

Faunal diversity during rainy season in reclaimed sodic land of Uttar Pradesh, India

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Abstract: Faunal diversity is an indicator of soil amelioration. Estimating the population size or density of an animal species in an area is fundamental to understand its status and demography, and to plan for its management and conservation. Considering this, faunal diversity in reclaimed sodic land was monitored during rainy season 2000-01 at different locations of district viz., Aligarh, Etah, Fatehpur, Mainpuri and Raebareli in Uttar Pradesh. The Shannon-Weiner species diversity index (H) of different fauna complex of each location was compared with zero years (1995-1996) indexes (before reclamation). Insects diversity index, in reclaimed sodic soil, varied from 3.8178 (Fatehpur: Bariyampur) to 4.623 (Fatehpur: Katoghan), which was 3.028 in zero year at Katoghan in Fatehpur. 'H' index of other-arthropods ranged widely from 0.9743 (Etah: Bawali) to 2.0674 (Mainpuri: Pundari). The species diversity index of molluscs registered as high as 1.8637 at Ladhauwa site in Aligarh, which exhibited identical with Saripur site of Raebareli. 'H' index of mammal resulted with the highest (2.19) at Pundari in district Mainpuri. The avifauna and amphibian's indices were recovered maximal at Saripur site of Raebareli and Bariyampur site of Fatehpur, respectively. Our result revealed that various fauna enriched with soil reclamation, which is good indicator of restoration of land, primarily due to soil-arthropods and earthworms and its eventual improvement along with succeeding rice-wheat cropping system widespread over there. It clearly shows that soil fauna strongly affects the composition of natural vegetation and we suggest that this knowledge might improve the restoration and conservation of biodiversity.

Key words: Faunal diversity, Sodic land, Species diversity, Species richness, Abundance, Reclamation
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Introduction

At the ecosystem level diversity provides the conditions and drives the processes that sustain the global economy and our very useful of the species. Land is one of the biggest resources of communities especially for over two-third of who reside in the rural areas and are solely dependent upon the land for their livelihoods, when a marginal or even small farmer loses a tract of his land to salinity it is treated equivalent to death of an earning members. With deforestation and increased use of canals for irrigation, large tracts of cultivable land are being continuously rendered worthless to salinity. Conversely, biological activity is a primary factor in the physical and chemical formation of soils (Bardgett, 2005).

In the background, the experimental districts, affected with salinity and their respective sites were earlier surveyed during 1995-96 which is treated as zero years and as with baseline faunal diversity before sodic land reclamation. The studies provide useful information on rate of enrichment in faunal diversities in reclaimed sodic soil, with passes of time due to crop cultivation. A survey of literature revealed that besides some stray information no systematic research has been made on this aspect in India and abroad. Kurti and Kevel (2003) reported that vegetation is the indicator of biotic factors with ecosystem who determined the diversity with the species richness and structural diversity on sodic land. Changing diversity of hymenopteran parasitoids from organically and conventionally managed tea-ecosystem of north Bengal, India (Das *et al.*, 2005),

distribution and diversity of ground beetles in Baskonus mountain National Park of Turkey (Avgn, 2006), the bird species of Kumasi lake (Kahramanmaras – Turkey) and a view of environmental ethics on sustainable wetland management (Inac *et al.*, 2008) are testimony as faunal diversity in diverse ecosystems. Anderson and Spain (2007) studied fauna of Brown Basin in the semi-arid Tropics of Central Queensland, who found richest genera were *Camponotus*. Sarvanakumar *et al.* (2008) reported abundance and seasonal variations of phytoplankton in the creek waters of western mangrove of Kochchh-Gujarat.

The present investigation was undertaken to determine the change on the faunal diversity after restoration of sodic land (degraded land) to agricultural production system in Uttar Pradesh, as faunal diversity is an indicator of soil amelioration and open a new door for the strategic management of the ecosystem.

Materials and Methods

In the command area of Usar Bhumi Sudhar Nigam, five districts viz., Aligarh, Etah, Fatehpur, Mainpuri and Raebareli, were surveyed periodically for exploring faunal diversities in restored lands after 5 years (2000-01) of sodic land reclamation during rainy season which were compared with fauna diversity of zero year rainy season fauna (1995-96) complex affected with sodicity, before the reclamation. The fauna population data were recorded in 2 sites of districts Aligarh, 1 site at Etah, 5 sites at Fatehpur, 4 sites at Mainpuri

and 1 site at Raebareli in Uttar Pradesh, India (Table 1). Surveillance was made in the rainy/Kharif season of the block year 2000-01 from middle of July to the middle of November 2000. The guidelines for measurement of species diversity suggested for the application of many available diversity indices (Peet, 1974).

