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A comparative study of biomass and net production of aquatic insects of Hardia wetland of Saran District of North Bihar, India.

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Abstract- Arthropods were the dominant group among macroinvertebrates, surpassing molluscs and annelids in abundance. Among arthropods, insects were the most dominant subgroup. In total, 85 species of macroinvertebrates were recorded in this study, classified into three major groups: arthropods, molluscs, and annelids. Arthropods occupied the highest position, comprising 66 species and accounting for 78.17% of the total. Molluscs followed with 11 species (12.64%), while annelids were the least represented, with 8 species (9.19%). Within arthropods, 66 species were identified, including 3 species of decapods. The insect subgroup was the most diverse, with 63 species. Among them, coleopterans (beetles) and hemipterans (true bugs) were equally dominant, each with 24 species. Odonates (dragonflies and damselflies) accounted for 8 species, dipterans (flies) for 4 species, and ephemeropterans (mayflies) for only 3 species. The density of arthropods varied throughout the year, ranging from 170 individuals per cubic meter in August to 980 individuals per cubic meter in February. Their population showed an increasing trend during winter and late monsoon and a decreasing trend during summer and early monsoon. Overall, macroinvertebrate populations were highest in winter, followed by summer and monsoon. The decline in summer is attributed to low water levels and the decomposition of macrophytes (aquatic plants). The monsoon decline is likely due to heavy rainfall, which disrupts habitats. In contrast, the winter increase is linked to the abundant growth of macrophytes, which provide shelter, food, and diverse spawning sites. The biotic index of insects suggests that the water quality is fair, with minor disturbances. The highest monthly and daily net production of aquatic insects was observed during summer and monsoon, while negative growth was recorded during the post-monsoon and winter months.

Keywords: Insect dominance, Macroinvertebrate, Increasing trend, Decreasing trend, Shelter food, Diverse niches, Biotic index, Aquatic insect.

INTRODUCTION

Secondary production refers to the accumulation of energy in the tissues of heterotrophic organisms over time and space. It has been defined by various ecologists. Waters and Crawford (1973)[1] specifically described secondary production or biomass as the amount of tissue produced by freshwater invertebrates per unit of time and area, regardless of its ultimate fate. This production can be measured in terms of dry weight (grams) or energy content (calories).

The estimation of secondary production is crucial for the effective management of aquatic resources. Researchers have suggested that understanding the production processes of invertebrates can aid in fisheries management. Fish yield has been found to correlate with the mean standing biomass of macrobenthos in lakes.[2] This suggests a general relationship between secondary productivity and fish

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production. Enhancing secondary production may play a significant role in the development of aquaculture.[3]

The productivity of aquatic insects has been extensively studied by various researchers.[4-6] The present study focuses on the standing crop biomass and secondary productivity of aquatic insects in the wetland throughout different months of the year.

MATERIAL & METHODS

Collection of insects:

The aquatic insects were collected with the help of an insect collecting dip net made up of nylon cloth (mesh size 40-80 meshes/cm^2).

Productivity Estimation:

The samples were placed in an oven at 60°C until they reached a constant weight. The productivity of aquatic insects was estimated using the biomass method, as suggested by Winberg (1971)[7]. The weight lost during drying was considered the amount of water present in the insect's body. To measure biomass, the ash-free dry weight of the insect was used. The results were expressed as:

- Biomass: grams per cubic meter (g/m^3)
- Net monthly growth: grams per cubic meter per month (g/m^3/month)
- Daily net growth: grams per cubic meter per day (g/m^3/day)

Collection, preservation and Identification:

Aquatic insects were collected using a dip net made of nylon cloth with a mesh size of 40-80 meshes/cm^2. Insects living among aquatic weeds were collected manually. The collected samples were then sorted and preserved in 80% alcohol for further analysis. Identification of the insects was carried out using reference books by Needham and Needham (1966)[8], Tonapi (1980)[9], Usinger (1956)[10], and Merritt and Cummings (1978)[11].

EVALUATION OF POLLUTION INDEX:

1. Palmer's algal index:

Palmer (1969)[12] algal species index were taken into consideration to know the pollution status of the system.

2. Biotic index:

It is also used to access the water quality. It was proposed by Hilsenhoff (1977)[13]. The index is determined usually on the basis of aquatic insects population available in water. The biotic index is calculated as following:

$$BI = \sum niai/N$$

Where ;

ni = number of specimen in each taxonomic group.

ai= pollution to tolerance score for that taxonomic group.

N= total number of biotic animal group present in the sample.

For each taxon the number of individual collected were multiplied by the following score for that group. The value for all the groups present were added and divided by the total number of biotic animal group collected from the medium. In the above manner BI is determined.

Biotic index	Water quality
Under 1.75	Excellent, no disturbance
1.75-2.25	Good, possibly some disturbance or organic enrichment
2.25-3.00	Fair, probably some disturbance
Over 3.75	Very poor, gross disturbance

RESULTS & DISCUSSION

Aquatic insects recorded in the study belonged to the orders Ephemeroptera, Odonata, Hemiptera, Coleoptera, and Diptera. Among them, Coleopterans (beetles) and

Table:1: Biomass and Net Production of aquatic insects of Hardia wetland in (2011-13)

