Practical Manual

Aquatic Ecology and Biodiversity

B. F. Sc 2nd Semester

INDEX

Sl. No.	*Practical*	*Page. No*	*Date of Submission*	*Signature*	*Remarks*
1	Study of sandy shore habitat and organisms	4-5			
2	Study of muddy shore habitat and organisms	6			
3	Study of rocky shore habitat and organisms	7			
4	Study of mangrove habitat and organisms	8-9			
5	Study of natural pond habitat and organisms	10			
6	Study of estuarine habitat and organisms	11			
7	Study of river habitat and organisms	12			
8	Study of fouling and borrowing organisms	13			
9	Study of endangered species and protection	14-15			
10	Study of indices of organisms	16			
11	Collection of plankton	17-18			
12	Study and analysis of plankton	19			
13	Study of macrobenthic organisms	20			
14	Study of meiobenthic	21-22			

	organisms				
15	Estimation of Primary Productivity in freshwater bodies	23-24			
16	Collection and identification of aquatic plants from different freshwater body	25-32			

Practical 1 Study of sandy shore habitat and organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:

Name of the Class:

Sandy shore

Sandy beaches results from littoral transport. It determines the appearance of the coastline. They are fairly calm in terms of wave conditions. Sandy beaches are soft shores that are formed by deposition of particles that have been carried by water currents from other areas.

Characteristics and adaptations plants and animals

This intertidal zone is covered part of the day by water and is part of the day exposed to air. High tides bring nutrients and food with it. When the tide retreats, waste products, eggs and larvae are taken. This causes changes for the organisms that live here and they have adapted to this changing environment.

The burrowing is rapid and powerful on high-energy sandy beaches. This is because the animals must not be swept away by incoming waves and swash. They also need to be high mobile and must be able to deal with the swash climate. Intertidal filter-feeders cannot feed while the tide has retreated. Many species of the meiofauna use vertical tidal migrations through the sand column. Other species move up and down the beach with the tides. Most are filter-feeding and scavenging. Some species descent into the burrow to escape from high temperatures. Another solution is evaporative cooling by replacing water through entering the burrow, plunging into the sea or absorption from the substratum. Another problem for intertidal animals is the time of reproduction. Adaptations for this is to reproduce at frequent times (iteroparous) or to reproduce just once in a year (semelparous). To ovoid predation, several behaviors are developed. The first one is to burrow very deep. Another one is tidal migration,so the animals remain protected from predation. Several groups of vertebrates make use of sandy beaches for foraging, nesting and breeding. Turtles nest on the backshore of sandy beaches. Birds use the beach for foraging, nesting and roosting. Seals use several areas of the beach for nesting, molting, breeding and raising pups. Most invertebrate phyla are represented on sandy beaches, either as interstitial forms

Macrofauna of the sandy beaches are often abundant and in some cases, attain exceptionally high densities. The macrofauna community consists of those organisms too large to move between the sand grains. - molluscs, crustaceans and polychaetes are the most important. Meiofauna - On most beaches the interstitial fauna is rich and diverse, even exceeding the macrofauna inbiomass . The dominant taxa of sandy beach meiofauna are nematodes and harpacticoid copepod with other important groups including turbellarians, oligochaetes, gastrotrichs, ostracods and tardigdades.

Plants low lying, prostrate, stoloniferous or cushion-like, dwarfed above ground, extensive underground growth, long tap root or widespread adventitious roots, adventitious buds and vegetative growth , leaves small, often spiny, leaves leathery or hairy, thick cuticle, thick epidermis, stem thorny, succulent, oil-dotted or bearing latex some fruits for water dispersal

Morphology of sandy shore:

Total Area ---------- Tidal condition----------

HHT & LLT zone: ---------- Aquatic weeds on sands----------

Water Characteristics:

Physical:Temperature------- Colour / Odour----------, Turbidity----------

Chemical: pH---------- Dissolved oxygen---------- Salinity----------

Sandy shore communities: Gastropods, Bivalves, Worms, Crustaceans etc.

Species Diversity and Associations:

Inferences:

https://www.youtube.com/watch?v=QHEWmMOhzt0

Practical 2 Study of muddy shore habitat and organisms

Date: Date & Time of Visit:
Place of Visit: Name of the Teacher:
Name of the Class:

Muddy shore habitats are areas of mud and sandy mud exposed between the extreme-high-tide and extreme low-tide marks. Mud flats form from the deposition of mud in sheltered tidal water, particularly in estuaries where there is a large sediment supply.

Characteristics of muddy shores and adaptations

Soil particles range from fine sand to silt, and are often compacted into clay. Drainage is poor and anaerobic conditions exist just below the sediment Surface.the surface sediment is mobile in moderate waves due to exposure to wave action related to wind. Vast numbers of a few species of infauna depend on a diet of organic detritus. *Meritrix*, *Corophium* sp, worms etc. These animal populations support large groups of migrating shore birds during the late summer. Migratory fish also visit to feed on the benthic (e.g., *Corophium*) and epibenthic species (e.g., *Neomysis*, *Mysis* etc.).

Primary production is limited to diatoms and other microscopic and filamentous algae and grass. The detritus and associated bacteria are consumed by large populations of bivalve molluscs, amphipods and polychaetes. These in turn eaten by carnivores, and particularly by migratory shore birds.

Morphology

- Type of soil
- Total Area
- Tidal condition / depth
- Marginal Vegetation

Water Characteristics

Physical: Temperature----------,Colour / Odour---------- Turbidity----------

Chemical: pH---------- DO---------- Salinity----------

Muddy Shore communities

- Plants
- Bivalves
- Gastropods
- Worms
- Crustaceans

Species Diversity Associates:

Inferences:

https://www.firstpost.com/india/wildlife-day-indias-shores-house-a-wealth-of-marine-life-that-turn-with-the-tide-6184521.html

Practical 3 Study of rocky shore habitat and organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:

Name of the Class:

Rocky shores are areas of bedrock exposed between the extreme high and extreme low tide levels on the seashore. The ecosystem is complex, as it is an interaction between terrestrial and aquatic systems. Plants and animals are distributed on the shore in horizontal zones. This zonation can be very clear and abrupt. Tide pools often have rich communities of organisms normally associated with the lower shore or sub tidal habitats. The plants are typically algae (seaweeds) and lichens. Algae, lichens, seaweeds, the animals such as periwinkle, barnacles, amphipod crustaceans, hydroids, mussels, sea urchin, dog whelks, starfish, limpets, isopods, sponges, tube worms, tunicates, sea anemones, rock crabs, sea slugs, bivalves etc. are common in rocky shores.