The quadrat method for non-jumping insects and sweeping method for flying and jumping insects was adopted (Southwood, 1978). Insect fauna, nocturnal in habit were sampled in the night by means of petromax as source of Light trap and for lepidopteran viz., *Helicoverpa armigera* and *Spodoptera litura*, pheromone trap tactics was employed. Most arthropods were collected in empty vials filled with ethanol or Kill jars. Lepidopterans (moth and butterflies) were kept separately in Glassine Envelops to reduce wings scale loss and odonates (Dragonflies) were placed in envelopes and then later curated in plastic sleeves to save space. The specimens were placed in the freezer for a week before pinning them. Sampling time, weather conditions, name of the area- sampled were noted, simultaneously. Snap cap vial and Ziploc bags were kept sufficient to maintain them for 1-2 weeks before curation. For aquatic- insect collection, aquatic net (Top 15" diameter and 3' length) were used. After returning from the field, specimens were pinned to avoid damage. Beetles were pinned on the upper quadrant of their right wing (elytra). Wasps, bees and flies were pinned to right of the thorax, near the base of the wings. Moth and butterflies were pinned in the middle of the thorax. Grasshoppers to the right of thorax, while dragonflies were not usually pinned, they were kept in envelopes. Too small insects were mounted on points made with paper with dip tips of the pin in the glue (Elmars glue) and labeled properly. The wings of butterflies and moths were spread on spreading board made of Styrofoam. Soft-bodied insects were preserved in ethyl alcohol (80%) to prevent them from shrinking.

In recording the frequencies and abundance of vertebrates viz., mammals, avifauna (birds) and herpetofauna (reptiles) line

Table - 1: Locations /villages sites surveyed for recording faunal diversities

District	Location / village	Abbreviation
Aligarh	Mandanpur	MND
	Ladhauwa	LDH
Etah	Bawali	BWL
Fatehpur	Katoghan	KTG
	Mirzapur	MRZ
	Bhouli	BHO
	Aliyabad	ALY
Mainpuri	Bariyampur	BRY
	Bichwan	BCH
	Surjanpur	SRJ
	Sultanganj	SLT
Raibareli	Pundari	PND
	Saripur	SRP

transects method was practiced (Laake et al., 1979). In this case, observers moved at a constant speed along with a particular transect through the habitat and recorded the number of animals visible at the sampling site. Both the static and dynamic models were followed. In the former model the animals were not moving and sighted, while in the later model both observer and animals were moving. Each transect was observed once in the morning (07.00 to 09.30 hr) and once in the evening (16.00 to 18.30 hr) each month in the season. The treatments were covered from opposite ends in order to minimize any bias arising from variation in animal activity with time. For each sighting, the central location of the animal group was noted and the perpendicular distance from the location to the transect line was recorded using a rangefinder (15 to 180 m range) at 10 m class-intervals. The insects' samples were brought to the laboratory of C.S. Azad University of Agriculture and Technology, Kanpur for their identification with the help of identification handbooks of insects (Lefroy, 1909), Golden guide

Table - 2: Species richness, abundance and species diversity index of insects during rainy season of Vth year (2000- 2001) and zero year (1995-1996)

District	Location / village	Number of spp at V th year	Total common spp occurred at V th year	Common spp observed at zero year	Total No. of individual at zero year	Total No. of individual at V th year	'H' index at zero year	'H' index at V th year	
Aligarh	Mandanpur	78	86	35	131	309	3.055	4.3937	
	Ludhauwa	70							180
Etah	Bawali	79	79	32	128	224	3.209	4.6103	
Fatehpur	Katoghan	78	102	34	138	241	3.028	4.6230	
	Mirzapur	61		32		174	3.223	3.8459	
	Bhouli	68		34		228	3.249	3.8845	
	Aliyabad	72		126		212	4.0574		
Mainpuri	Bariyampur	64	106	34	124	202	3.159	4.4173	
	Bichhawan	97				473			4.2635
	Surjanpur	90				467			4.2635
	Sultanganj	65				167			3.8446
Raebareli	Pundari	97	75	31	132	456	3.206	4.3742	
	Saripur	75		33		120			175

Table - 3: Faunal diversity of insect, Other-arthropods, molluscs, mammal, avis, reptiles-amphibian in restored lands at different locations in U.P.

