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Study of soil macrofauna in relation with some of selected soil physio- chemical properties at sumayar-nagar in district Hunza-Nagar Gilgit-Baltistan, Pakistan

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Abstract

Soil is one of the most essential and diverse natural habitat of biodiversity on earth. Soil organisms (biota) carry out a wide range of processes that are important for soil health and fertility in both natural and managed agricultural soils. Total number of organisms, diversity of species and the activity of the soil biota will fluctuate as the soil environment changes. The present preliminary study aims to investigate the abundance, diversity and community composition of Macrofauna in agricultural soils in Nagar-Sumayar in Hunza-Nagar district of Gilgit-Baltistan. Beside soil Macrofauna some of the selected physio-chemical properties of the soil were also investigated. For sampling the entire Sumayar-Nagar is divided into 9 clusters and total 54 soil pits were dug out with Quadrate size (25*25*15cm) and Macrofauna was picked and preserved in 4% formalin. Soil temperature was determined using Temperature probe, air humidity by humidity probe, and moisture determined by Gravimetric method. A total of 718 soil Macrofauna were recorded from 14 orders, the most abundant taxa was Diptera comprising of (59%). Other major orders were Coleoptera (15%), Chilopoda (4.5%) Aranea (3%), Potworms (3%), Hemiptera (2.7%) Hymenoptera (2.7%) Oligochaeta (2%), unidentified Macrofauna (2.9%), Lepidoptera, Acari, Orthroptera and Homoptera (1%) respectively. pH of the soil varies from 7.7 to 8, soil temperature from 10-220C and soil moisture from 14-20% in different clusters or areas of Nagar- Sumayar. Pearson's correlation indicated that pH was positively correlated ($p<0.01$) with Diptera larva while soil temperature with Diptera adult. Soil moisture was positively correlated with Lepidoptera and Aphidae and negatively correlated ($p<0.01$) with Orthroptera. Macrofauna abundance was positively correlated with soil pH. One way ANOVA showed that there were no significant differences of soil Macrofauna abundance among the various clusters. Highest soil quality was attributed to Daltho area and lowest was Yal area as determined by Macrofauna abundance. Further research need to be done with more intensive sampling to investigate the influence of seasons and other soil management practices on soil Macrofauna abundance and diversity.

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Introduction

Soil is the essential natural means for bionetwork and biosphere route. Soil and sediments are helpful in regulation of ecosystem (Freckman, 1996). Macrofauna are those species having the size above 2 mm (Thomas *et al*., 1993; Swift and Anderson, 1993) helps in mixing of organic matters and changes the chemical and physical state of soil. Soil invertebrates are affected or flourished by human activities (Lavelle *et al*., 1994). Ants, termites, and aranea are directly affected by agriculture (Mathieu *et al*., 2005). The inhabitants of macrofauna were exaggerated by a variety of nature of residue breakdown and plant residue (Tian *et al*., 1993). In moderate and humid ecosystem macro invertebrates are predicted as significant regulator (Lavelle *et al*., 2006; Jenkinson and Ladd, 1981). Soil fertility enhance when these fauna makes their association with fungi or decomposers (Lavelle *et al*., 1997). Beside with the soil organisms, earthworms acting key role in chemical and physical independence of soil (Aina, 1984; Edwards and Bohlen, 1996; Abdul Rida and bouché, 1997). Beetles and other species are favoured by climatic conditions (Coulson *et al*., 1999; Wichmann and Ravn, 2001; Eriksson *et al*., 2005; Gilbert *et al*., 2005). The movement of nutrients is due to oligocheates (Anderson *et al*., 1983). Beare *et al*., (1997) stated that due to continuous cultivation of same crop and application of nutrients changes the soli fauna.

The aims and objectives of the study are to investigate the abundance, variety or diversity and community composition of macrofauna in agricultural soils in Nagar-Sumayar in Hunza-Nagar district of Gilgit-Baltistan. Beside soil macrofauna some of the selected physico-chemical properties of the soil were also investigated.

