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Abundance and Distribution of Waders in the Vembanad - Kole Ramsar Site, Southern India

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Abstract

Abundance and distribution of migratory and resident waders were studied at the Kole wetlands of Thrissur from November 1998 to October 2001. A total of 39 species of waders was recorded. Species richness, abundance, density and diversity of waders have been varied in different months. Wader species showed an increase in the population during November, December and January. The presence of 39 species of waders showed the importance of the wetland for transcontinental migratory species. The Kole wetland is an ideal habitat for migratory and resident waders.

Introduction

The Order Charadriiformes is a large diverse group of birds. They are considered distinct among the avian fauna for being waders or shorebirds. The Charadriiformes consist of approximately 350 species under 19 families (Marchant and Higgins, 1993). They are amongst the world's longest migrants and considered as "truly international" species, as most of them nest in one country, migrate long distances and spend non-breeding period in another country (Howes and Bakeswell, 1989). The ecology of waders is strongly influenced by food availability. Access to food is constrained by several environmental factors, principally tides and weather, on a relatively predictable daily and seasonal basis (Colwell, 1993). Biotic factors, such as prey characteristics that determine ingestibality, profitability and detectability all mediate the intake rate of shorebirds (Zwarts and Blomert, 1992). Further biotic factors, such as interspecific and intraspecific aggression also determine possible intake rates (Metcalfe and Furness, 1987). The importance of food resources are often exacerbated in migratory species, such as shorebirds, as prey intake rate determines the "fuel stores", a critical factor for successful long-distance migration (Kvist *et al.*, 2001). The aim of this paper was to describe the abundance and distribution of waders in the Vembanad-Kole Ramsar Site, Kerala.

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Study Area

The study area located in Thrissur and Malappuram District of Kerala State, (10° 20' - 10° 40' N, 75° 58' - 76° 11' E) Southern India with an extent of 13,632 ha and it extends from the northern banks of Chalakudy River in the South to the southern banks of Bharathapuzha River in the North. Eastern side of Kole wetlands is Thrissur town and western side extends up to Arabian Sea. This wetland are low lying tracts located 0.5 to 1 m below MSL and it remains submerged for about six months in a year.

The climate of the area is moderate and there are three different distinct seasons. The dry season (December to April), wet season-I (May to August) during the period of southwest monsoon and wet season-II (September to November) during northeast monsoon. The average annual rainfall is 3,200 mm (James, 1983) and there is a variation in the temporal distribution of rainfall. Maximum rainfall is received during the month of June followed by July. Extremes of heat or cold are not felt and the temperature varied from 28° C to 31.5° C. Atmosphere is always damp along the coastal belt due to high humidity.

Intensive study areas

The Kole wetlands are divided into many blocks for better management of the paddy cultivation. They are Adat, Aranattukara, Enamavu, Manakkodi, Mullurkayal, Palakkal, Pudukkad, Anthikad and Parappur. After a thorough reconnaissance survey, four intensive study areas were selected namely Chettupuzha, Kanjany, Enamavu and Parappur in the Kole wetlands of Thrissur.

Chettupuzha: Chettupuzha is the gateway of the Kole wetlands from Thrissur town and is located 10 km from West of the Thrissur town. Southern side of the wetlands is connected to the Kanjany Kole fields. Through the eastern side, the main irrigation canal is passing and the western side is adjoining with coconut plantations.

Kanjany: The second intensive study area at Kanjany is located in the central portion of Kole wetlands. Southern side of Kanjany extends up to Muriyad Kole of Irinjalakuda and the northern side is connected to the Enamavu. Eastern and western side of this Kole is adjoining with the human habitations and coconut plantations and one main canal is passing through the area.

Enamavu: The third intensive study area was Enamavu, which is located on the western end of the Kole wetlands. It is situated on the northern side of Kanjany and the main canal dividing this block finally empty into the sea. Northern side of this region extends up to Parappur and Adat. Enamakkal barrage was constructed about five decades ago to prevent salinity intrusion into the Kole wetlands from the Chettuva. Thrissur Kole wetlands used to have salinity intrusion through openings at Chettuva and Kottapuram. The regulator at Enamakkal and one at Kottenkottuvalavu in the lower

reach of the Karuvannur River act both as a spill way for the flood waters from the wetland and as a regulator for preventing salt water entry into the Kole wetlands. Regulator is usually opened from June to August and closed during September to May.

Parappur: The fourth intensive study area, Parappur is located on the northern side of the Kole wetlands. It is continuous from Enamavu and is divided by Thrissur - Chavakkad main road and Thrissur - Guruvayur railway line. Northern side of the wetlands is connected to the Ponnani Kole. Small patch of coconut and rubber plantations is located in the middle of the wetlands.