Adaptations of rocky shore organisms

Structural - eg. thick, impermeable shells to reduce water loss and radiation effects.

Behavioural - eg. seeking small crevices for shelter to reduce the drying effects of the wind.

Physiological - eg. an ability to lower metabolic rates during exposed periods to minimise oxygen consumption.

Morphology of rocky shore:

- Type of rock
- Total area
- Tidal area / exposure

Water Characteristics

Physical: Temperature-------- Colour ---------- Turbidity----------

Chemical: pH----------,Do---------- Salinity----------

Rocky shore communities and zonation of organisms

- Algae
- Benthic organisms
- Rocky pool fishes / crabs / prawns etc.

Species diversity and associations

Inference:

https://www.pathwayz.org/Tree/Plain/THE+ROCKY+SHORE+%5BNZ%5D

Practical 4 Study of mangrove habitat and organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:

Name of the Class:

Mangroves are salt-tolerant aquatic ecosystems found mainly in tropical and sub-tropical inter-tidal regions. They are trees or shrubs, common in shallow and muddy salt water or brackish waters, along quiet shorelines and in estuaries. Mangroves are absent on sandy beaches and rocky shores. This eco-system is highly fragile, subjected to physiological and morphological stresses, salinity effect, aeration and wave action. Mangroves are also called as mangal, mangrove forest biome, mangrove swamp, mangrove forest etc. Mangroves protect coastal areas from erosion, storm surge (especially during hurricanes), and tsunamis. The mangroves' massive root systems are efficient at dissipating wave energy. Of the recognized 110 mangrove species, only about 54 species in 20 genera from 16 families constitute the "true mangroves". Important mangrove species are *Rhizophora mucronata, R. apiculata, Bruguiera gymnorrhiza, B. parviflora, Avicennia officinalis, A. marina, Ceriops tagal, Heritiera littoralis, Sonneratia caseolaris, S. alba, Exoecaria agallocha, Xylocarpus granatum, Aegiceras corniculatum, Scyphiphora hydrophyllacea, Nypa fruticans* etc.

Adaptations of mangroves

Mangroves have Pnuematophores (aerial roots), allow mangroves to absorb gases directly from the atmosphere and other nutrients such as iron from soil. The roots also contain wide aerenchyma to facilitate transport gas within the plant. Mangroves exclude salt by having significantly impermeable roots which are acting as an ultra filtration mechanism to exclude sodium salts from the plant. Red mangroves can also store salt in cell vacuoles and can secrete salts directly through salt glands. Because of the limited fresh water available in salty intertidal soils, mangroves limit the amount of water lose through their leaves. They can restrict the opening of their stomata. Mangroves have evolved a special mechanism to help their offspring survive. Mangrove seeds germinate in soil .The mangrove roots offers host for many include algae, barnacles, oysters, sponges, and bryozoans. Shrimps and mud lobsters use the muddy bottoms as their home. Mangrove crabs mulch the mangrove leaves, adding nutritients to the mangal muds for other bottom feeders.

Morphometry of Mangroves

Water Spread Area -

Water Depth -

Water Width -

Characteristics of water

Physical: Temperature---------- Colour / Odour---------- Turbidity----------

Chemical: pH--------- Do---------- Salinity----------

Mangroves Communities: Mangrove Plants – *Rhizophora, Avecennia, Sonnerata, Ceriops etc.*

- Plankton, Benthic , Organisms, Fishes, Birds

Species diversity and association:

Inference:

https://oceana.org/marine-life/marine-science-and-ecosystems/mangrove-forest

Practical 5 Study of natural pond habitat and organisms

Date: Date & Time of Visit:
Place of Visit: Name of the Teacher:
Name of the Class:

A pond is a body of standing water, either natural or man-made, usually smaller than a lake. A wide variety of man-made bodies of water are classified as ponds, including water gardens. While fish ponds are designed for commercial fish breeding, and solar ponds designed to store thermal energy. Standing bodies of water such as puddles, ponds and lakes are distinguished from a water course, such as a brook, creek, or stream via current speed. While, currents in ponds and lakes possess thermally driven micro currents and moderate wind-driven currents. These features distinguish a pond from many other aquatic terrain features, such as stream pools and tide pools.

Formation of ponds

Ponds can result from a wide range of natural processes, severely constrained by human activity. Any depression in the ground which collects and retains a sufficient amount of rain water can be considered a pond, and such depressions can be formed by a variety of geological and ecological events.

Characteristics of ponds

Some ponds have no surface outflow draining off water and ponds are rain fed. Hence, because of the closed environment of ponds, such small bodies of water normally develop self contained ecosystems. Ponds' calm waters are ideal for insects and other water dwelling invertebrates. This includes the pond skater, the water boatman, the diving beetle, the whirligig beetle and the water scorpion. The pond needs plants within it, too, of three kinds: marginal, submergent and floating. Natural ponds supports verities fish population.

Submerged weeds: Submergent plants, also called oxygenators, live underwater. They're important to aquatic species -- fish, plants and everything else -- because they absorb carbon dioxide and release oxygen just as terrestrial plants do. They help keep water clear and alive.

Marginal (emergent) plants have their roots in shallow water and their shoots growing above the water. Plant these along the margin, they offer hiding and mating places, surfaces for eggs and critters to cling to and beauty.

Characteristics of water

Physical: Temperature---------- Colour / Odour-------- Turbidity----------

Chemical: pH---------- Do---------- Salinity----------

Aquatic communities:

Phytoplankton,zooplankton, fishes and Aquatic weeds – floating , submerged and marginal types

Species diversity and association of organisms

Inferences

https://letstalkscience.ca/educational-resources/backgrounders/introduction-lakes-ponds

Practical 6 Study of estuarine habitat and organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:

Name of the Class:

Estuaries are partially enclosed bodies of water along coastlines where fresh water and salt water meet and mix. Estuary is acting as a transition zone between oceans and continents. It has a free connection with the ocean. Fresh water input from land sources dilutes the estuary's salt content. They characerstic feature or the estuary is the mixing of fresh and salt water Pritchard (1967) defined as"An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage."

