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Climate change and its impact on aquatic ecosystem in the central Himalayas

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INTRODUCTION

The Himalayas is considered as one of the most unstable ecologically fragile regions on earth. Due to their wide exposure to environmental stressors, lakes in the region are more susceptible to global warming.

Lakes at different altitudes can be used as a climatic gradient and could serve as models for predicting the possible impacts of climate change.

A high incident of UV-B irradiance and change of climate may transform not only on the physical characteristic of the aquatic ecosystem but also the chemical and biological parameter.

The adaptive strategies of aquatic biota may occur by developing specialized protective mechanism that pledges long-term survival and domination in the upland lakes.

The main objectives

- *To identify planktonic group in aquatic ecosystem that could be used for monitoring the impact of climate change in the central Himalayas,*
- *To determine the adaptive strategies of aquatic organism to the changing climate.*

MATERIAL & METHODS

Water and sediment samples were collected from seven lakes of the central Himalayas (2 sites; 2 seasons).

Water temperature, pH, DO, Conductivity, ORP, PO4-P & NH4-N, Turbidity, Transparency, Alkalinity & Hardness of water were determined using standard methods (USEPA, 2007 & APHA, 1999).

Total organic matter (TOM) was estimated by ignition loss method.

Humic compounds (HA) and Lignin like compound (LLC) were extracted using IHSS protocols & determine their concentrations & degree of humification.

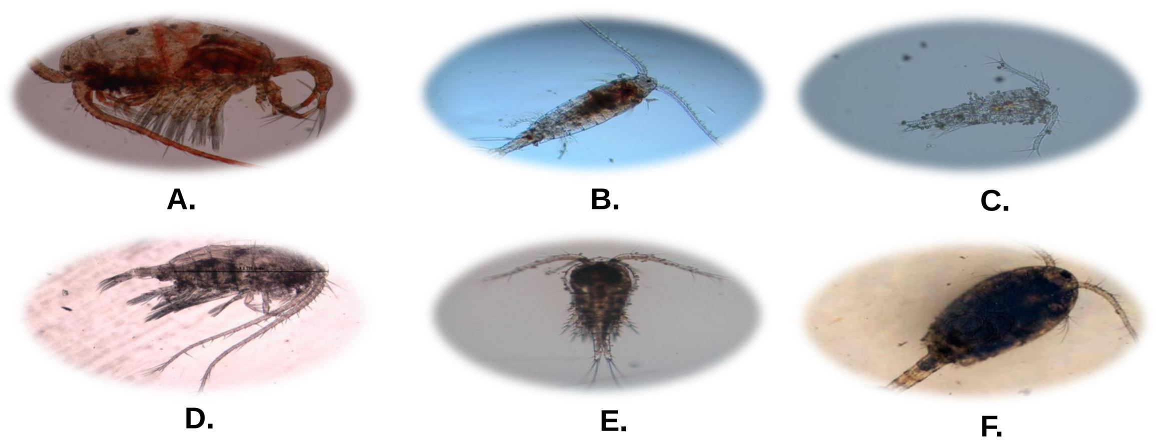


Fig. 1A-F Copepods collected from six lakes of the central Himalayas

Zooplankton species were collected by sieving water in plankton net (25µm mesh size) & identified under microscope. Abundance was estimated by enumerating under Sedgewick rafter.

Carotenoids pigments from was copepods was extracted using acetone: hexane (1:3) & determined their concentrations in UV-VIS spectrophotometer.

Statistical analyses through EXCEL, SPSS 16.0 & PAST3.

RESULTS

Water temperature and pH decreases with rises in elevation (F = -0.891, p = 0.001 & F = -0.550, p = 0.042).

TOM were low in high altitude shallow lake.

TOM influenced on the water transparencies (-0.660, p = 0.010) and is lower with increasing altitudes (F = -0.577, p = 0.031).