District	Sampling sites / village	Insect			Other-arthropods			Molluscs			Mammal			Avis			Reptile and amphibian		
		Species richness	Abundance	Index value	Species richness	Abundance	Index value	Species richness	Abundance	Index value	Species richness	Abundance	Index value	Species richness	Abundance	Index value	Species richness	Abundance	Index value
Aligarh	Mandanpur	78	309	4.4	6	21	1.6	7	25	1.7	7	26	1.8	15	60	2.4	9	21	1.9
	Ludhauwa	70	180	4.0	4	8	1.3	7	12	1.9	9	21	1.9	13	43	2.2	7	12	1.8
Etah	Bawali	79	224	4.6	3	8	1.0	4	9	1.5	8	24	1.8	19	40	2.1	8	11	2.0
Fatehpur	Katoghan	78	241	4.6	6	16	1.7	3	6	1.0	9	36	1.9	15	44	2.4	8	17	1.8
	Mirzapur	61	174	3.8	5	13	1.4	4	8	1.3	6	31	1.2	16	50	2.4	6	11	1.7
	Bhouli	68	228	3.9	4	6	1.3	5	14	1.8	10	30	1.8	14	39	2.4	4	6	1.2
	Aliyabad	72	212	4.1	8	36	1.5	5	13	1.4	11	40	2.1	17	40	2.6	5	9	1.5
	Bariyampur	64	202	3.8	7	18	1.6	5	16	1.5	10	24	2.1	11	30	2.2	10	17	2.2
Mainpuri	Bichhawan	97	473	4.4	7	21	1.7	4	17	1.2	9	28	2.0	15	43	2.5	8	19	1.8
	Surjanpur	90	467	4.3	4	26	1.3	6	20	1.5	9	28	2.0	17	45	2.5	7	12	1.8
	Sultanganj	65	167	3.8	5	10	1.6	4	12	1.1	10	34	2.0	12	20	2.3	6	9	1.7
	Pundari	97	456	4.4	9	35	2.1	6	23	1.6	11	34	2.1	16	48	1.7	6	10	1.6
Raebareli	Saripur	75	175	4.1	6	21	1.7	7	12	1.9	11	26	2.2	17	41	2.6	5	12	1.6

(St. Martin's Press), mammals (Prater, 1997), birds (Ali, 1979). The survey data recorded on invertebrates and vertebrates were computed by following the statistical method of species diversity index (H): the most widely used index *i.e.* Shannon index of general diversity (Shannon and Wiener, 1949).

Results and Discussion

In restored land the species richness complex of insect, other-arthropods, mollusc, mammal, avifauna and reptile- amphibian at different sites resulted with the highest fauna (10%) each at Pundari (PND) and Bichwan (BCH) sites in District Mainpuri and lowest (6%) at Mirzapur (MRZ) and Bariyampur (BRY) sites (District: Fatehpur) and Sultanganj (SLT) site ((District: Mainpuri). All other sites revealed intermediary in fauna complex diversity (Fig. 1). The faunal diversity of insect in rainy season of the year 2000-2001 revealed with amplified species diversity (3.8178 to 4.6230) to that of the zero years' (3.028 to 3.249) as evident from Table 2. In restored land the highest population revealed in district Mainpuri, particularly its Bichwan, Surjanpur and Pundari. Surprisingly, Sultanganj site of the district resulted as poorest (167 individuals) compared to the other sites investigated. Mandanpur site of district Aligarh also showed its significant positive impact in building up of arthropods population. Rest other sites manifested their intermediate response. The species richness also varied greatly, ranging from 61 to 97 at various sites. Collectively, Mainpuri site elicited maximal index of richness (106 individuals) followed by Fatehpur (102 individuals). The species richness and abundance enhanced double to zero year's insect-fauna in the majority of the sites while certain sites showed more than that or even thrice. Raebareli and Etah district sites did not differ statistically and numerically in view of the common species recorded. The plant fauna, particularly rice in reclaimed sodic land has enhanced the arthropods diversity at various sites, remarkably. Convey *et al.* (1996) reported terrestrial arthropods fauna of the Bayers Peninsula where species occurrence and abundance differed between samples collected from poorly vegetated stony ground and vegetation cores, the later registered more richness abundance with arthropods. Diversity and structure of the arthropods fauna in central Panama exposed arthropods abundance, primarily due to a function of host-plant biomass (Stuntz *et al.*, 2002), from United Kingdom (Jepson, 1993), biology of springtails (Hopkin, 1997). The restored land exhibited enrichments in faunal diversity in winter season (Srivastava *et al.*, 2007).