	Biomass		Net monthly production	Period	Net Daily Production
Month	g/Haul	g/cubic m	g/ m^3/month	Days	g/m^3/day
Nov	1.6	3.238			
Dec	1.4	2.834	-0.404	34	-0.011
Jan	1.5	3.036	0.202	36	0.005
Feb	1.7	3.441	0.405	32	0.012
Mar	2.1	4.251	0.203	24	0.008
Apr	1.8	3.643	0.608	25	-0.024
May	1.8	3.643	0	26	0
Jun	2	4.048	0.405	30	0.013
Jul	2.1	4.251	0.203	25	0.008
Aug	2.3	4.655	0.404	25	0.016
Sep	2.2	4.453	0.202	36	-0.005
Oct	2	4.048	-0.405	36	-0.011
Nov	1.7	3.441	-0.607	25	-0.024
Dec	1.5	3.036	-0.405	21	-0.019
Jan	1.6	3.238	0.202	35	0.005
Feb	1.9	3.846	0.608	35	0.017
Mar	2.2	4.453	0.607	33	0.018
Apr	2.1	4.251	0.202	28	-0.007
May	2.3	4.655	-0.404	31	0.013
Jun	2.4	4.858	0.203	36	0.005
Jul	2.4	4.858	0.203	32	0.006
Aug	1.8	3.643	0.608	29	-0.02
Sep	1.6	3.238	-0.405	29	-0.013
Oct	1.3	2.631	-0.607	28	-0.021

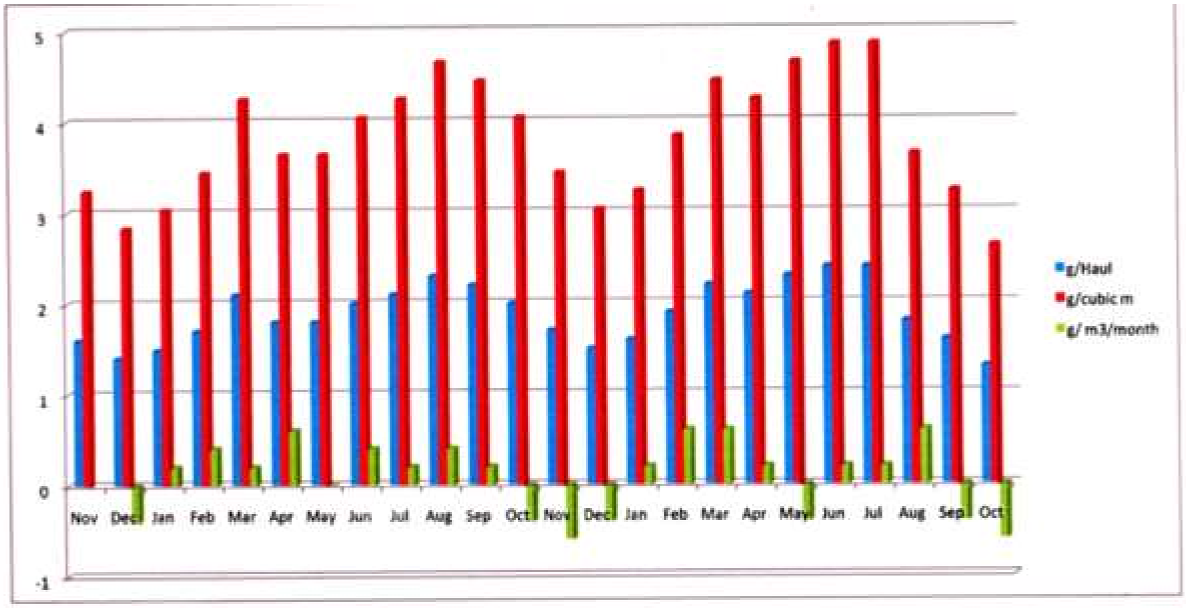

Fig:1 : Biomass and Net Production of aquatic Insects of Hardia wetland in (2011-13)

Hemipterans (true bugs) were the dominant groups, including both larvae and nymphs. Biomass and net production of aquatic insects are summarized in Table 1. During the first year of the study, the maximum biomass recorded was 4.858 g/m³, while the minimum biomass was 2.631 g/m³. The biomass per haul ranged from a maximum of 2.3 g/haul in August 2012 to a minimum of 1.4 g/haul in December 2011. The highest monthly and daily net production occurred in April 2012 (0.608 g/m³/month) and August 2012 (0.016 g/m³/day).

Negative growth was also recorded in some months (Table 1, Figure 1). For the period November 2012 to October 2013, the lowest biomass was recorded in October 2013 (2.631 g/m³), while the highest biomass was observed in June 2013 (4.858 g/m³). The biomass per haul was also at its lowest in October 2013 (1.3 g/haul) and peaked in June and July 2013 (2.4 g/haul). The highest monthly and daily net production was recorded in February 2013 (0.608 g/m³/month) and March 2013 (0.018 g/m³/day), respectively. Negative growth was more prominent in 2012-2013 compared to the previous year. It was generally observed during the post-monsoon season. (Table 1, Fig.1).

DISCUSSION

The process of production in an aquatic environment is regulated by the trophic interactions among organisms. These interactions facilitate the transfer of matter and energy from one trophic level to the next.[7] The growth patterns of aquatic organisms, whether positive or negative, are influenced by environmental conditions, food availability, and predation. The highest net production observed during summer suggests a positive effect of temperature on production. This may be due to optimal average temperatures, an ecosystem's ability to produce sufficient food of acceptable quality, the nature of the substrate, and the availability of oxygen. Several researchers have also reported that temperature directly influences production.[14-17]

Secondary production is further affected by the morphological characteristics of the ecosystem. In this particular wetland, which becomes shallow during summer, the gradual rise in temperature creates favorable conditions for higher insect production. In contrast, insect biomass shows a declining trend in winter, as the non-growing phase and low temperatures hinder development. Low temperatures are particularly unfavorable for oviposition (egg-laying) and growth in stenothermal organisms (species that thrive within a narrow temperature range). These findings are consistent with the research conducted by Benke and Benke (1975)[18].

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