Estuaries are vital habitats for many marine and fresh water species. They are called the "nurseries of the sea" **Salinity** Variations in salinity are affected by temperature, dissolved gases, density and viscosity. Salinity in the estuary varies with depth, flux of fresh water, and changes with the tide.**Temperature:** Shallow estuarine waters exhibit great temperature changes. **Oxygen:** Some estuaries have very low oxygen levels. **Sediment:** Particle size and chemistry of estuarine sediments can make a difference in the organisms that can survive. Infiltration of the estuarine sediments by nutrients, trace elements, sewage and industrial waste can influence the productivity of the estuary.Wave action: reduced wave action in turn promotes the deposition of sediments and development of rooted plants in the estuarine regions.Turbidity: As this region is having good amounts of fine sediments or particles, turbidity of the estuarine waters is very high in most of the periods. The highest turbidities are known to occur during the maximum freshwater discharge into the estuaries.

Morphology of estuary:

- Depth
- Width
- Speed of water
- Point of joining to the sea

Characteristics of water

Physical: Temperature---------- Colour / Odour---------- Turbidity---------

Chemical: pH---------- Do---------- Salinity----------

Estuarine communities – Plankton, Benthos, Fishes etc.

Species diversity and association

Inferences

https://study.com/academy/lesson/estuary-definition-facts-characteristics-examples.html

Practical 7 Study of river habitat and organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:

Name of the Class:

Rivers are called running water systems. River waters are characterized by movement of water and it is the unique characteristic of river waters. The interchange between the soil and water is higher in the river waters than the pond waters. Dissolved oxygen content is more and uniformly distributed in running waters and there is no physical and chemical stratification. Depending on the water movement in different zones, the nature of bottom materials is changing with sandy, muddy, rocky or pebbles.

Adaptations of organisms

The living organisms of the running water systems possess a variety of adaptations to maintain their position against the fast moving waters. They are as follows:

The plants and animals are permanently attached to the hard substratum like stones and pebbles. Some animals are able to maintain their position against the moving water currents by possessing strong hook like structures. Lotic animals have the inherent behaviour to adhere close to the surface of the bottom or substratum. The animals have a streamlined body shapes which offers minimum resistance to the water flowing over them. Most of the animals inhabiting the streams and rivers are positively rheotatic and they are capable of moving against the water flow or currents. Freshwater animals body fluids are hypertonic to their environment and constantly take in water by osmosis which is referred as endosmosis. Special types of adaptations for respiration are seen in the freshwater animals.

Morphology of natural ponds:
Depth
Width
Speed
Point of joining to estuary
Characteristics of water
Physical:Temperature--------- Colour / Odour---------- Turbidity----------
Chemical: pH---------- Do---------- Salinity / chloride----------
River water communities
Plankton
Benthos
Fishes
Aquatic weeds / macro algae
Species diversity and association
Infrences
https://www.ausableriver.org/blog/food-webs-along-river-continuum-headwaters

Practical 8 Study of fouling and borrowing organisms

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:
Name of the Class:

Befouling or biological fouling is the undesirable accumulation microorganisms, plants, algae, and/or animals on wetted structures. Fouling organisms are aquatic flora and fauna that attach to and grow upon hard objects below water. Biofouling is divided into microfouling — biofilm formation and bacterial adhesion — and macrofouling — attachment of larger organisms, of which the main culprits are barnacles, mussels, polychaete worms, bryozoans, and seaweed. Together, these organisms form a fouling community. Barnacles (a type of marine crustacean), encrusting bryozoans, mollusks, tube worms, and mussels create a type of fouling known as calcareous (hard) fouling, while organisms such as algae, slimes and hydroids make up non-calcareous (soft) fouling.
The fouling organisms encountered at the New Mangalore Port at Panambur and the Fish Landing Jetty on the Nethravati-Gurpur estuary near the old Mangalore Port, India, was Barnacles, oysters, bryozoans, polychaetes and hydroids. Barnacles are by far the most important foulers. Biofouling can reduce the performance of the vessel and increase its fuel requirements.
Fouling causes huge material and economic costs in maintenance of mariculture, shipping industries, naval vessels, and seawater pipelines. Anti-fouling is the process of removing the accumulation, or preventing its accumulation. In industrial processes, bio-dispersants can be used to control biofouling. In less controlled environments, anti-fouling coatings which contain biocides or non-toxic coatings which prevent organisms from attaching can be used.
Marine wood-borers destroy timber structures, Bankia campanellata, B. gracilis, B. rochi, Nausitora dunlopei, N. hedleyi, Nototeredo edax, Spathoteredo obtusa, Dicyathifer manni, Lyrodus pedicellatus, Teredo furcifera and Martesia striata. Of these, B. gracilis, is a new record from Indian waters, and S. obtusa is reported for the first time. Of the 25 species (i.e. 14 Teredinidae, 2 Pholadidae, 2 Sphaeromatidae and 7 Limnoriidae), so far reported in india. The occurrence and distribution of marine wood-borers along the west coast of India, from Mangalore to Kandia, showed 12 spp. of Teredinidae, 1 sp. of Pholadidae, 3 spp. of Sphaeromatidae and 1 sp. of Limnoriidae. Among these, the most destructive species are Bankia campanellata, B. rochi, Lyrodus pedicellatus, Dicyathifer manni, Teredo clappi, T. furcifera, Martesia striata and Sphaeroma terebrans. The destruction caused to timber constructions by these organisms was very severe and the problem is of great economic importance.
Collection of Foulers and Bores – Concrete walls, wood – Jetties, wharfs collect from a unit area by scrapping boats hull.

