnion:- In dry season , water is shallow and transparent. At high temperature, transparency increases downward some $^3/_4$ of the water depth. During rain, temperature decreases (south) and stratification breaks down, density increase lead to surface water sinking and hypolimnion water rises up (upwelling/overturn/mixing). Or due to strong storm/wind.

Stability of stratification is the amounts of energy require mixing the entire water volume to a uniform temperature. The greater the energy required the more the stable the stratification. Upwelling classified on the basis of number of times to occur includes:

- MONOMICTIC - upwelling occur once in a year e.g. in Nigeria, it occur during rain of July - Oct.
- DIMITIC - upwelling that occurs twice in a year. During rain and harmatan e.g. North Nigeria
- POLYMICTIC - upwelling occurring several times in a year. Most ideal for aquaculture.
- MEROMICTIC - incomplete upwelling only some partial, not reach lower part
- HOLOMICTIC - complete mixing of both lower and upper part. Important one as seen in large water body with more prolong stratification
    1. During mixing, stratification breaks down with homogenate temperature occurring. Mixing of nutrient concentrations occurs, thus help to re-distribute water material.
    2. During mixing mass fish kill occur as deoxygenated water from hypolimnion comes up and probably contain some toxic materials which is poisonous to fish
    3. Phytoplankton bloom in the upper part as the hypolimnion reach the surface encourage mass growth of phytoplankton population especially blue-green algae, microcystis, Anabaena and osallatorid which produce

toxic materials which irritates the alimentary canal of fishes i.e. starvation and finally death

Sudden lowering of oxygen concentration also kills. Mixing occurs in small shallow water artificially by man e.g. man made lakes, dams and reservoir.

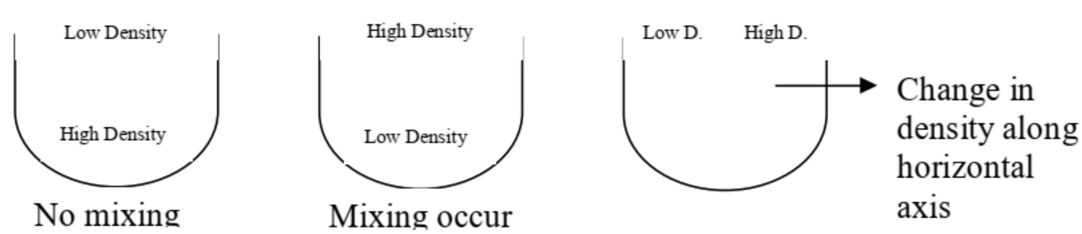
Measurement of temperature

Simple mercury in glass thermometer that ranges between $0^{o}C$-$50^{o}C$ e.g. reversing thermometer and thermogram can be used to measure temperature of 1000km away on satellite.

Electrical thermometer operated using batteries and resistance wire with amount of current to temperature.

DENSITY

Density is mass per unit volume (g/cm^3). Density is closely related to viscosity and specific gravity. Viscosity is the relative amount of water molecules in relation to one another. Water density affects movement of organism. Organism can move on dense water than on light water by floating, for example plankton and mosquito larvae. Differences in density of water (due to temperature difference) bring water stratification or vertical flow or horizontal flow.



Density is also affected by temperature, increase in temperature result in low density though to a maximum temperature of $4^{o}C$ when it is constant. Annual water variation in density in tropic is greater than variation in temperate. Water density is also affect by salinity (amount of salt in water). Water containing high salt concentration has increase water density compared with water with low salt concentration. Relationship between salt and density is not direct as temperature also plays a role. In high temperature, salt concentration dissolve very well hence low, while in low temperature, reduced salt dissolve hence density is increase. Soap and oil presence in water increase water viscosity, decrease water density hence reason why they are put in water to prevent mosquito larvae hanging in water as a result of surface tension.

Measurement of density

1. Hydrometer
2. Specific gravity bottle