Methods

The study was conducted from November 1998 to October 2001 and it was mainly based on direct observational methods (Altman, 1974). The whole area was surveyed on foot and vehicle and all the important areas were visited. After the reconnaissance survey, four intensive study areas *viz.* Chettupuzha, Kanjany, Enamavu and Parappur were selected. These areas were selected since all the microhabitats were available and represented the main part of the Kole wetlands.

Bird census

After considering all available census methods, total count method was selected and bird population was estimated using the total count method (Hoves and Bakewell, 1989). In this method, representative blocks were identified and birds in the blocks were counted using a telescope (15x - 45x). These blocks had natural boundaries in the form of bunds. The time of observation was from 0700 hour to 1000 hour. On an average, 20 days were spent in the field in a month and no census was made during heavy rain. In the each intensive study area, four blocks of 10 ha were selected for bird census. Four counts were made in each block in each month and the pooled average was used for estimating species richness and abundance. Night surveys were also conducted for recording the nocturnal birds in the intensive study areas. Birds were identified based on physical features with the help of field guides and reference books (Ali and Ripley, 1983; Grimmett *et al.*, 1998).

Species richness and abundance of birds : Species richness and abundance of birds in every month in the intensive study areas were calculated from the census data and field observations.

Species diversity indices : Shannon-Weiner (H') index was calculated using the computer program SPDIVERS. BAS developed by Ludwig and Reynolds (1988).

Density : Density of birds in each month was calculated for the intensive study areas. The density was estimated from the daily census of birds. The extent of each census block was collected form the Kole Land Development Corporation, Thrissur.

Similarity Indices : Similarity Indices between the intensive study areas were calculated using Jaccard Index, Sorenson Index (Magurran 1988).

RESULTS

Overall species richness, abundance and density

The overall variations of species richness of waders varied in different months and the highest of 28 species was recorded during December and the lowest of 3 during June and July. Similarly the abundance of birds also varied from 45 to 48,044 individuals in a month (Fig. 1).

As observed in the species richness and abundance of birds, density of birds also varied in different months. Highest density of 35,244 birds/ha was recorded in November (24,373 birds/ha) and lowest density of birds was observed in July (33 birds/ha). Density of birds in different months

and standard error is presented in Fig. 2).

Species richness, abundance, diversity and density in the intensive study areas

Species richness of birds varied in different months in the intensive study areas. Highest number of species was recorded at Kanjany during November (23) and lowest was at Chettupuzha and Enamavu during May, June and July (1). Total number of birds in the intensive study areas varied from 2 to 32,805 individuals in a month. Highest number of birds was recorded at Kanjany during November (32,805) and lowest was at Chettupuzha during July (2). The highest diversity Index (H') was observed in January (1.84) at Kanjany and the lowest diversity