Materials and methods

Description of study site

Whole study was carried at Sumayar Nagar; district Hunza-Nagar, Gilgit Baltistan. Elevation of Sumayar-Nagar valley is approx 2251m. Maximum temperature in summer is 15-20°C while in winter it is -5 to -10°C. Sampling was carried out in October 2011.

Agriculture soil was sampled. Whole Sumayar-Nagar was divided into 9 areas. Then further each area was divided into 6 clusters. For macrofaunal sampling total 54 soil pits were dug out. The characterization and identification of macro fauna are totally depending on their body size describe by Blair *et al*., 1996 and Anderson and Ingram in 1993.75% alcohol and 4% formalin is used for preservation of organisms, took them in lab for identification only at order level. Organisms were identified and calculated their abundance. For macrofauna sampling we have used quadrate size 25*25cm and dugout till 15cm depth. Carefully dugout soil till depth of 15cm with the help of troval and spade and spread the soil in the tray and handpicked all the visible macrofauna and preserved them in 75% alcohol and 4% formalin (for earthworm). For determination of soil moisture 5 grams of soil were taken and kept in plastic bag. Extra set of soil samples were also taken to laboratory for determination of soil pH. Gravimetric method was used for determined of soil moisture by drying soil samples at 105°C for 24 hours. Soil moisture content was calculated as follows:

Moisture content % = (weight of moist soil-weight of oven dried soil) / (weight of oven dried in grams)*100.

Before analysis pH, soil samples were air dried and sieved it using 2mm sieve. Soil pH was measured using pH probe with glass-calomel electrode and 1:1 soil: water ratio (Mc Lean., 1982). GPS was used to determine the elevation of the area and clusters. Data was analyzed by using SPSS-16.0 and MS Excel software. One way ANOVA was performed to determine the significance difference of soil macrofauna abundance among various clusters. Pearson's correlation was applied to determine the relationship among various investigated parameter.

Results

A total of 718 soil macrofauna were recorded belonging from 14 orders. The most abundant taxa was Diptera 428 (60%) (Both larvae and adults), followed by Coleoptera (15%) both larvae and adults. The other orders were Chilopoda (4.5%) which includes both Lithobiomorpha and Geophylomorpha, Aranea (3%), potworms (3%), Hemiptera (2.7%), Hymenoptera (2.7%) Oligochaeta (2%), unidentified macrofauna (2.9%) few Lepidoptera, Acari, Aphidae, Orthroptera and Homoptera respectively (Fig 1)

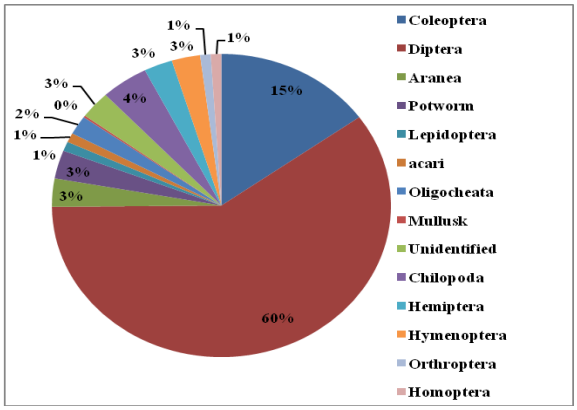

Fig. 1. Total percentage of macrofauna abundance from study area.

One way ANOVA revealed non-significant differences of soil macrofauna and physic-chemical properties with respect to various clusters in Sumayar- Nagar. This could be due to similarity in habitat and management practices as we have sampled macrofuana and soil only agriculture soil.

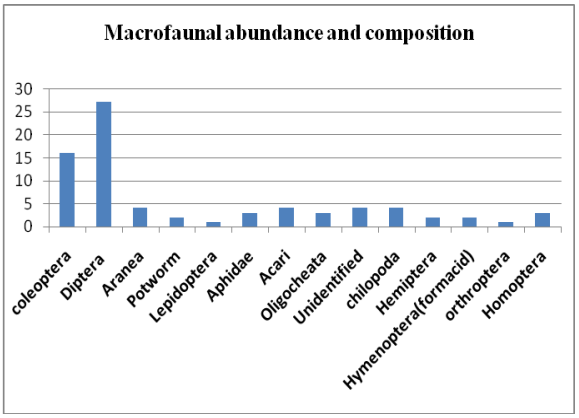

Fig. 2. Macrofauna composition and their abundance in Boshat.