Table 1. Physico-chemical parameters of seven lakes of the central Himalayas

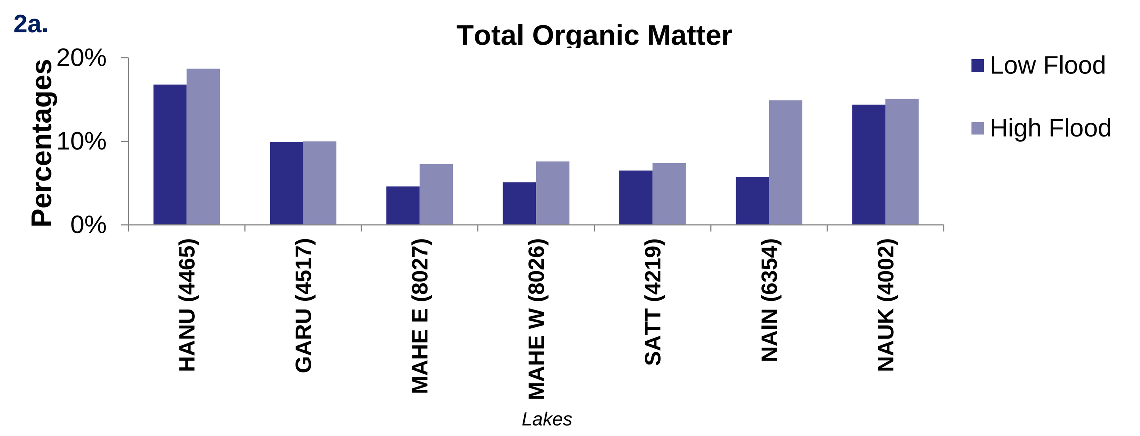
Lakes	Depth	Temp.(°C)	pH	Transp. (m)	DO (mg/l)	Turbidity (NTU)	Hardness (mg/L)	TDS	NH4 - N (mg/l)	PO4 - P (mg/l)
HANUMANTAL	6	**23.1** ± 1.1	**8.7** ± 0.5	**0.4** ± 0.1	**8.0** ± 0.6	**15.8** ± 1.6	**47.5** ± 6.4	**36.0** ± 2.8	**0.020** ± 0.007	**0.038** ± 0.004
GARURTAL	15	**22.1** ± 2.3	**9.7** ± 0.8	**2.1** ± 0.4	**7.6** ± 0.0	**1.7** ± 0.4	**44.5** ± 4.9	**36.0** ± 1.4	**0.010** ± 0.000	**0.010** ± 0.000
MAHESHWRKUND E	7	**15.1** ± 0.5	**6.9** ± 0.3	**2.5** ± 0.3	**9.4** ± 0.1	**0.6** ± 0.1	**18.5** ± 2.1	**59.0** ± 7.1	**0.010** ±0.000	**0.050** ± 0.000
MAHESHWRKUND W	7	**16.1** ± 1.5	**8.5** ± 0.4	**2.0** ± 0.1	**9.1** ± 0.7	**1.0** ± 0.1	**17.0** ± 1.4	**16.5** ± 0.7	**0.010** ± 0.000	**0.040** ± 0.000
SATTAL	20	**23.1** ± 2.9	**9.3** ± 1.2	**1.2** ± 0.3	**8.4** ± 0.1	**1.7** ± 1.1	**51.0** ± 7.1	**41.5** ± 0.7	**0.015** ± 0.007	**0.015** ± 0.007
NAINITAL	29	**20.8** ± 2.3	**8.2** ± 0.5	**1.4** ± 0.4	**6.5** ± 0.1	**3.0** ± 0.5	**258.0** ± 55.2	**290.0** ±4.2	**0.080** ± 0.071	**0.060** ± 0.014
NAUKUCHIYATAL	40	**23.6** ± 2.5	**8.1** ± 0.5	**1.8** ± 0.3	**10.3** ± 1.5	**2.1** ± 0.4	**85.5** ± 3.5	**94.0** ± 2.8	**0.043** ± 0.029	**0.011** ± 0.001