Fig. 1. Species richness and abundance of waders in different months (n = 36)
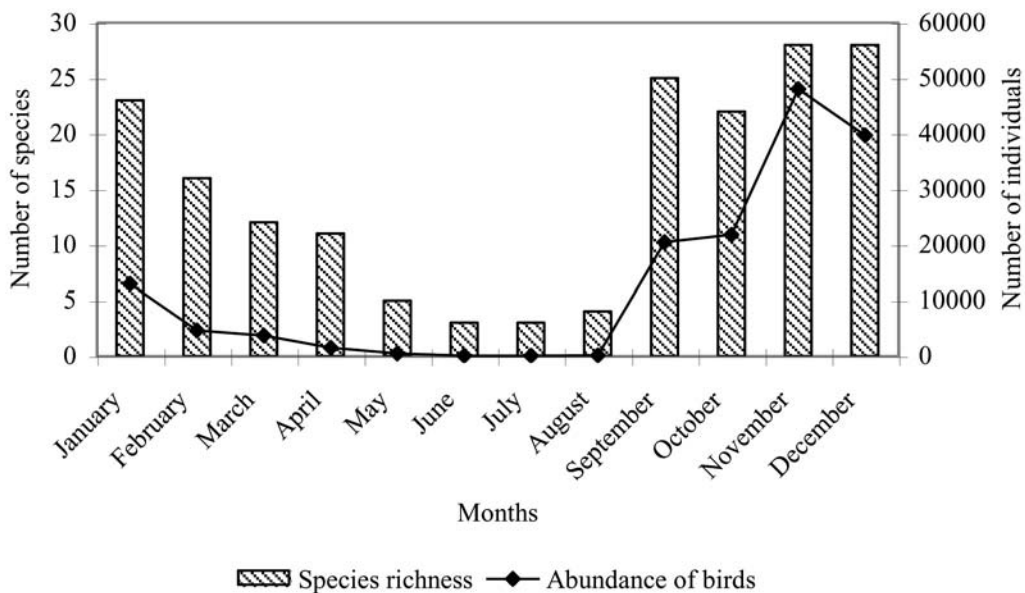
Fig. 2. Density of waders in different months (n = 36)
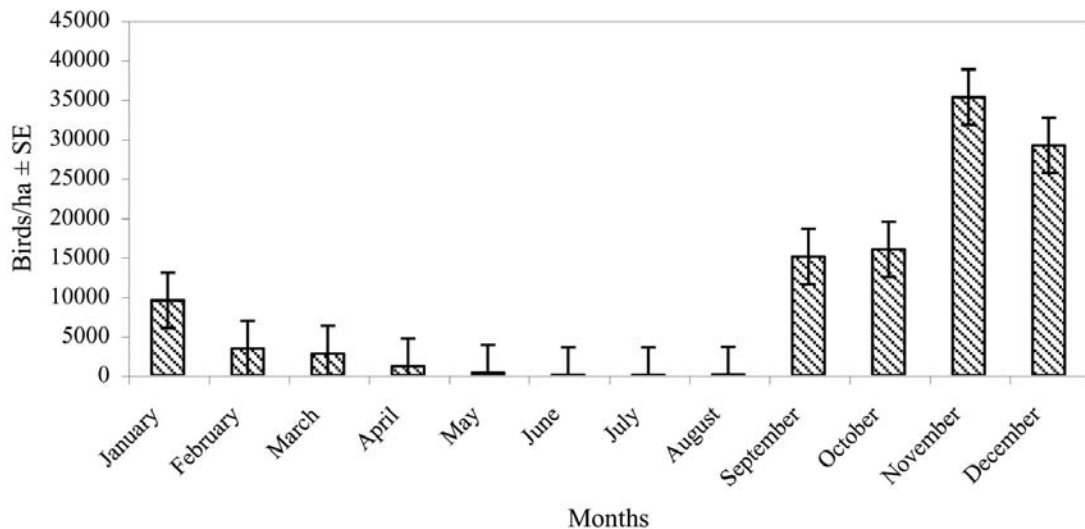
Index in February (0.33) at Parappur. Similarly, the lowest and the highest diversity Index were recorded at Parappur. The highest density of birds was recorded in December (24,065 birds/ha) at Kanjany and the lowest was in July (1 bird/ha) at Chettupuzha and Enamavu (Table 1).

Similarity

Two similarity indices namely Jaccard Index and Sorenson Index were calculated. An alternative approach to measure the similarity of different sites is using similarity indices, using the proportional similarity measures. Similarity indices between the intensive study areas were computed using qualitative data (Table 2). Both indices showed highest similarity between Enamavu and Kanjany (0.65 and 0.79). Similarity between Chettupuzha, Kanjany and Parappur was less than fifty per cent.

Discussion

The Vembanad-Kole Ramsar site support at least 39 species of waders. Migratory species showed an increase in population size during November, December and January. Waders feed on a wide variety of foods such as Insecta, Crustacea and Polychaeta. Invertebrates formed the main food of waders. Waders were opportunistic in feeding and fed on suitable items as they are encountered. The size of prey eaten by Waders generally increases with the size of the Waders. At the Kole wetlands, the abundance of Curlew Sandpiper is the closely related to Insecta and Crustacea. Curlew Sandpiper is tactile forager and prey on nerids of different sizes in proportion to their relative abundance in the substratum, avoiding only the smallest nerids (Kalejta, 1993). The lack ness of prey size selectivity in Curlew Sandpiper implies that their

Table 1. Abundance and diversity indices of waders in the intensive study areas (n = 36)

Intensive study area	Indices	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
Chettu-puzha	R	8	8	2	5	1	0	1	1	6	4	12	3
	A	366	716	17	35	7	0	2	5	430	52	4894	73
	H'	1.34	1.05	0.61	0.98	0.00	0.00	0.00	0.00	0.85	1.22	1.16	1.91
	D	268	525	12	26	5	0	1	4	315	38	1389	54
Kanjany	R	19	14	10	8	3	3	2	2	9	13	23	22
	A	10456	3367	1141	519	87	33	19	46	2236	4196	32805	19445
	H'	1.84	0.76	1.31	0.74	0.76	1.02	0.69	0.39	1.62	0.67	1.38	1.59
	D	7670	2470	837	381	64	24	14	34	1640	3078	24065	14264
Enamavu	R	6	4	9	5	5	1	1	2	20	15	5	6
	A	540	134	664	586	327	15	2	27	17185	4691	1145	1379
	H'	0.82	1.00	0.53	0.37	1.08	0.00	0.00	0.64	1.74	1.47	0.50	0.42
	D	396	98	487	430	240	11	1	20	12606	3441	840	1012
Parappur	R	3	4	5	5	2	2	2	3	5	7	13	13
	A	141	267	373	163	26	22	19	27	607	6702	3831	3579
	H'	0.55	0.33	1.05	0.87	0.54	0.00	0.66	0.91	0.51	0.25	1.82	1.50
	D	103	196	274	120	19	16	14	20	445	4916	2810	2625