Fig. 02 showed that there were total of 9 taxa present in Boshat. Aranea were dominated followed by Coleoptera.

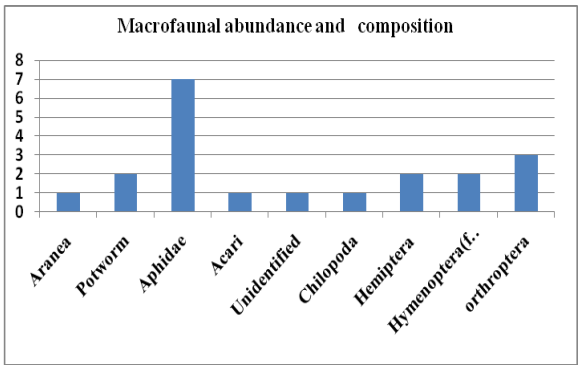

Fig. 3. Macrofaunal abundance and composition in Yal.

Fig. 03 showed total of 9 taxa present in Yal. Aphidae was dominated followed by Orthroptera.

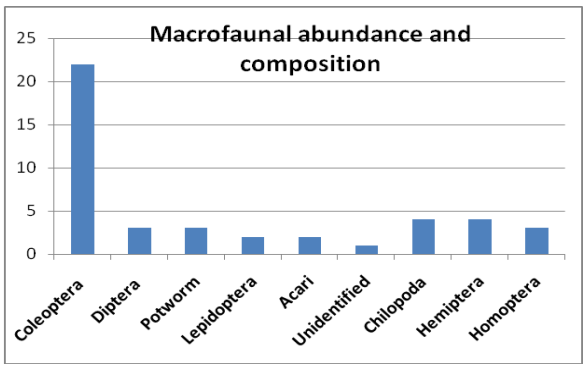

Fig. 4. Macrofauna abundance and composition in Futkhai.

Total 9 taxa were present in Futkhai (fig. 4). Coleoptera were dominated followed by Chilopoda and Hemiptera.

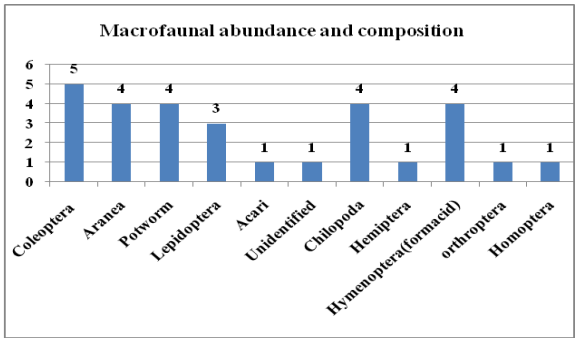

Fig. 5. Macrofauna abundance and composition in Daltho.

Total 11 taxa were present in Daltho. Coleoptera was dominant followed by Aranea, Potworm, Chilopoda and Hymenoptera.

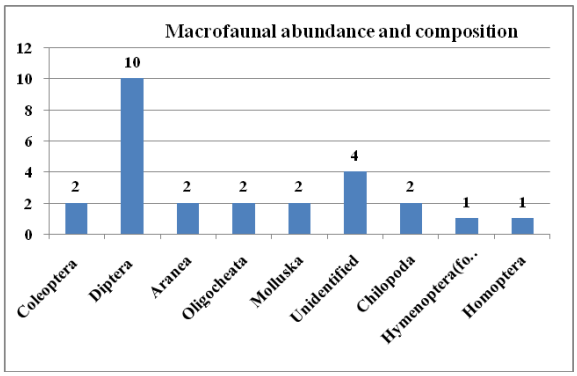

Fig. 6. Macrofaunal abundance and composition in Resmen.

Fig. 06 showed total of 9 taxa were present in Resmen and Diptera being dominated group.

