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ANALYTICAL STUDY OF TROPHIC LEVEL ALONG WITH, FOOD CHAIN AND FOOD WEB IN THE PONDS OF L.N.M.U., CAMPUS, DARBHANGA (BIHAR), INDIA

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Abstract: *The pond ecosystem on the planet is a carefully balanced cycle of life and death based on the series of food chains. If any one of these trophic levels becomes disproportionate to the others by taking too little or too much, the ecosystem is thrown out of balance and nothing within it will be able to function properly. A analytical study conducted in Manokamana Temple pond and Aanandbag pond located on L.N.M.U. campus of Darbhanga, Bihar, India from January to December, 2012. A total of 17 genera of phytoplanktons, 5 genera of macrophytes,14 genera of Zooplanktons, 7 genera macroinvertebrates, 10 genera of vertebrates and 2 types of decomposers were observed in the study area as a whole, out of which pond has greater taxonomic richness of producers, consumers and decomposers organism. Food chain of both ponds start at trophic level one with producers, such as phytoplanktons (Chlorophyceae, Bacillariophyceae, Cyanophyceae) and macrophytes (Angiosperms) than the 2nd level are consumers such as zooplanktons (Cladocera, Rotifer and Copepoda), macroinvertebrates (Annelida and Mollusca) and vertebrates (Pices, Amphibia, Reptilian, Birds) and top level is group of decomposers such as Bacteria and Fungi. Finally we conclude that the organism of Aanandbag pond and Manokama Temple pond get everything they need from the pond itself, they makes the trophic level of pond ecosystem self-sustaining along with food chain and food web of both the ponds.*

Keywords: *Consumers, Decomposers, Macrophytes, Macroinvertebrates, Producers, Phytoplanktons, Vertebrates, Zooplankton.*

Introduction: A pond ecosystem, a basic unit in ecology formed from the cohabitation of plants, animals, microorganisms an a surrounding environment, refers to a community of freshwater organisms largely dependent on each of the surviving species too maintain a life cycle. A pond's ecosystem consists of abiotic environmental factors and biotic communities of organisms. Abiotic environmental factors of a pond's ecosystem include temperature, flow and salinity. The percentage of dissolved O_2 levels in a water body determines what kind of organisms will grow there. After all, fish need oxygen in order to survive, however, anaerobic bacteria will not thrive in an ecosystem pumped with dissolved O_2.

A pond ecosystem consists of algae, fungi, microorganism, plants and various fish, which may fall into three distinct classification, producer, consumer and decomposer. The ponds and natural cycle begins with the producers and then to the consumers before ending with the decomposers.

A pond's ecosystem food chain has three basic trophic levels. The first trophic level represents the producer and autotrophs such as phytoplankton and plants. Producers prepare their own food with the energy emitted from the sun through a process known as photosynthesis. The second trophic level consists of herbivores, such as insects, crustaceans and invertebrates that inhabit the pond and consume the plants. The third trophic level comprises of carnivores, such as various size of fish, which feed on both the plants and animals, carnivores stop. The first and second trophic levels saprotrophic organism, also known as decomposers located on the bottom of the food chain, help decompose dead organic matter, which further breaks down into XO_2 and essential nutrients, such as nitrogen, phosphorus and magnesium. These nutrients supply the necessary life force for the first trophic level organisms to produce food for the second trophic organism, which results in the perpetual flow of energy in the ponds ecosystem.

The food web is a central organizing theme in ecology, depicting the feeding relationship between species in a community [1] and providing a framework for understanding energy transfer and biological process [2], biodiversity and trophic interactions, consumer behaviour and movement [3,4] perturbation [1]. Food web structure is summarized by emergent properties such as food chain length which measure the number of energy transferring between the base and the top of a food web, and is considered a central attribute of ecological communities.