R = Richness; A = Abundance, H' = Diversity; D = Density

Table 2. Jaccard Index and Sorenson Index values (in parenthesis) for the intensive study areas

	Chettupuzha	Kanjany	Enamavu	Parappur
Chettupuzha	0 (0)	0.44 (0.61)	0.41 (0.58)	0.38 (0.55)
Kanjany		0 (0)	0.65 (0.79)	0.53 (0.69)
Enamavu			0 (0)	0.50 (0.55)
Parappur				0 (0)

foraging density will be determined by prey abundance, but they should forage preferentially in areas where nerids are large and abundance. The Curlew Sandpiper fed on a wider variety of food items and the importance of benthic fauna in their diet has been reported previously (Kalejta, 1993). Little Stint fed on a wide variety of inter-tidal invertebrates generally Insecta and Crustacea. Feeding Little Stints favoured areas of mud flats, because of the high abundance of benthic fauna.

Population of Little Ringed Plover and Lesser Sand Plover were significantly correlated with Insecta, Polychaeta and Crustacea, which is comparable with the study of Kalejta (1993). Occurrence of wader species like Common Sandpiper was significantly correlated with the abundance of the Crustacea and Polychaeta. Abundance

of Curlew was found significantly positively correlated with Insecta, and negatively correlated with Crustacea and Gastropoda. Wood Sandpiper was found significantly correlated with Insecta Crustacea and Gastropoda.

Population of Common Red Shank was found to be significantly positively correlated with population of Insecta and Crustacea, negatively correlated with Polycheata. Significant correlation was also found between the abundance of Common Green Shank with Gastropoda and Insecta. The population abundance of Green Sandpiper was found significantly negatively correlated with Gastropoda. However, a positive significant correlation was found with Insecta. The abundance of Small Indian Practincole was found to be significantly positive correlated with Polychaeta, Gastropoda, Crustacea and Insecta.

Mud flats greatly influence the distribution, abundance and behaviour of soil organisms (Connors et al., 1981). For waders mud flats was good site of foraging and availability of prey (Puttick, 1981; Evans and Dugan, 1984). Similar habitat preference was shown in waders at the Berg River Estuary, South Africa (Kalejta and Hockey, 1994); at Iceland (Gudmundsson and Gardarsson, 1993); at Chilika Lake (Acharya, 2000). The high density of benthic fauna in shallow water serves as a foraging habitat of waders, which has also been recorded by Sampath et al., (1995) in Great Vedaranyam Salt Swamp and Pichavaram mangroves.

The wader species fed mostly in mud flats, shallow waters and water edge, presumably because many species were more active in the microhabitats. Optimal foraging theory predicts that predators should aggregate in areas where their net rate of energy gain is maximal. In the case of waders, it appears that the numerical abundance of prey is a more important determinant of foraging dispersion than the demography of the prey population. Sediment characteristics and penetrability may also influence the availability of estuarine polychaetes of birds (Myers et al., 1980).

Comparisons of waders in different wetlands are presented in Table 3 and the result of the Vembanad-Kole wetlands is comparable with other wetlands in the world. Presence of 39 species of waders showed the importance of the wetland for the trans-continental migratory species. Among the four study sites, highest number of Wood Sandpiper was recorded from Kanjany. This is comparable to the report of Wood Sandpiper from Gulf of Mannar Marine National Park in small numbers by Balachandran (1995). Abundance of Black-tailed Godwit, Great Knot and Marsh Sandpiper were higher in the Kole wetlands compared to the other wetlands of Kerala and other States (Hoffmann 1983; Balachandran 1995; Acharya and Kar 1996; Verma et al. 2002). Wader communities have been varied in the the Vembanad-Kole Ramsar site in association with the seasonal dynamica of the wetlands. Data suggest that the waders relied less on the wetlands as a feeding site as the study progressed and the site