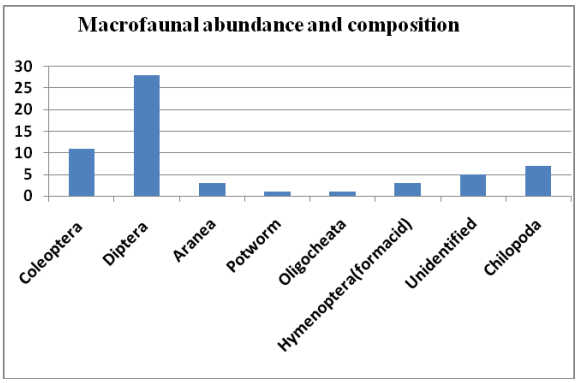

Fig. 7. Macrofaunal abundance and composition in Rushfari.

Total 8 taxa were recorded in Rushfari and Diptera being dominated followed by Coleoptera.

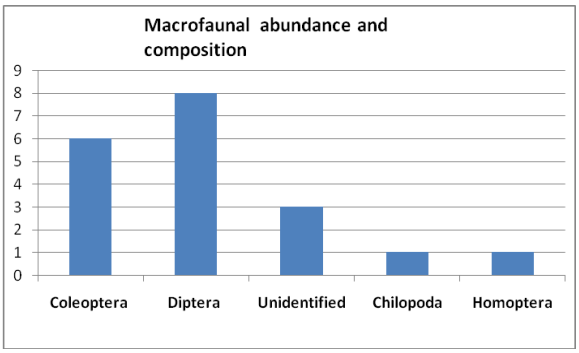

Fig. 8. Macrofaunal composition and abundance in Khai.

Total 5 taxa were recorded in Khai and Diptera were dominated followed by Coleoptera.

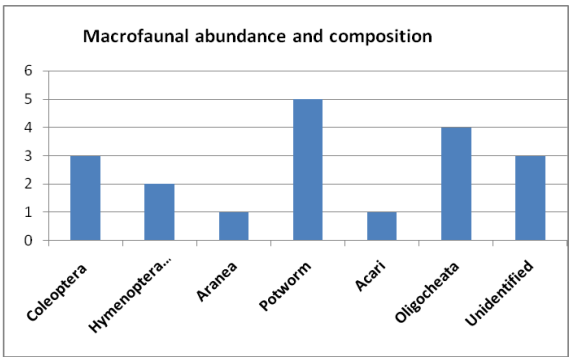

Fig. 9. Macrofaunal composition and abundance in Thopkhun.

Total 7 taxa in Thopkhun and Potworms being dominated followed by Oligocheata.

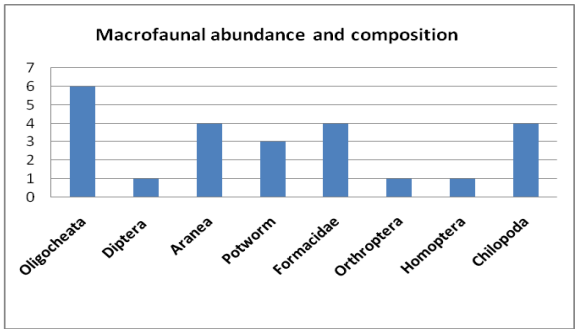

Fig. 10. Macrofaunal composition and abundance in Jatorkhun.

Fig.10 showed total of 8 taxa were recorded in Jatorkhun. Oligocheata were dominated followed by Aranea, Hymenoptera and Chilopoda.

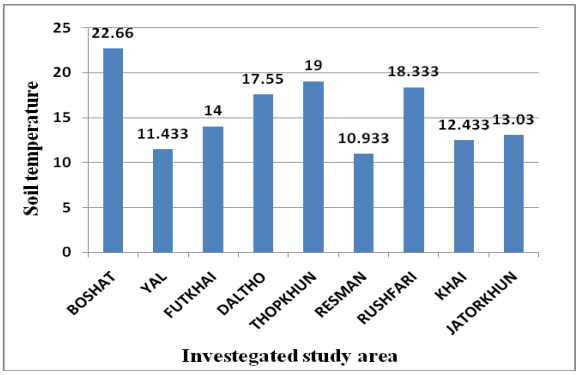

Fig. 11. Soil temperature between different clusters.