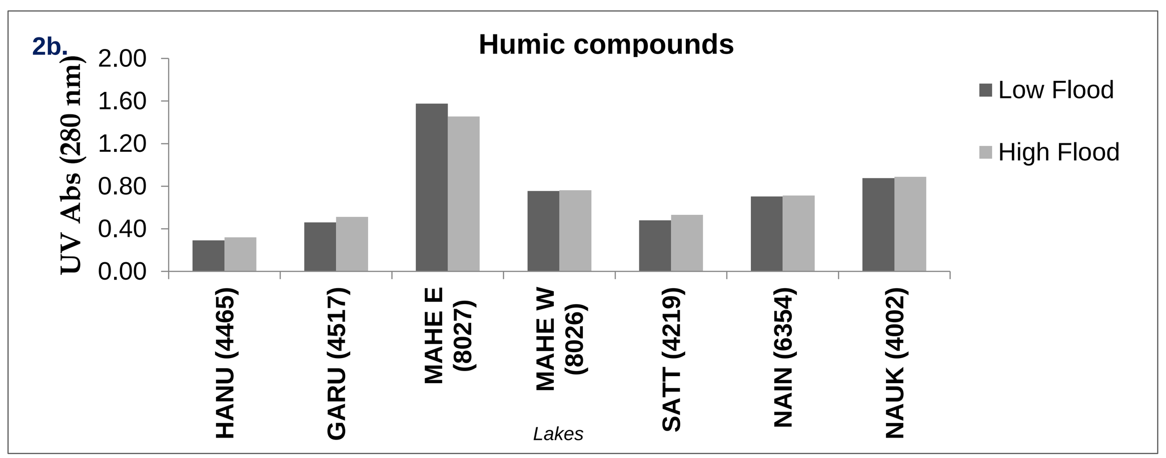
In low altitudinal lakes, TOM are significantly high particularly during high flood(Fig. 1a).

Lake sediment generated higher amount of humic substance (Fig. 2a) & Lignin like compounds (fig 2b) in higher transparent lakes (F = 0.693, p = 0.006 & F = 0.751, p = 0.002).

High LLC deposited in the sediment of the shallow high altitude lakes (fig 2c). Aromatization & and condensation processes from plants leaves and twigs.

In turbid shallow lakes where high depositions of TOM occurs, concentration of humic compounds are greatly reduces & low degree of humification also (Fig.2c).





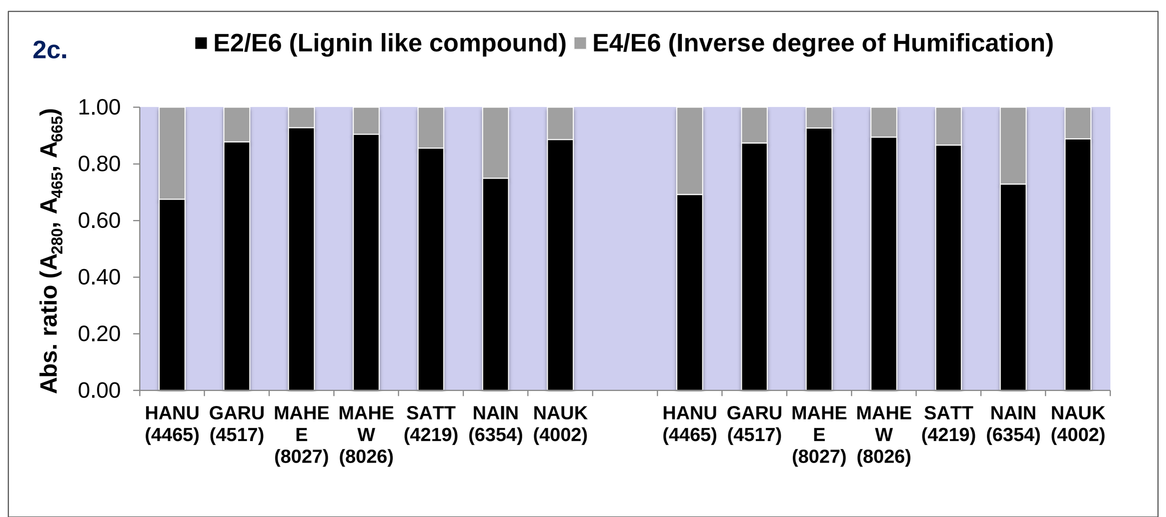
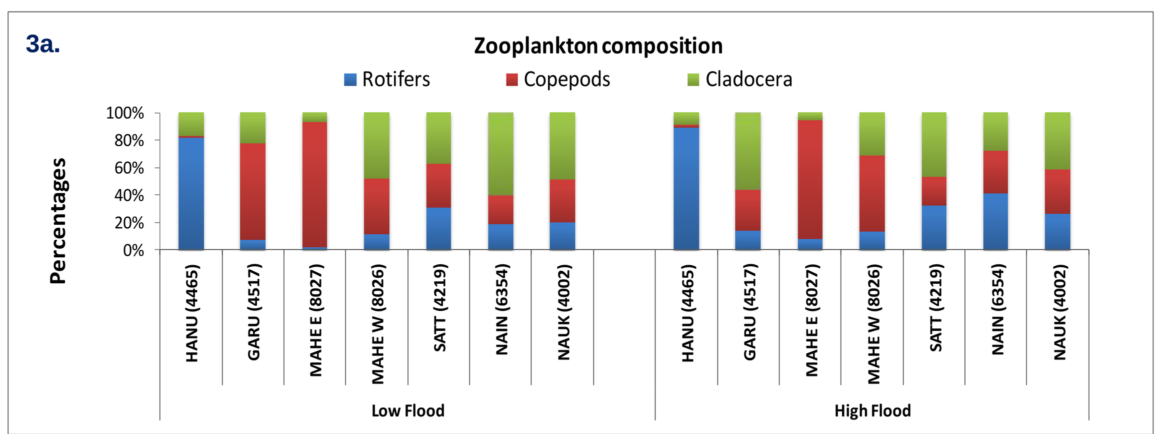