Materials and Methods

1. Description of Experimental Site: Darbhanga is situated in 25.53^0 to 26.27^0 (North) latitude and 84.45^0 (East) longitude and the average of temperature variation in this area are 12^0 to 38^0C with average rainfall of 1638 mm. Darbhanga could easily be called ‘city of ponds’. From as small as 500 sq. meters to as large as 190,000 sq. meters in size, there are no less than 213 ponds in the town of little over 300,000 inhabitants. Darbhanga is most sensitive flooded area that’s why various number of pond found in entire Darbhanga including Aanandbag pond and Manokamna Temple pond of L.N.M.U. campus.

The Anandbag pond is situated back to the PG Department of Zoology, L.N.M.U.. The Nargauna palace haweli is situated at one side of pond. Another side of pond have historical Ram Mandir and MBA and PG Commerce Department of L.N.M.U. is also situated. While the Manokamna Temple pond is situated on the back side of Narguana haweli. At the one side of Manokamna Temple pond Naulakha Haweli and historical Manokamna Mandir is found and its bounderies are encircled by agricultural fields and residual buildings.

2. Collection of Samples: The samples of planktons were collected from the water surface of both the investigation sites i.e. Aanandbag pond and Manokamna Temple pond, in a 5 litre of plastic container. The sample were filtered through plankton net formed of standard bolting silk cloth no. 25 (mesh size 0.03 to 0.04mm).

The plankton was collected from each sample in small bottle attached to the lower end of the bottle. The collected samples were again filtered through sieve (mesh size 0.3 mm) in order to make then free from other materials. The filterate containing plankton were transferred to specimen tube. The filterate along with the plankton were preserved in Lugol’s solution with the help of monograph and available relevant literatures, the plankton were identified upto speices.

The collected samples of macroinvertebrates were washed through salve no. 40 (256 meshes/ cm^2) and macrobenthic invertebrates were transferred to vials containing 5% formalin for further identification. Preserved sample of macrobanthic invertebrates were identified [5,6].

Macrophytes were identified with the [7] while identification of fish, frog and snakes was assisted by the publication of [8]. Identification of the bird fauna was confirmed by the book [9].

To study and model the pond ecosystem, diversity of phytoplankton(algae), macrophytes, snails and other small animals (Zooplanktons), detritus (organic material found suspended in water) and fish fauna was estimated by sampling 10’×10’ area on at each side of the water boides and 10’×10’ area in the different sites of the pond in monthly pattern regularly.

Results

The present study was undertaken to investigate trophic level along with food chain and food web of Anandbag pond and Manokamna Temple pond of Darbhanga (Table-1 and Table-2). The first trophic level of both the ponds was groups of phytoplankton and macrophytes. During the present investigation total seventeen species of phytoplankton were encountered in both ponds viz:- *Euglena, Spirogyra, Volvox, Pediastrum, Cosmerium, Cladophora, Rhizoclonium, Nostoc, Spirulina, Oscillatoria, Anabaena, Microcystic, Pinnularia, Cymbella, Synendra, Frogilaria, Navicula, Nitzhiapelea* and total three species of macrophytes such as *Eichhornia Crassipes, Pistia Stratiotes, Postamogeton macronatus hydrilla* species.

The second trophic level was group of Zooplanktons. Total fourteen species of Zooplankton species were encountered in both ponds namely, *Bosmina sp., Dephnia sp., Ceripdaphnia sp., Alonella sp., Monia sp., Chydorus sp., Brachionus sp., Trichocera sp., Monia sp., Chydorus sp., Brachionus sp., Trichocera sp., Euchlanis sp., Nothola sp.,* *Rotaria sp., Filnia sp., Diaptomus sp., Cyclops sp.*

The third trophic level of both ponds was group of macroinvertebrates. The group of macroinvertebrates in both ponds was showed the seven species viz. *Hirudinaria granulosa, Pheratima posthuma, Palaemon Malcolm sonii, Chironomus pupae, Culicodes sp., Tabanus sp., Erosus sp., Hydroglyphus sp., Pila globosa.* The top level of both investigation pond ecosystem was group of vertebrates. During the present investigation ten species of vertebrates found in both ponds viz.- *Labeo rohita, Catla catla, Anabas testidineus, Clarius batracus, Channa puntatus, Frog, Snake, Tortoise, Duck, White heron birds* etc. the bacteria and fungi was decomposers of both ponds.