During study period the soil temperature of different areas were investigated. Fig. 11 showed the average soil temperature of the area was 13.446°C. Highest temperature was of Boshat area 22.6°C and lowest in Resmen i-e 10.9°C.

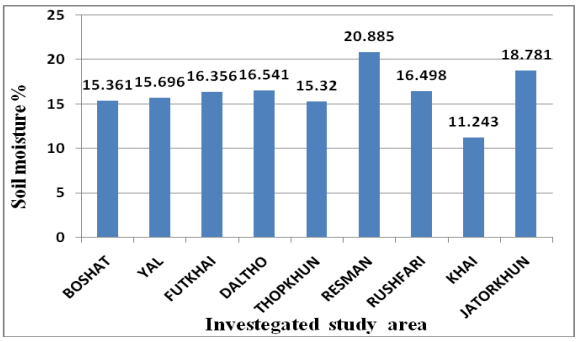

Fig. 12. Soil moisture content % in different clusters

Fig. 12 showed average soil moisture content% between different clusters. The average moisture content of the areas was 16.3%. Moisture varies from 20.9% to 11.3%.

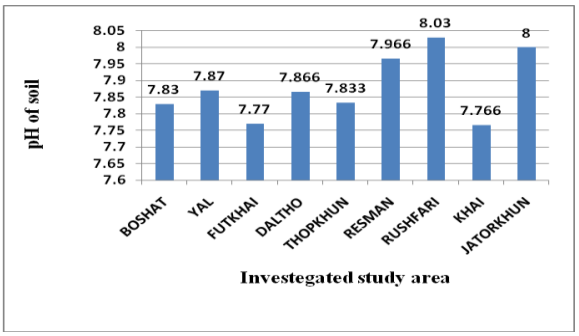

Fig. 13. Soil pH between different clusters.

Fig. 13 showed the mean pH of different areas. The overall pH of the total 54 clusters was 7.881. The highest pH was in Khai that is 8.03 while lowest in Rushfari 7.76.

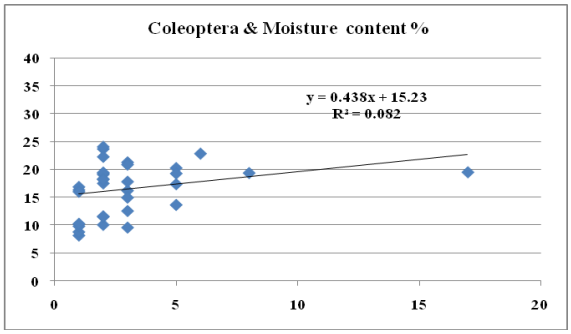

Fig. 14. Relationship between Coleoptera and moisture content.

The scattered fig. 14 showed weak positive correlation between Coleoptera and moisture content.

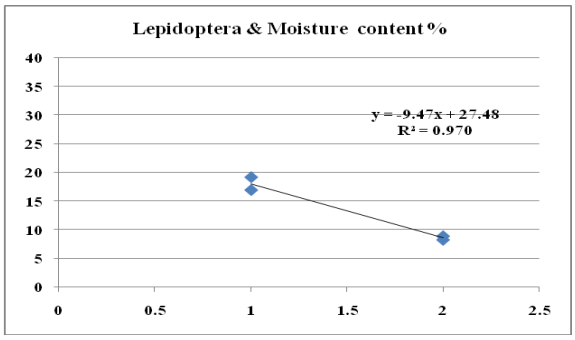

Fig. 15. Relationship between Lepidoptera and Moisture content.

The scattered fig. 15 showed positive correlation between Lepidoptera and moisture content. However the coefficient of determination (R^2 =0.970) does supports the level of relationship between dependent and independent variables.