Identification of foulers and bores
Foulers (No./Unit area)

- Plants
- Spats of oyster, barnacles
- Worms
- Adult oyster and barnacles

Borers

- *Teredo Sp.*
- *Marteria sp.*
- Crustaceans

Assessment of damage and measurement

- Biological erosion
- Number of holes

Inference:
https://wyss.harvard.edu/media-post/fouling-marine-fouling/
Practical 9 Study of endangered species and protection

Date: Date & Time of Visit:

Place of Visit: Name of the Teacher:
Name of the Class:

Endangered species are species which are in danger of becoming extinct. Endangered species are Blue whale, Fin Whale –Baleen whales, Spermwhale, Bowhead whale,Dolphin Sharks, Sea turtleSeals, Sea lions, Waters Sea birds,Giant clamsSea snakes etc. Species need conservation in nature. International Union for Conservation of Nature and Natural Resources (IUCN) and survival service commission (SSC) have published two volume of animal that have in need for conservation **"Red Data Book"**

Categories of Species

• **Endangered species (E) :** Species which are in danger of becoming extinct
• **Vulnerable species (V) :** Species which likely move into the endangered category, if present situation continues.
• **Rare species (R):** Species restricted to specific geographic location or thin by scattered distribution.
• **Threatened (T):** Species are small in numbers and their more survival is at

Whales and Dolphins were hunted almost to extinction and demand for consumer goods saw the mass harvesting of many marine turtle, fish and seals for their skins, shells and oils, as well as their meat and other body parts. Whales, Porpoises, Fish, Turtles and Seals that are currently endangered and/or threatened with extinction. In the case of Whales, Fish and Turtles, direct hunting and killing for use of their body parts has been a threat for centuries and the affects of those threats are now taking their long-term toll.

It is essential to prevent the further decline of fish germplasm. Allen et al. have identified five principal elements or tasks in the recovery programmes such as (i) habitat management (ii) habitat development and maintenance, (iii) native fish stocking, (iv) non-native fish and sport-fishing and (v) research data management and monitoring. Indian Fisheries Act 1897 (modified in 1956) along with the following measures would positively help in restoration of the threatened fish fauna.

Methods of conservation

• *In- situ* conservation
• *Ex- situ* conservation

In- situ conservation

It helps to maintain high genetic variability for introduction of improved varieties and to reduce problems of maintenance of brood stock in-site condition and transportation. *In-situ* conservation means "on-site conservation". It is the process of protecting an endangered plant or animal species in its natural habitat either by protecting or cleaning up the habitat itself or by defending the species from predators.

Ex-situ conservation

Ex-situ conservation means literally off-site conservation. It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans.

The two main pillars of ex- situ conservation programmes are (i) live gene bank and (ii) gamete / embryo Bank. In a live gene bank, the endangered species are reared in captivity, bred therein and genetically managed avoiding inbreeding depression, domestication and unintended selection. Use biomarkers such as Molecular genetics tools- PCR, chromosomes, Electrophoresis and DNA sequencing etc. used in the conservation of biological resources is gaining more importance today.

Main conservation projects for restoration of habitats are

• Marine parks
• Sanctuaries
• Protected areas

Marine parks

Marine Park is an area of the sea zone as a sanctuary for protection of its bio resources in coral reefs, mangroves, floods and other associated flora and fauna. The park was created 24 May 1983 under the Wildlife Protection Act of 1972 to protect marine life such as the corals and nesting sea turtles prevalent in the area

- Protection of horse shoe crab
- Protection of marine turtles
- Protection of marine sharks
- Protection of marine mammals

https://www.marinebio.org/conservation/marine-conservation-biology/threatened-endangered-species/

Practical 10 Study of indices of organisms

The number of species and their abundance by one or a few species in their environment is referred to as diversity. Diversity indicates the degree of complexity of community structure. It is a function of two elements-the number of species (richness) and the equitability (evenness) with which individuals are distributed among species. Diversity index is used for assessing the degree of environmental pollution. E.g.the diversity is generally lowest in polluted waters, and also it provides useful information on the succession of community structure.

Species diversity indices:

Species diversity is a measure of species richness. Shannon-Wiener's index of general diversity (H) (Shannon & Wiener's, 1949):

Where : Pi is the proportion of individual in the i^{th} species
Pi=ni/N ni is the number of individuals for each species
N is the total number of individual organisms
Also

$$H1 = \frac{3.321928}{N}\left(N \log 10N - \Sigma^{S}_{i=1}\, ni \log ni\right)$$

Note : H1 increases as both the number of species and the equitability of species abundance increase.

Diversity index as a measure of 'Species richness' (d) (Margalef, 1951):

$d = (S-1)/\log_c N$

Where : S is the number of species
N is the number of total individuals.
Note : If all the individuals in a sample (population) belong to one species then 'd' becomes zero.

Diversity index as a measure of 'Species Eveness' (J1) (Pielou'w, 1966):

$$J1 = H1/\log 2S = J1 = \frac{H1}{3.3219 \text{long}_{10} S}$$

Where H is the Shannon index,
S is the number of species

Index of dominance (c) (hulburt's index):

$C = \Sigma(n_i/N)^2$

Where :
ni is the number of individuals for each species, number of individuals
biomass, production and so forth.
N is the total number of individuals.

Index of similarity (s) (similarity index):

It is the measure of comparing experimental stations belonging to different biotopes for obtaining an integrated picture of the biotopes. It is calculated by the following equation.

S = (2c/a+b) x 100

Where c is the number of species common at any two stations
a is the number of species at one station
b is the number of species at the other station.

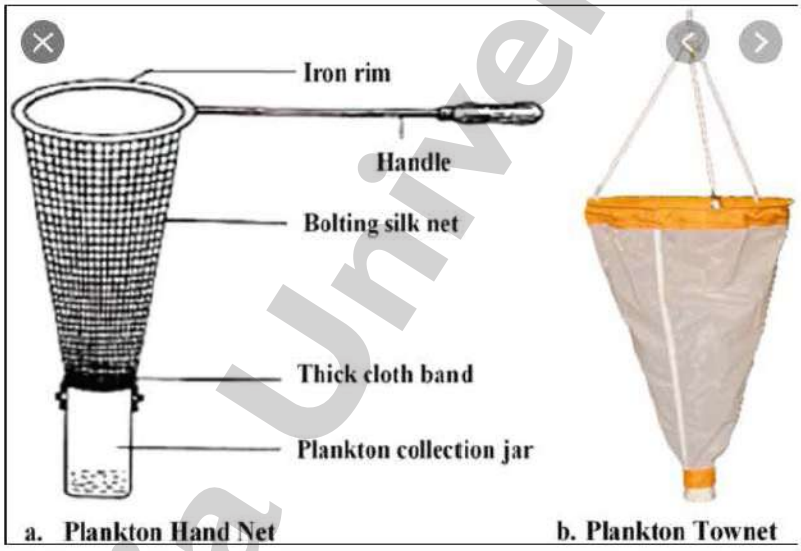
Practical 11 Collection of plankton

Plankton

The term 'plankton' was coined by Victor Henson in 1887 to designate the heterogeneous assemblage of suspended microscopic materials, minute organisms and detritus in water which wander at mercy of winds, currents and tides. However, the use of the term has been confined to designate only the microscopic, free-floating organisms; which depending on their nature are divided in two major groups, namely, phytoplankton and zooplankton.