Table 3. Comparison of species richness of waders in different wetlands

Sl.No.	Name of the wetland	Number of species	Reference
1.	Mad River, Califoria	23	Colwell, 1993
2.	Texas Estuarine wetland	23	Weller, 1994
3.	Puerto Rico	28	Collazo et al., 1995
4.	North Carolina	21	Dinsmore et al., 1998
5.	Pacific coast, United States	43	Page et al., 1999
6.	Corpus Christi, Texas	26	Withers and Chapman, 1993
7.	Virginia	21	Rotternborn, 1996
8.	Western Great Basin	31	Warnock et al., 1998
9.	Bay of Fundy, South America	34	Hicklin, 1987
10.	Northern Territory	33	Chatto, 2003
11.	Africa and Western Eurasia	55	Stroud et al., 2004
12.	Paraguary River, Paraguay	21	Hayes and Fox, 1991
13.	Pichavaram mangroves	28	Nagarajan, 1990
14.	Gulf of Mannar	23	Balachandran, 1995
15.	Chilika Lake	47	Acharya and Kar, 1996
16.	Kole Wetlands	39	Present study

became less predictable. In the Kole wetlands waders were used paddy field from the month of November when paddy cultivation begins. At this time access to foraging ground within the wetlands is contrained and more profitable for foraging. The Kole wetland is an ideal habitat for migratory and resident waders.

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References

❖ Acharya, S., (2000), *Studies on some ecological aspects of Waders (Family: Charadriidae) with species reference to Plovers of Nalabana Island, Chilika Lagoon, Orissa.* Ph.D. Thesis, Utkal University, Bhubaneswar, Orissa. 177 p.

❖ Acharya, S. and Kar, S.K., (1996), Checklist of Waders (Charadriiformes) in Chilika Lake, Orissa. *Newsl. Birdwatchers* 36(5): 89-90.

❖ Balachandran, S., (1995), Shore birds of the Marine National Park in the Gulf of Mannar, Tamil Nadu. *J. Bombay nat. Hist. Soc.* 92(3): 303-313.

❖ Chatto, R., (2003), *Shorebirds of the coast and coastal wetlands of the Northern Territory.* Parks and Wildlife Commission of the Northern Territory. Technical Report 73: 1-277.

❖ Collazo, Jaime A., Harrington, B.A., Grear, J.S., Colon, J A. (1995), Abundance and distribution of shorebirds at the Cabo Rojo salt flats, Puerto Rico. *J. Field Ornithol.*, 66(3):424-438.

❖ Colwellm, A., (1993), Shorebird community patterns, in a seasonally

dynamic estuary. *Condor* 95: 104-113.

❖ Dinsmore, S.J., Collazo, J.A., Walters, J, R., (1998), Seasonal numbers and distribution of shorebirds on north carolina's outer banks. *Wilson Bull.*, 110(2): 171-181.

❖ Evans, P.R. and Dugan, P.J., (1984), Coastal birds: numbers in relation to food resources. pp. 8-29. *In*: Evans, P., J.D. Goss-Custard and W.G. Hale (Eds.) Coastal Waders and Wildfowl in Winter. Cambridge University Press, London.

❖ Gudmundsson, A.G. and Gardarsson, A., (1993), Numbers, geographic distribution and habitat utilization of waders (Charadrii) in spring on the shores of Iceland. *Ecography* 16(1): 82-93.

❖ Hicklin, P.W., (1987), The migration of shorebirds in the Bay of Fundy. *Wilson Bull.* 99:540-570.

❖ Hoves, J.G. and Bakewell, D., (1989), *Shore Bird Studies Manual* AWB. Publications No. 55 Kula Lumpur. 362 p.

❖ Kalejta, B., (1993), Diets of Waders at the Berg River Estuary, South Africa: spatial and temporal variation. *Ostrich* 64: 123-133.

❖ Kalejta, B. and Hockey, P.A.R., (1994), Distribution of Waders at the Berg River Estuary, South Africa, in relation to foraging mode, food supply and environmental features. *Ibis* 136: 233-239.

❖ Ludwig, J. A. and Reynolds, J. F., (1988), Statistical Ecology, A Premier On Methods And Computing. A Wiley-Interscince publication. 337 p.

❖ Magurran, A.E., (1988), *Ecological Diversity and its Measurement.* Croom Helm Ltd. London. 179 p.

❖ Myers, J.P., Williams, S.L., and Pitelka, F.A., (1980). An experimental analysis of prey availability for Sanderling (Aves: Scolopacidae) feeding on sandy beach crustaceans. *Can. J. Zool.* 58: 1564-1574.

❖ Nagarajan, R., (1990). *Factor influencing wader (Ciconiiformes and Charadriiformes) populations in the Wetlands of Pichavaram, Tamil Nadu, South India.* A.V.C. College (Autonomous), Mayiladuthurai. M.Phil., Dissertation, Bharathidasan University, Tiruchirapali.

❖ Page, G.W., Palacios, E., Alfaro, L., Gonzalez, S., Stenzel, L. E., Jungers, M., (1997). Numbers of wintering shorebirds in coastal wetlands of Baja California, Mexico. *J. Field Ornithol.*, 68(4):562-574.

❖ Puttick, G.M., (1981). Sex related difference in the foraging behaviour of Curlew Sandpiper. *Ornis. Scand.* 12: 13.