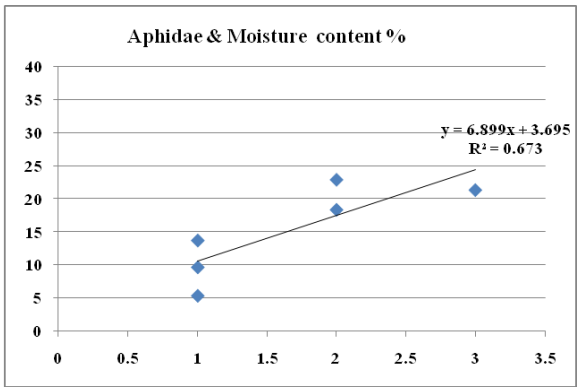

Fig. 16. Relationship between Aphidae and Moisture content.

The scattered fig. 16 showed positive correlation between Aphidae and moisture content. However the coefficient of determination (R^2 =0.673) does supports the level of relationship between dependent and independent variables.

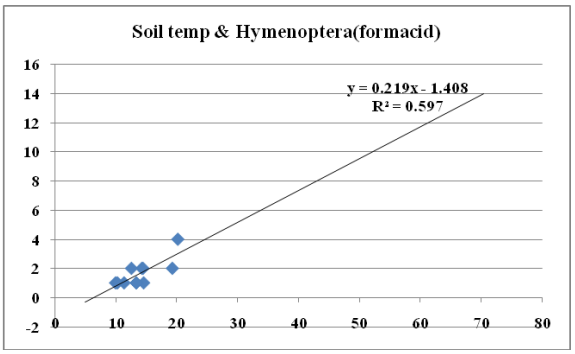

Fig. 17. Relationship between Soil temp and Hymenoptera.

The scattered fig. 17 showed positive correlation between soil temperature and Hymenoptera. However the coefficient of determination (R^2 =0.597) does supports the level of relationship between dependent and independent variables.

Discussions

Soil is made up of organic matter and minerals and it surrounds the earth surface. It supports macrofauna by providing them food and shelter that in turn helps in increasing of soil fertility. Soil biodiversity has very high functional significance but it receives only little attention. Whole study was conducted in Sumayar–Nagar in October 2011 at elevation of 2251m. A total of 718 macrofauna were recorded belonging from 14 orders. The most abundant taxa was diptera (59%) both larvae and adults, followed by Coleoptera (15%) both larvae and adults, Chilopoda(4.5%) which includes both Lithobiomorpha and Geophylomorpha , Aranea population (3%), potworms (3%), Hemiptera (2.7%), Hymenoptera (2.7%), Oligochaeta(2%), unidentified macrofauna (2.9%), and few Lepidoptera , Acari , Aphidae , Orthroptera and Homoptera (1%) respectively. The fluctuation in macro invertebrates was due to environmental factors. The other factors which changed the population were pH of soil, temperature, soil moisture and height of the area. The abundance of Diptera and Coleoptera larva present in those places where animal manure was in greater amount. Same type of study was conducted by Karanja *et al.*, in 2009 in Taita Hills of District Taita Taveta, located in Southeastern Kenya but there were some differences of macrofaunal communities. These variations are due to microclimatic change in soil and indirect influence of soil physico-chemical changes and land use practice and the geographical location of both study areas. Yusnaini *et al.*, 2004 reported that the survival of earthworm in soil is prejudiced by soil microclimate and for their improved growth and development pH of about 6 and an optimum at pH 7. During our study we got few earthworm species from different clusters because of the climatic condition or sampling period. Anderson and Ingram, 1993 found 133 macrofauna morphospecies.The macrofauna abundance were in the agriculture land is due to the use of animals manure.

Conclusion and recommendations

Conclusion

The study demonstrates the diversification and abundance of soil macrofauna in relation with the some physio-chemical properties in various clusters. One way ANOVA showed no significant differences of soil macrofauna abundance among various clusters. Highest soil quality was attributed to Daltho and lowest was Yal area as determined by macrofauna abundance.

Recommendations

- Further research need to be done with more intensive sampling to investigate the influence of seasons and other soil management practices on soil macrofauna abundance and diversity

- Comparison between the different land use practices such as forest ecosystems agriculture need to investigated

Effect of organic and inorganic fertilizers on macrofauna density need to be considered in future studies

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