Collection of nano plankton

The nano plankton compared to net plankton has less number of species flagellates diatoms which have a size range of 5-20µm contribute more than 90% in the phytoplankton biomass.



Methods of collection

Bottle sampler

Bottle samplers are ideal for small quantitative phytoplankton collection. It is mainly used for the collection of water samples from any desired depth of shallow ecosystem from a stationary vessel – near shore waters, estuaries and mangroves. Surface water can be obtained by gently scooping water in to a container of suitable size from the leeward side of the ship. Subsurface water can be obtained by using sampler like Mayer's Water Sampler, Friedenger's Water Sampler, Nansen reversing water sampler, Vaan Dorn water sampler, Niskin water bottle, NIO water bottle, Universal water sampler, etc. Samplers are sent to a desired depth on the rope in an open condition.

Collection of net (micro) plankton

Plankton of more than 50µm size can be collected by ordinary net sampling. This method could preferably used for quantitative plankton collections, as large quantity of water is filtered. Net is towed vertically, horizontally, or obliquely. Shape of nets commonly used is conical, conico-cylindrical and conical with a mouth reducing cone. Rectangular shaped nets have been designed. The net is attached to the wire directly with a bridle. At the cod end of the plankton net, a sampling bucket is attached.

Preservation of plankton

After the collection of plankton, the samples should be preserved immediately. For determination of chemical composition, specimens should be fixed within 10 min after collection. Add 2-3 drops of 2.5% formalin to each 100ml of sample.

Storage of sample

Container such as glass bottles with wide mouth, polypropylene with plastic screw on lid, polycarbonate containers, whirl pack – polypropylene bag are commonly used.

• Store the sample in a dust free dark and cool place

• Maintain the pH (6.5 to 7.5)

• Periodic checking for colour and pH is required

Labels

Water resistant papers are used for external and internal labeling with following information in each container. External label should have bottle no, station no, date of sampling, day/night, sky, time, depth of sampling, type of net, mesh aperture, type of haul, flow meter reading, collector name etc. and internal label should have station no, date of sampling, sampling depth, type of net, mouth size and mess size, type of haul, number of turns in flow meter, collector's name, etc.

https://www.discovercayugalake.org/plankton-sampling

Practical 12 Study and analysis of plankton

Phytoplankton

The phytoplankton is collated using bottle samplers and Pump and hose. Bottle samplers are ideal for small quantitative phytoplankton collections in coastal waters,estuaries and mangroves etc. Surface water can be obtained by gently scooping water into a container of a suitable size from the leeward side of the

vessel. Subsurface water can be obtained by using sampler like Mayer's water sampler, Friedenger's water sampler, Nansen Reversing water Sampler. Van Dorn Water Bottle, Niskin Water Bottle, NIO Water Bottle, Universal Water Sampler etc.

Zooplankton

Zooplankton of more than 50µm size can be collected by ordinary net sampling. This method could preferably used for qualitative plankton collections, as large quantity of water is filtered. A net is towed vertically, horizontally or obliquely. Shape of nets commonly used are-conical, conico-cylindrical (conical net with a collar) and conical with a mouth reducing cone. Rectangular shaped nets have also been designed. The net is attached to the wire directly with a bridle. At the cod-end of plankton net, a sampling bucket is attached.

Micronekton:

Issacs-Kidd Midwater Trawl (IKMT) is a midwater trawl used to sample larger plankton having considerable swimming ability and net avoidance. It has a horizontal bar in the upper part and a depressor in the lower part of the net. Net is obliquely towed at a speed of over 2.5m.sec$^{-1.}$

Neuston

Pleuston and Neuston are the zooplankton community organisms associated with the surface layer, between the water's surface and a few centimeters below. The ORI neuston net, has a rectangular mouth opening, attached to a frame which holds float on both sides and the net is towed from its sides.

Epibenthic Plankton:

Some zooplankton occur in midwater during the night and aggregate close to the area floor during the day often form assemblage in benthic layers. Bayer's epipenthic closing net is designed primarily to collect epibenthic plankton.

Preservation of plankton

Preservation is the maintenance of the fixed condition for extended periods of time. After collection of plankton, the sample should be preserved immediately. For determination of chemical composition, specimens should be fixed within 10min after collection. Samples should be norcotised, fixed and preserved in the order. Use Lugol's solution for phytoplankton and Buffered formalin for zooplankton.

Storage of samples

Containers such as glass bottles with wide mouth, Polypropylene with plastic screw-on lid are commonly used. Store the samples in a dust free dark and cool place. Maintain the pH between 6.5 and 7.5. Periodic checking for colour and pH is required. The preservative should be changed if necessary.

Analysis of plankton

Transfer one ml of well mixed plankton sample using stempel pipette into the Sedgwick Rafter cell (50x20x1mm) with 1ml. Spread evenly in the form of a thin layer. Allow the chamber undisturbed for half an hour under microcope. Count the organisms in the cell by moving horizontally or vertically.