Fig. 2 (a). Total organic matter, (b) Humic substances, (c) Lignin like compound and degree of humification in seven lakes of the central Himalayas

Copepods were dominated in high altitude shallow lakes (fig 3a & b) while cladoceran in the deeper lakes.

Copepods abundance showed significant positive correlation with amount of humic compounds (F = 0.755; p = 0.002).



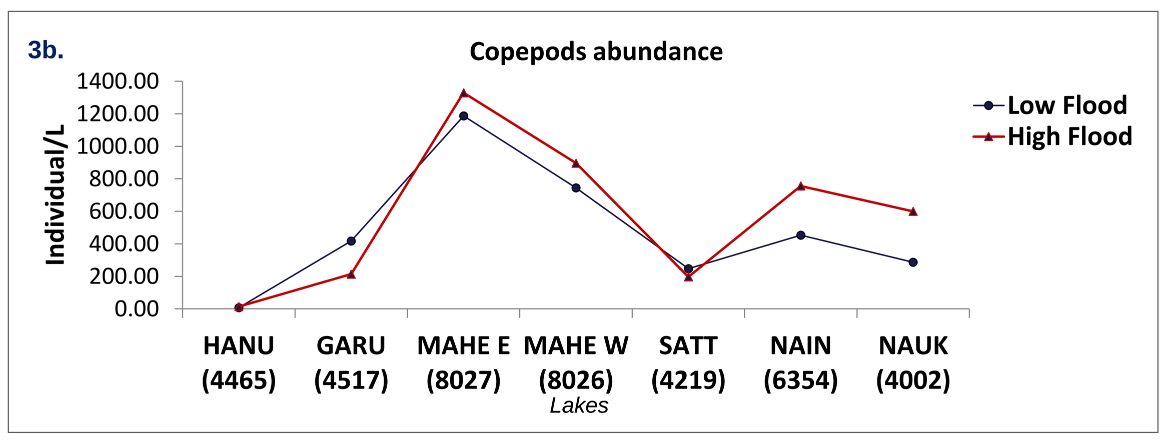


Fig. 3 (a) Percentage composition of Zooplankton groups (b) Abundance of copepods in seven lakes of the central Himalayas

The copepods of high altitude shallow lakes contain greater amount of carotenoid pigments (fig 4) & positively correlated with humic substances (F = 0.652, p = 0.012).