❖ Rottenborn, S.C., (1996), The use of coastal agricultural fields in Virginia as foraging habitat by shorebirds. *Wilson Bulletin* 108: 783-796.

❖ Sampath, K., Krishnamurthy, K. and Vijayan, V.S., (1995). Foraging behaviour of Waders. *J. Ecol. Soc.* 8: 13-22.

❖ Stroud, D.A., Davidson, N.C., West, R., Scott, D.A., Haanstra, L., Thorup, O., Ganter, B. & Delany, S. (compilers) on behalf of the International Wader Study Group 2004. Status of migratory wader populations in Africa and Western Eurasia in the 1990s. *International Wader Studies* 15: 1-259.

❖ Warnock, N. and Bishop, M.A., (1998). Spring stopover ecology of migrant western sandpipers. *The Condor* 100: 45&467.

❖ Weller, M.W., (1994), Seasonal dynamics of birds assemblages in a Texas Estuarine Wetland. *J. Field Ornithol.* 65(3): 388-401.

❖ Withers, K. and Chapman, B.R., (1993). Seasonal abundance and habitat use of shorebirds on an Oso Bay mudflat, Corpus Christi, Texas. *Journal of Field Ornithol.* 64:382-392.

Seasonal diets of Small Bee-eater in an agro-environment of Nagapattinam District, Tamil Nadu, India

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Introduction

A large number of birds directly of indirectly depend upon the crop fields and hence they are integral part of the agro-ecosystem. As enemies of insects, birds stand supreme among vertebrates because they are highly mobile and are able to congregate quickly in large numbers as sudden outbreaks of insects pests occur. Avian prey selection is influenced by prey availability, including proximity, detectability, acceptance and ability to successfully capture a potential prey item (Wolda, 1990). Accurately determining prey availability, as perceived by birds, is a research challenge with many potential biases (Johnson, 1980; Cooper and Whitmore, 1990, Wolda, 1990). A bird's ability to capture prey is determined by vegetation structure in the foraging habitat (Robinson and Holmes, 1982), arthropod prey characteristics such as life stage, activity level and palatability (Cooper and Whitmore, 1990) and the bird's behaviour and search tactics (Hutto, 1990).

Food supply plays an important role in determining the breeding biology, dispersion pattern and social system of a species through the natural selection. Detailed analysis of food and feeding behaviour of different bird species of a region is the first and foremost requirement to asses their economic status and to initiate work on bird management in that region (Toor and Saini, 1986). Unfortunately, only limited information is available

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on the feeding ecology of Indian birds. Our objective was examined the food and feeding habits of Small Bee-eater *Merops orientalis* in an agro-environment of Nagapattinam District, Tamil Nadu, India.

Methods

The study was conducted in an about 150km² in Nagapattinam District (18°18" N latitude, 79° 50" E longitude) of Tamil Nadu, Southern India, from 2005 to 2006. Three different transects of 1000 m length and 100 m width of agricultural lands were laid and all the data were collected within transects.

Pellet analysis

Analysis of regurgitated pellets of insectivorous birds is the most reliable and easy method for studying food habits (Herrera and Ramirez 1974, Asokan 1998). The regurgitated pellets of the Small Bee-eater were collected opportunistically at perch and roost-site where we observed the birds within the targeted study area. The collected pellets were bagged, labeled and dried in hot air oven at 60°C for later identification of prey remains (Asokan 1998, Sivakumaran and Thiyagesan 2003). Insect prey remains were identified and enumerated following Herrera and Ramirez (1974) and Asokan (1998). Insect remains were identified up to order level by looking at some of the most important exoskeletons such as mandibles, head capsules, elytra, etc., where identification was not possible, they were grouped into unidentified remains. Jacobs (1974) index was used to evaluate seasonal use of each arthropod order relative to availability:

$$D_{hb} = \frac{r - p}{r + p - 2rp}$$

where D_{hb} is the index of arthropod use, r represents the percentage of an arthropod order in the pellets and p represents the percentage of a particular arthropod order in the total arthropod sample. Values of D_{hb} range from -1 to 1. The terminology associated with relative values of the index (Morrison, 1982) as follows: -1 to -0.81 = used much less than availability, - 0.80 to -0.41 = used moderately less than availability, -0.40 to -0.16 = used slightly less than availability, -0.15 to 0.15 = use equals availability, 0.16 to 0.40 = use slightly exceeds availability, 0.41 to 0.80 = use moderately exceeds availability.

Arthropods sampling

The insect preys available in the study area were collected by using a sweep net method (Pradhan 1991). In each transect of 1km length, 50 sweepings were made at randomly an interval of 20 m.