Calculation

N = nxv/V

Where: N=Total number phytoplankton cells/l
n= Average number of phytoplankton cells in 1ml of sample
v=Volume of plankton concentrate
V=Volume of total water filtered in litre.

https://www.discovercayugalake.org/plankton-sampling

Practical 13 Study of macrobenthic organisms

Benthic organisms

- Macrobenthos
- Meiobenthos

• Microbenthos

Macrobenthos

Macrobenthos comprises the burrowing fauna (**Infauna**) of sediments and the surface living fauna (**Epifauna**) of both rocky and sediment grounds, together with associated bottom living fish and crustaceans. **Meiobenthos** consists mainly the small metazoans – nematodes, herpecticoid copepods, turbellariona, gastrotrichas, larvae of bivalves, gastropods, polychaetes. While the smallest forms – ciliate protozoans, other protozoans and organisms of bacteria size – are grouped as **microbenthos**. The remaining benthic organisms – polybenthos – are primary producers, comprising macroalage and unicellular living plants.

Collection of macro benthos

Sampling of macro fauna

A wide variety of grab samples are available for quantitative sampling of soft bottoms. For general purpose, Day grab is recommended, as it is simple and reliable on a wide variety of sediment types is lowered on a wire rope with the help of winches on board in opened condition. It penetrates the bottom sediment with its gravity, and closed which hauled by wire cables attached to the bucket arms. The grab is emptied into the sieving table for sorting. For collection of the larger encrusting epifaunal species, a rectangular framed natural dredge is adequate on hard rocky bottom.

Sampling at Muddy and Sandy Shore

The most usual method of macrofauna and flora sampling is by pushing a $0.1m^2$ or $0.25m^2$ wooden or steel frame to a depth of 30cm, into the sediment, within the frame. Sediment is excavated to the desired depth (15cm). Plastic or metal tubes ($0.1m^2$) are also used to take an undisturbed core of sediment (10cm) from beaches.

Sampling at rocky shores

A square frame of heavy gauge wire laid on the substratum or marked, the animals within the frame being hand picked, counted, weighed, identified and transported to laboratory. For larger organisms, a frame of $0.25m^2$ is suitable.

Preservation of benthic organisms

After initial sieving and sorting of animals samples are preserved. Add 10% solution of 40% formaldehyde (2.5 to 5% buffered formalin is used for storage). 10% of dowacil – 100 solution or 70% ethenal with 5% glycerine are also used for storage.

Sorting of macrofauna

Grab sample is emptied on a wooden or metal lined sieving table or hopper and the contents are washed through a series of sieve baskets (16,2 and 0.5mm mesh) using a jet of water. Each sieve basket is washed and agitaed to separate three size class of organisms. Each size class is transferred to a container for fixation and transferred to laboratory

Sorting

Each size class sampler are transferred into a glass tray below which black or white material is inserted to provide varying background for distinguishing animals from debris. Larger individuals are hand sorted. For smaller individuals, divide the sample into fractions by agitating the light materials into suspension and pouring it through a fine sieve and collect. Add vital stains (rose Bengal, rodamine B, casin etc) to facilitate sorting for samples containing large quantities of detritus.

https://environment.arlingtonva.us/streams/macroinvertebrates/

Practical 14 Study of meiobenthic organisms

Collection

Subsamples are taken with core tubes from a grab or gravity corers. The craib corer with ball closing device in position, essentially a frame mounted core tubes, 5-7cm in diameter which is forced into the

bottom by weights. Gently lower the core tube into the sediment. Remove the core tube from the bottom sediment and empty the core sediment into a container and transport to the laborartory for extraction of meiofauna.

Shore samples

Samples are usually collected by using core tubes of various diameters depending on the abundance of the meiofauna. Corer of about 10mm internal diameter suitable for estuarine muds sediments, and 22.5 mm internal diameter for sands where numbers are generally lower. Sediment samples are brought to the laboratory for extract meiofauna after preservation.

Preservation

Preservation and extraction depends on the degree to which taxa are to be identified. "Hard" meiofauna like nematodies, copepods, ostracods and kinorhynchs preserved in 4% formaldehyde. Soft meiofauna like gastrotrichs and turbellarions are difficult to recognize after preservation. When the soft meiofauna need to be examined, live extraction and examination are recommended. Preserved samples are stained with rose Bengal before extraction.

Extraction of meiofauna from sand

• Decantation technique (for living soft meiofauna)
• Elutriation technique

Decantation technique (for living soft meiofauna):

Wash the sample into one litre capacity stoppered measuring cylinder and make up to 800ml with tap water giving a sedimentation height of about 30cm. Invert the cylinder several times to suspend the sediment and leave it for 60 sec. for sand particles to settle. Decant the supernatant through a sieve with a pore size not more than 63um (45um and 37um may also be used). Repeat several times (3 times). Wash the material in the sieve into a petri-dish for counting.

Elutriation technique

Biosseau type apparatus is for elutriation of sand, which has closed system arrangement. Sand sample is elutriated. Elutriation carries over most of the light fauna and the same is collected in sieve mesh. The sediment should be examined for heavier organisms (mollusks, ostracods) which can be extracted by hand.

Sea-ice technique

It is used for extraction of interstitial fauna (Uhlig 1966, 1968). The sediment is placed in a tube on a nylon guaze which just dips into filtered sea water in a collection dish. (Fig 148)' Add crushed sea-water ice to a layer of cotton wool on top of the sediment. As the ice melts, organisms move down into the collecting dish. This technique is well suited to soft meiofauna – ciliates and glagellates; however nematods and larger animals are extracted by elutriation or decantation.

Extraction from mud and detritus

Floatation technique using Ludox- TM:

• Remove any large particles, pieces of shell etc and the fine silt fraction from the sediment sample by decantation and sieve separation.
• Wash the light fraction with tap water into a centrifuge (50ml – 250 ml capacity)
• Add a teaspoon full of Kaolin powder to each container
• Shake vigorously for 7 min at 6000rpm in a high speed centrifuge.
• Pour off the water, the kaolin settles last and forms a plug over the sediment preventing it from being poured out.
• Add Ludox – TM until specific gravity is 1.15 and then resuspend the sediment by vigorous agitation.
• Stirring with spatula may be necessary to break up the Kaolin plug.
• Rebalance the pots and spin again for 7 min at 6000rpm.
• Pour off the supernatant through the meiofauna sieve and wash thoroughly with tap water before washing into the sorting dish.
• Repeat the extraction through the meiofauna sieve all but a few animals, virtually free of detritus and sediment.

Note: Centrifugation in a silica sol-sorb mixture is recommended if living material is extracted.