Among other-arthropods (soil- arthropods) arachnids were dominated in restored soil. The species diversity indices of various classes of soil- arthropods ranged from 0.9743 to 2.0674; it was poorest at Belha and richest at Pundari sites of district Etah and Mainpuri, respectively. Only 8 species were noticed in district Aligarh (Mandanpur and Ladhauwa sites). The Species richness in district Fatehpur and Mainpuri was in uniformity and each having 11 common species. The highest population abundance was at Bariyampur (36 individuals) followed by Pundari (35 individuals) and rest of the sites exhibited their intermediate response (Table 3). Diversities of Arachnids from United Kingdom (Jepson, 1993)

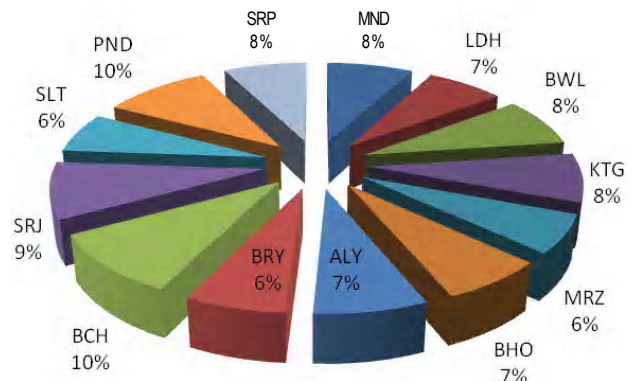


Fig. 1: Species richness of insect, other-arthropods, mollusc, mammal, avifauna, reptile-amphibian at different sites

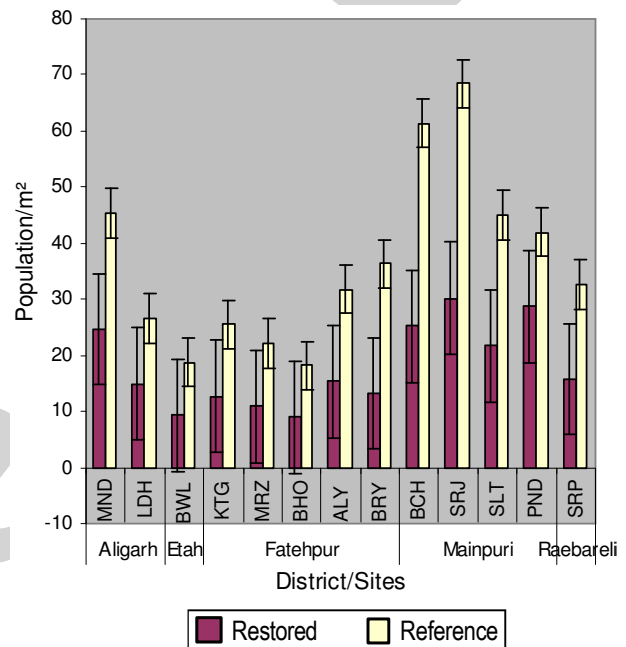


Fig. 2: Earthworm intensity in restored and reference land

and Anchorage Island (Convey and Smith, 1997) are well documented.

Molluscs-fauna comprised nine species of class: gastropoda and subclass: pulmonata. Its maximal diversity (1.8637) exhibited at Ladhauwa site (Aligarh), was numerically similar to that of Saripur site of district Raebareli. Katoghan site of district Fatehpur registered the poorest richness (1.0114). The Mandanpur site (Aligarh) showed its highest abundance (25 individuals) followed by Pundari (23 individuals) and Surjanpur (20 individuals) of district Mainpuri, with maximal richness (9 individual) (Table 3). Interestingly, no traces of mollusc fauna found in Aligarh, Etah, Fatehpur, Mainpuri and Raebareli at zero years (1995-96). Biodiversity of rangeland ecosystem and effect on mankind activity was studied in China (Li, 1994). Contrary, a catastrophic decline was observed in mollusc