In this present investigation different types of food chain was found in Aanandbag pond and Manokamna Temple pond. The design of food chain in both pond was given below:

Primary Producers←Primary consumers←Secondary consumers←Tertiary consumers←Quaternary consumers.

Some examples of food chain in Anandbag pond and Manokamna Temple pond was given below

eg;-

1. Algae←Mosquito larva←Dragonfly larva←Fish
2. Algae←Mayfly←Small fish←Heron
3. Algae←Insect←Fish←Duck/Heron
4. Pond grass←Mosquito←Small Fish←Frog←Snake
5. Phytoplankton←Zooplankton←Fish
6. Pond grass←Mollusca←Fish

Discussion

A food web is graphically represents the paths of nutrients and energy through the living components of an ecosystem and the context in which individuals exploit their prey and avoid their enemies, understanding food webs begins with population biology. The regulation of population density and the fitness of individuals are determined by complex interaction among competition, predation and uncertainty in the length of the time ponds retain water. The present study site located on L.N.M.U. campus contains the unique scenario of two nearly ponds one is Aanandbag pond and another is Manokamna Temple pond.

Food web are central idea to understand the any type of ecosystem. They represent known or sometimes just suspected trophic connections among taxa in ecological communities. These connections represent the paths of energy and nutrient flow through living organisms. The food web structure is often summarized by emergent properties such as food chain length, which measures the number of energy transfers between the base and the top of a food web and is considered a central attribute of ecological communities [10].

Variation in food chain length has been observed in both ageing ponds i.e. Aanandbag pond and Manokamna Temple pond and is hypothesized to be controlled by basal productivity, disturbance and ecosystem size [11, 12]. The productivity or resource availability hypothesis states that, because energy is lost through length is limited by available energy resources [13]. The disturbance hypothesis predicts shorter food chains in more disturbed ecosystems due to either longer food chains being less resilient to perturbations than shorter food chain [14] or species at higher trophic levels being rarer and more likely to be lost during disturbance events [15, 16].

Food chain length can be altered by the addition and removal of a top consumer, the addition and removal of an intermediate consumer insertion or a change in the degree of trophic omnivory shown by a top consumer. Hence food chain length, should vary according to local environmental conditions and provide an opportunity to investigate the mechanisms underpirating such variations.

According, the investigation predicted that, (1) more productive sites, as indicated by nutrient concentrations, would have longer food chian, (2) more hydrologically isolated sites, which serves as an analog for more disturbed sites, in this landscape setting, would have shorter food chain and (3) longer ecosystems would have longer food chain. The strength of these relationships would be related to degree of trophic omnivory in the top predator, where food webs with omnivores rather than piscivores as the top predators would have shorter food chain but would still show a positive relationship between food chain length and ecosystem size [12].

This present investigation described the flow energy in natural system, using the law of thermodynamics and citing the sun as the main source of energy. Energy flows through a pond ecosystem via food webs. In this present study, it has been understood that, (1) The sun is the primary source of all energy on earth, (2) All organisms need energy to survive and thrive.(3) The amount of energy available in a pond ecosystem is a limiting factor (4) The amount of energy in a pond ecosystem determines the population it can support. (5) A pond food chain is made up of producers and consumers. A food chain describes the sequence of who eats or decomposes whom to another through the ecosystem. Food webs are made up of food chain. (6) Energy exists in many forms in a ponds ecosystem. (7) Energy moves through an ecosystem with seasonal changes. (8) The first and second law of thermodynamics govern the activities of all living things.