Results

Pellet analysis

Totally 250 regurgitate pellets were analyzed and identified 3152 individual prey items representing 7 arthropod orders (Table 1). Pellet measurements ranged from 0.9 to 2.9cm in length (mean = 1.7; SE = 0.02), from 0.1 to 1.7cm (mean = 0.6; SE = 0.24) and from 0.07 to 2.15g in weight (mean = 0.5; SE = 0.01). Mean number of prey per

Table 1 : Availability and use seasonal use (percent of individuals in arthropod samples and pellets respectively) of arthropod samples and pellets) of arthropods by the Small Bee-eater in Nagapattinam District.

Season	Order	Availability (%)	Use (%)
Post Monsoon (Jan. – March)		*N = 62*	
	Orthoptera	18	13
	Odonata	10	10
	Hemiptera	14	14
	Hymenoptera	14	17
	Coleoptera	15	18
	Lepidoptera	10	09
	Diptera	11	09
Summer (Apr. – June)		*N = 65*	
	Orthoptera	20	13
	Odonata	09	10
	Hemiptera	15	13
	Hymenoptera	14	15
	Coleoptera	15	16
	Lepidoptera	10	12
	Diptera	10	10
Pre Monsoon (July – Sep.)		*N = 74*	
	Orthoptera	22	13
	Odonata	09	10
	Hemiptera	14	13
	Hymenoptera	12	16
	Coleoptera	15	20
	Lepidoptera	10	11
	Diptera	09	07
Monsoon (Oct. – Dec.)		*N = 55*	
	Orthoptera	20	12
	Odonata	10	10
	Hemiptera	13	17
	Hymenoptera	13	16
	Coleoptera	15	19
	Lepidoptera	11	10
	Diptera	10	08

pellet 11 ± 0.19 (range = 3 to 25). The most commonly identified prey was in the order coleoptera (18% of arthropods collected during pellets), hymenoptera (16%), hemiptera (14%), orthoptera (13%), lepidoptera (11%), odonata (10%) and diptera (10%). Together these orders comprised 90% of the arthropods identified in pellets. Remaining 10% of the prey remains could not identify.

Arthropod sampling

Arthropods in 7 orders comprised 92% of all arthropods captured in sweep nets, including orthoptera (20% of total arthropods captured), coleoptera (15%), hemiptera (14%), hymenoptera (13%), lepidoptera (11%), odonata and diptera (10% respectively).

Arthropod use and availability

The order orthoptera were used in proportion to slightly less than availability by Bee-eater in all seasons. The other arthropods orders viz., odonata, hemiptera, hymenoptera, coleoptera, lepidoptera and diptera were used equally in all seasons (Table 2).

Discussion

The Bee-eater consumed similar proportions of coleopterans and hymenopterans in our study. Mathew *et al.* (1978) reported that Bee-eater consumed almost equal proportions of hymenoptera, coleoptera, odonates and lepidopterans. Asokan (1998) stated that coleopteran insects were the most frequent food items in the diet of Bee-eater the same was recorded in the present study. However, Douthwaite and Fry (1982)

and Fry (1984) who studied the Little Bee-eater *Merops pusillus*, reported that hymenopterans formed the principal diet. Douthwaite and Fry (1982) reported that Little Bee-eater in Africa consisted of 57% of hymenoptera and remainders coleoptera, diptera and odonata. Fry (1984) found that hymenopterans constituted more that 75% in the pellets of Bee-eaters with beetles constituting only 17% and remaining 8% were termites, assassian bugs, squash bugs, shield bugs, microlepidoptera and so on.

Many researchers have reported that coleopterans and hymenopterans and lepidopterans (Raley and Anderson, 1990; Sillett, 1994; Poulin and Lefebvre, 1996; McMartin *et al.*, 2002; Yard *et al.*, 2004; Asokan *et al.*, 2006, Moorman *et al.*, 2007) are an important food resource for insectivorous birds. Small Bee-eater is an aerial feeder and caught varieties of beetles, butterflies, dragon flies, bees, etc., on the air. In general, Bee-eater preferred coleopteran and hymenopteran insects in all seasons. Many investigators have described in food habits within (Hejl and Verner, 1990) or between (Martin and Karr, 1990) seasons, probably due to changes in food availability. However, arthropod availability was relatively consistent among seasons in our study.

Direct observations of avian diets are complicated by variable digestion rates of different arthropods (Swanson and Bartonek, 1970; Rosenberg and Cooper, 1990). Digestibility is affected by body type (soft or hard) and prey size (Custer and Pitelka, 1975). Caterpillars and other soft-bodied insect larvae are more easily digested than arthropods with hard parts and therefore, may be

Table 2: Index of seasonal of arthropod use by Bee-eater relative to availability in an agro-environment, 2005- 2006.