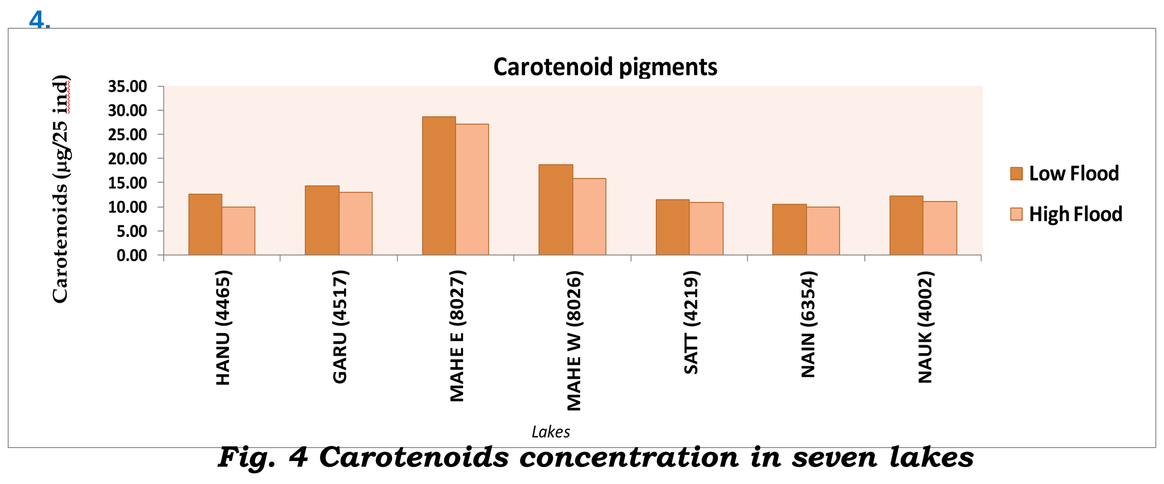


Fig. 4 Carotenoids concentration in seven lakes

From CCAs transparencies of water in elevated lakes augmented in formation of Lignin like compound.

Concentration of carotene in copepods were influenced by deposition of humic substances increased with the rises of elevation.

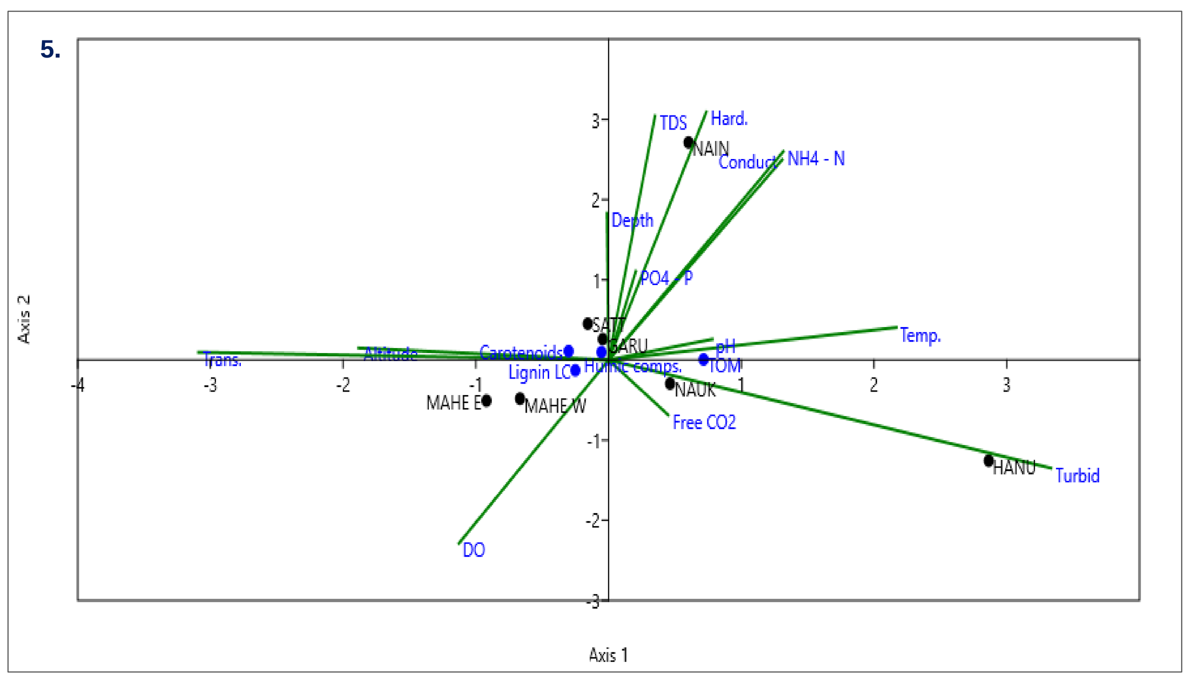


Fig. 5 CCAs biplot of physico-chemical parameter of water, sediment characteristics and carotenoids in seven lakes of the central Himalayas

CONCLUSION

In the high latitude lakes of the Himalaya, changes in climate influenced greatly on the species composition of aquatic biota.

Copepods of shallow lakes unable to migrated and appear to develop adaptive strategies by changing food habits. They adapted to persistently low temperatures and high transparency.

The remnants of leaf litter derived from the shoreline generated humic compounds.

The photoprotective compounds accumulated through the food chain helps in survival (against oxidative stress from ultraviolet sunlight) & adaptation of Copepods from high intensity UV irradiances.

Shoreline plantation in Lake Ecosystem augmented in survival and adaptation of the aquatic organism to climate change.

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