Examination and counting

The animals are sorted and counted under a stereoscopic microscope in petri-dishes. For identification to species, the animals can be picked out mounted, on slide using a fine pipette, needle etc and focus under high power microscope.

Mounting

Transfer formalin preserved specimens to a mixture of 9 parts of 70% alcohol to one part of glycerol by volume contained in a cavity block. Allow to evaporate slowly, leaving the animals cleared in pure glycerol. Mount on slides in anhydrous glycerol, supporting the cover slip with fine glass beads or rods of appropriate diameter. The mount can be made permanent by sealing the edges with glycerol.

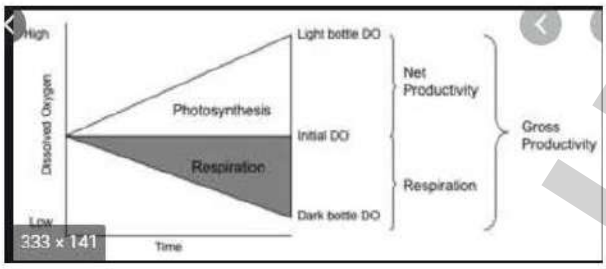
https://environment.arlingtonva.us/streams/macroinvertebrates/

Practical 15 Estimation of Primary Productivity in freshwater bodies

The primary production in the aquatic ecosystem starts with the synthesis of organic compounds from the inorganic constituents of water by the activity of plants / phytoplankton in the presence of sunlight. The

inorganic constituents which form the raw material for this synthesis are water, carbon dioxide, nitrate ions, phosphate ions and various other chemical substances. The products are mainly carbohydrates and proteins and fats in very small quantities. Organic production by plants is the first step in tapping energy by living beings from non-living natural resources and hence called primary productivity.

The method of estimating primary productivity by **dark and light bottle method** was introduced by Garder and Gran (1930). In this method, the water samples are incubated for a certain period in light and dark bottles which are then suspended at the same depths from where the samples are taken. In light bottles, oxygen is released as a result of photosynthesis and a part of oxygen is used for community respiration. In the dark bottles, only oxygen consumption takes place as a result of respiration. The amount of oxygen liberated by phytoplankton during photosynthesis is considered as a measure of primary production.



Materials required

1. BOD bottle (2 light / transparent and 1 dark)
2. Nylon or Jute ropes
3. Burettes,
4. Reagents (Manganous sulphate solution, Alkaline iodide azide solution, Sodium thiosulphate, Concentrated Sulphuric acid, Starch indicator solution) etc.

Procedure:

a. Fill three BOD bottles with water sample in round stopper bottles (1 Light bottle, 1 dark bottle and 1 control light bottle) avoiding air bubbles.

b. Water sample in the control bottle is immediately fixed by using Winker's fixatives.

c. The dark bottle is wrapped with aluminum foil and kept in a black bag to protect from light.

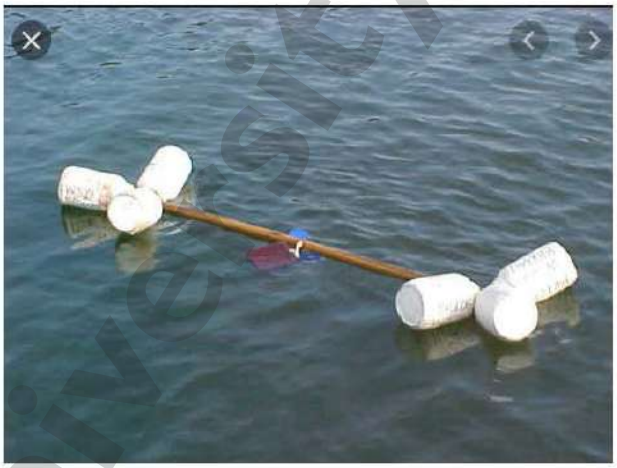
d. Use one of the light bottles for estimating the initial dissolved oxygen As control)

e. Suspend both light and dark bottles exactly at the depth from where the sample was drawn are then suspended on to a raft and anchored.

f. The bottles are normally incubated for a period of 3-4 hrs between dawn to midday or sunset in the respective depths

g. At the end of incubation period, the bottles are retrieved and fixed with oxygen fixatives.

h. The oxygen content in the sample is determined by using Winkler's method.



Calculation

IB=Initial oxygen level
DB= Final oxygen level in dark bottle
LB=Final oxygen level in light bottle
LB – IB= Net oxygen production
IB – DB=Oxygen consumed for respiration
LB – DB=Gross production of oxygen
T=Incubation period
0.375: Ratio of weight of C and O

PQ (Photosynthetic co-efficiency) =1.2

Gross primary productivity= **GPP**

Net primary productivity=**NPP**

$$\textbf{G.P.P} = \frac{(L.B - D.B) \times 0.375 \times 1000}{T \times PQ} \text{ mg C/m3/hour}$$

$$\textbf{N.P.P} = \frac{(L.B - I.B) \times 0.375 \times 1000}{T \times PQ} \text{ mg C/m3/hour}$$

$$\textbf{Respiration rate} = \frac{IB - DB \times 1000 \times 1 \times 0.375}{t} \text{ mg C/m}^3\text{/hour}$$

https://www.youtube.com/watch?v=ibeR7Y_smec

Practical 16 Collection and identification of aquatic plants from different freshwater body

The plants vary greatly in the degree to which they have become truly aquatic and present in an interesting series of gradations from those which are little more than amphibious, living at the

edge of the water in very moist or water saturated soil. Aquatic plants are those unwanted and undesirable vegetation which reproduce and grow in water and if left unchecked may choke the entire body of water posing a serious menace to pisciculture. Another definition is that the surplus growth of a plant that influences adverse physical, chemical and biological effects on a water body with its resultant economic and aesthetic losses.