On average about ten percent of net energy production at one trophic level is passed on to the next level. Processes that reduce the energy transferred between trophic levels include respiration, growth and reproduction defection and non-predatory death (Organisms that die but are not eaten by consumers). Previous research such as [17, 18] suggest that ecosystem size increased food chain length because larger bodies top predators tend to be absent from smaller ecosystems or that the insertion of a new species at lower trophic levels increases the trophic position of the top predators [18, 19]. These mechanisms depend on food webs having a strong size structure, where top predators are notably larger than prey from lower trophic level [20].

In this present investigation used two ponds into which a diverse community of zooplankton, phytoplankton, periphyton and microorganisms were introduced the randomized collections made in Aanandbag pond and Manokamna Temple pond of L.N.M.U. campus. The herbivores caused a significant reduction in their food source, the periphyton and the predicted increase in phytoplankton. The periphyton was reduced more on the bottom litter than on the sides of the ponds, perhaps due to both the grazing habits of the herbivores and shadings of the bottom by the dense bloom of phytoplankton that occurred when grazer were present. In this present investigation shows that primary productivity often, but not always, saturates with species richness within single trophic levels, however, any interpretation of such patterns must consider that variation in biodiversity is necessarily associated with changes in species composition and that changes in biodiversity often occur across multiple trophic levels. The present investigation result from easily manipulated species richness and species composition across multiple trophic levels in pond food webs. Indirect evidence suggests that richness and associated changes in species composition affect ecosystem attributes through indirect effects and trophic interactions among species, features that are highly characteristic of natural, complex ecosystem.

Conclusion

Finally we conclude that ponds are excellent areas for the study of community ecology. Individual ponds are part of a larger landscape. They protect stream network by trapping nutrients, toxins, sediments and serve as critical sustaining regional aquatic biodiversity. The food web is the useful departure point for the development of a productive theory of community ecology. The food web structure, food chain length, should vary according to local environmental conditions and provide an opportunity to investigate the pond community ecology. Thus, careful maintenance of individual ponds also contributes to the ecological integrity of the surrounding region.

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Table-1: Analytical study of Aanandbag pond and Manokamna Temple pond of L.N.M.U. campus, Darbhanga for their producer organisms during January to December 2012

Different groups of producers organisms			
Producers Organism	Phytoplanktons	Chlorophyceae	*Euglena*
			Spirogyra
			Cosmerium
			Cladophora
			Rhizoclonium
			Pediastrum
		Cyanophyceae	*Spirulina*
			Oscillatoria
			Anabaena
			Microcystic
			Nostoc
		Bacillariophyceae	*Pinnularia*
			Cymbella

			Synendra
			Frogilaria
			Navicula
			Nitzhiapelea
	Macrophytes	Angiosperms (Flowering plants)	*Eichhornia crassipes*
			Pistia stratiotes
			Postamageton
			Macronatus
			Hydrilla sp.

Table 2: Analytical study of Aanandbag pond and Manokamna Temple pond of L.N.M.U. Campus, Darbhanga for their consumers and decomposers organisms during January to December 2012

Different groups of consumers and decomposers organisms			
Consumers Organisms	Zooplanktons	Clacocera	*Bosmina sp.*
			Dephnia sp.
			Ceripdaphnia sp.
			Alonella sp.
			Monia sp.
			Chydorus sp.
		Rotifera	*Brochionus sp.*
			Trichocera sp.
			Euchanis sp.
			Nothola sp.
			Rotaria sp.
			Filinia sp.
		Copepoda	*Diaptomus sp.*
			Cyclops sp.
	Macronivertebrates	Annelida	*Palaemon Malcolm Sonni*
			Chironomus pupae
			Culicodes sp.
			Tabanus sp.
			Erosus sp.
			Hydroglyphus sp.
		Mollusca	*Pila globosa*
	Vertebrates	Pieces	*Labeo rohita*
			Catla catla
			Anabus testitinecus
			Clarias batracus
			Channa puntatus
		Amphibia	*Frog*
		Reptalian	*Snake, Tortoise*
		Birds	*Duck, White Heron bird*
Decomposer Organisms	Bacteria		
	Fungi		

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