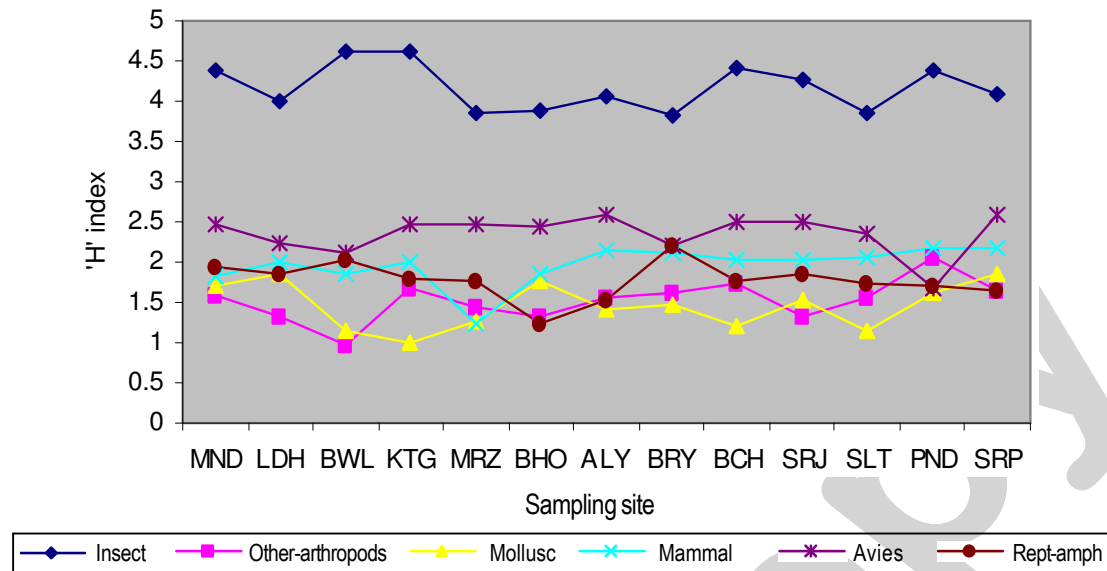


Fig. 3: Species diversity indices of fauna-complex in restored land at different sites

diversity, but due to interspecific differences, and its concurrence with Shellfish fisheries in the habitat in eastern Tasmania (Edgar and Samson, 2004).

Heavy flush of mammals was witnessed in the restored land at various sites in district Fatehpur. However, species richness was highest in Mainpuri district with higher species diversity as well. The H' index varied from 1.237 to 2.19 at respective sites of Mirzapur (Fatehpur) and Pundari (Mainpuri) as evident from Table 3. There was no prevalence of mammals at zero year (1995-96). Osbourne *et al.* (2005) observed the effect of habitat on small-mammal diversity and abundance between riparian and upland habitats in West Virginia. Srivastava *et al.* (2007) reported enriched mammals diversity in reclaimed sodic soil in winter season.

So far as the avifauna, higher proportion (60 individuals) substantialized at Mandanpur followed by 50 individuals at Mirzapur site of district Fatehpur with the diversity indices of 2.463 and 2.47, respectively. The highest species diversity index (2.602) showed at Saripur site of district Raebareli with relatively lower index (2.582) at Aliyabad site of district Fatehpur (Table 3). Conspicuously, avifauna posed highest abundance to vertebrates during the season. Among the birds, *Passer domesticus*, *Psittacula krameri* and *Corvus splendens* were the commonest at all the sites. Reclaimed sodic land showed enriched avifauna in winter (Srivastava *et al.*, 2007).

In restored land, 6 species of reptiles and 4 species of amphibians was recorded in all the five districts. Among reptiles, *Echis carinatus* was seen at every site, while *Rana tigrina* was only an amphibian at every sites in the reclaimed sodic land. The highest (H') index (2.20) reflected at Bariyampur (Fatehpur) followed by 1.9499 at Mandanpur and 2.0198 at Bawali site (Table 3), which is a good indicator of land restoration where co-existence and

interrelation of flora and fauna, with species richness is quite spectacular, seeing as alpha-diversity in this ecosystem.

The earthworm in reclaimed sodic land comprised of major species viz., *Eulyphoeus waltomi*, *Eulyphoeus* sp., *E. incommodus*, *Lenogaster pusillus*, *Pellogaster bengalensis* and *Ramella bisambari*. Its population in reference sites (natural crop land) outnumbered the restored land, however restoration sites populations of earthworm are quite encouraging to that of sodic land left in nearby areas and the most from the zero years populations (1995-96). Where there was no traces of earthworm fauna before the reclamation of sodic land, it enhanced significantly to a low ebb ($8.98 \pm 2.17 \text{ m}^{-2}$) at Bhoul in Fatehpur to a maximal ($30.17 \pm 11.35 \text{ m}^{-2}$) in restored soil at Surjanpur (Mainpuri district) (Fig 2). The crops raised in restored land contained higher earthworm populations and exceedingly more humus. This is a good indicator of soil restoration of degraded land due to earthworm fauna. Earthworm diversity varied significantly over the season (Tondoh, 2006). Blakemore (1999) reviewed the diversity of exotic earthworms.

While considering the overall enrichment in diversity of different fauna (fauna-complex) in reclaimed sodic land (restored land), insect fauna including soil arthropods and earthworm have been found to be quite spectacular in view of species richness, abundance and species diversity index amongst the prevailing other fauna during the rainy/Kharif season.

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