Collection of Aquatic plants

The aquatic plants can be collected using a long handled hook, nets or by hand. For quantification of sample in a given area the floating or sinking type of quadrates of known size namely (1m x 1m or 0.5m x 0.5m) made up of PVC pipes or wood are used. These quadrates are placed to mark the area from which sample is to be taken. After collection, these plants are brought to the laboratory for identification. Before identification of these plants, they must be classified based on their habitat into the following classifications, they are :

i. Floating macrophytes

ii. Marginal macrophytes

iii. Submerged macrophytes

iv. Emergent macrophytes

Identified of Plants using the following keys:

i. Floating macrophytes

1**. Eichhornia sp (Water hayacinth or blue devil)**

Class : Angiosperm

Family : Pontederiacea

It is native of Brazil, accidentally brought to India and released in West Bengal, one of the most damaging aquatic weeds, inhabits stagnant and slow moving rivers.

Leaves broad with swollen stalks filled with air to enable them to float on water surface, dense leathery roots, flower pinkish in colour, multiplication by vegetative propagation, dries off in winter and spourts during summer.

2. **Salvinia (water fern velvet)**

Family : Salviniaceae

This plant has got rhizome, stalk or stem is delicate, oblong or hemispherical leaves, actual roots absent, leaves sessile with short stalk, leaves in two or more whorls, second whorl is either

lateral and floating, third one submerged in water which looks like roots, lateral leaves sometimes filled with air which aids in floating.

3**. Pistia (water lettuce)**

Family : Araceae

A free floating perennial plant, plant body comprise a shell like rosette of tongue shaped leaves, reduced stem, sessile leaves and numerous branching roots, leaves form common cup shaped structure, leaves ovate and surrounded at the base by membranous sheath.

4. Lemna (duck weed)

Light green in colour, occurs in group of one to three, no distinct stem, leaves have flattened, minute leaf-like fronds, vegetative reproduction is rapid, often forming a scum over the surface, flowers are rare and so small that they are invisible to naked eye, appear as small weeds.

5**. Azolla (water velvet)**

Family : Azollaceae

Smaller plant, found in stagnant water bodies, about 0.5 mm in

length, the entire plant is 1.5 – 2.0 cms in length, impart reddish green colour to water surface by covering it, it fixes atmospheric nitrogen.

ii**. Marginal macrophytes**

1. Colocasia

Family : Araceae

This plant covers large areas of the water body, leaves ovate, 6-20 inches long and 3-12 inches wide, leaf margin dark green in colour, base of stem triangular, petiole long up to 3-4 inches, colour of petiole green, violet or purple.

2**. Typha (Cat tail or Elephant grass)**

Family : Typhaceae

Common in margins of ponds, lakes, rivers and canals, perennial, creeping rhizome with leaves growing up to 2 m height and leaves have sheath at the base. Leaves bi-serrate, thick and spongy, secreting organ present at the leaf base, flower numerous and cylindrical.

1. **Marsilea (water shamrock)**

   Family : Marsiliaceae

   It inhabits ponds, rooted in shallow and stagnant r and

thin, roots burrowed into the ground, petiole long with four cloves like or sharp pointed leaflets.

4. Scirpus (Bullrush)

Family : Cyperaceae

Annual herb, triangular in cross section, stem bears sheath at the base but sometimes leafy and naked, spiklets numerous with one or more long leaves from the base of branch, spiklets are usually with more flowers.

2. Cyperus (Flat sedges)

Family : Cyperaceae

Perennial herb with a single stem, cylindrical in cross section and hallow. The stem has sheath at the base and with one or more leaves on top forming a cluster, flowers or spikltes are present at the top.

iii. **Submerged macrophytes (Rooted)**

1. **Hydrilla**

Family : Hydrocharitacea

It is found to occur in almost all water bodies in India like ponds, lakes tanks etc. Leaves linearly arranged in whorls while stem is slender, grows up to 45 cms, has got fibrous roots, multiplies very rapidly by spores and vegetative propagation, infestation density is 20-30 kg per square meter, broken parts of this plant develops into a new plant by attaching themselves with the help of roots, provides shelter to young fish in aquaria offer a substrate for attachment of spawn of common carp.

2. **Chara (stonewort)**

Occurs in all types of freshwater bodies, stem has got erect branches and are gregarious in habit, nodes and internodes can be easily distinguished, grow up to 15 – 30 cm in length, remains unattached to the bottom, plant is rough to touch.

3. **Vallisneria (eel grass / tape grass)**

Plant with long ribbon like leaves measuring 0.5 – 1 m width, female flowers are long, thread like, twisted and appear at stalks, propagation is by offshoots, it can tolerate temperature of 25 – 30°C and medium water hardness.

3. **Ceratophyllum (Horn wort) - (Non-rooted)**

   It has got a fragile algal like structure, grows to about 80 cms in length, roots are lacking, leaf branches are sometimes modified into rhizoids, lower part of stem serves as an anchore and helps in the absorption of nutrients, leaves are set in whorls, repeatedly forked with minute teeth on the side of the segment.

4. **Cobamba (Fan wort)**

   Leaves are opposite, cut into thread like regions, stem slender with a gelatinous lining; plant provides shade and shelter for small organisms and forms a beautiful aquarium plant.

iv. Emergent macrophytes

1. Nymphaea (Water lily / Nilkamal)

Found in ponds, lakes, canals and also in water up to 1.5 m depth, perennial herb, petiole with

lower end of leaflet, leaf round, veins radiating from the centre, leaves float on the surface of water, flower white or pink and solitary.

2. Nelumbo (Lotus)

Perennial herb, inhabiting tanks, ponds, lakes and other stagnant water bodies, leaves almost brown and are raised well above the water surface when mature, petiole attached to the centre of leaf, veins prominently radiate from the centre, flower large pinkish red leaf diameter ranging from 30 to 90 cms.

3. Trapa (Water chestnut / Singhara)

A perennial herb, occurs commonly in wild waters, leaves floating, solitary, branched or rhomboidal in shape, petiole with spongy swelling, flowers are solitary projecting over water surface, nuts with two or four sharp spines.

4. **Myriophyllum (Parrot head / Water milfoil)**

Found in stagnant and slow moving waters especially in places which are sheltered from wind, plants with slender, sparingly branch ooting freely at lower nodes, leaves opposite or whorled, the emer owers are very small and sessile

and found in the axis of upper, emergent leaves grows to moderate height.

Other emergent type of plants are Nymphoides (Floating or Tringed water lily), Nuphar (Yellow lily or Cow lily) etc.

https://www.youtube.com/watch?v=UaAO2aDhtBg