Season	Orth	Odon	Hemi	Hyme	Cole	Lepi	Dipt
Post Monsoon	-	0	0	0	0	0	0
Summer	-	0	0	0	0	0	0
Pre Monsoon	-	0	0	0	0	0	0
Monsoon	-	0	0	0	0	0	0

For each order, D_{hb} values (Morrison, 1982) are represented as follows:
- = - 0.40 to – 0.16; 0 = - 0.15 to 0.15.

Orth = Orthoptera; Hemi = Hemiptera; Hyme = Hymenoptera;
Cole = Coleoptera; Lepi = Lepidoptera; Dipt = Diptera.

underrepresented in bird diet samples (Wheelwright, 1986). Thus, proportions of soft-bodied arthropods, such as those in the orders lepidoptera, odonata and diptera were probably under represented in our analyses and may more important in bird diets than indicated in our results. However, we believe that our data represent the wide variety of insect prey items consumed by Small Bee-eater and act as a very active bio-control agent against agricultural insect pests.

Acknowledgements

References

1. Asokan, S., 1998, "Food and feeding habits of the Small Green Bee-eater *Merops orientalis* in Mayiladuthurai", *J. Ecobiol.*, 10(3): 199-204.
2. Asokan, S., A.M.S. Ali and M. Chakravarthy, 2006, "Population, food and feeding habits of the Black Drongo *Dicrurus macrocercus* (Vieillot, 1817)", *Mayur*, 2: 8-13.
3. Cooper, R.J. and R.C. Whitmore, 1990, "Arthropod sampling methods in ornithology", *Stud. Avian Biol.*, 13: 29-37.
4. Custer, T.W. and F.A. Pitelka, 1975, "Correction factors for digestion rates for prey taken by Snow Buntings (*Plectrophenax nivalis*)", *Condor* 77: 210-212.
5. Douthwaite, R.J. and C.H. Fry, 1982, "Food and feeding behaviour of the little bee-eater *Merops pusillus* in relation to tsetse fly control by insecticides". *Biol. Conservation.* 23: 71-78.
6. Fry, C.H., 1984, "*The bee-eaters*", T. and A. D. Poyser, Calton, UK.
7. Hejl, S.J. and J. Verner, 1990, "Within-season and yearly variations in avian foraging locations", *Stud. Avian Biol.*, 13: 202-209.

8. Herrera, C.M. and A. Ramirez, 1974, "Food of Bee-eaters in southern Span", *British Birds*, 67: 159-164.

9. Hutto, R.L., 1990, "Measuring the availability of food resources", *Stud. Avian Biol.*, 13: 20-28.

10. Jacobs, J., 1974, "Quantitative measurements of food selection: a modification of the forage ratio and Ivlev's Electivity Index", *Oecologia*, 14: 413-417.

11. Johnson, D.H., 1980, "The comparison of usage and availability measurements for evaluating resource preference", *Ecology*, 61: 65-71.

12. Martin, T.E. and J.R. Karr, 1990, "Behavioural plasticity of foraging maneuvers of migratory warblers: multiple selection periods for niches", *Stud. Avian Biol.*, 13: 353-359.

13. Mathew, D.N., T.C. Narendran and V.J. Zacharias, 1978, "A comparative study of the feeding habits of certain species of Indian birds affecting agriculture", *J. Bombay Nat. Hist. Soc.*, 75(2): 1178-1197.

14. McMartin, B., I. Bellocq and S.M. Smith, 2002, "Patterns of consumption and diet differentiation for three breeding warbler species during a spruce bud worm outbreak", *Auk*, 119: 216-220.

15. Morrison, M.L., 1982, "The structure of western warbler assemblages: ecomorphological analysis of the Black-throated Gray and Hermit warblers, Auk, 99: 503-513.

16. Moorman, C.E., L.T. Bowen, J.C. Kilgo, C.E. Sorenson, J.L. Hanula, S. Horn and M.D. Ulyshen, 2007, "Seasonal diets of insectivorous birds using canopy gaps in a bottomland forest", *J. Field Ornithol.*, 78(1): 11-20.

17. Poulin, B. and G. Lefebvre, 1996, "Dietary relationship of migrant and resident birds from a humid forest in central Panama", *Auk*, 113: 277-287.

18. Pradhan, S. 1991, "*Agricultural entomology and pest control*", Indian Council of Agricultural Research, New Delhi.

19. Raley, C.M. and S.H. Anderson, 1990, "Availability and use of arthropod food resources by Wilson's Warblers and Lincoln's Sparrows in south -eastern Wyoming", *Condor*, 92: 141-150.

20. Robinson, S.K. and R.T. Holmes, 1982, "Foraging behaviour of forest birds: the relationship among search tactics, diet and habitat structure", *Ecology*, 63: 1918-1931.

21. Rosenberg, K.V. and R.J. Cooper, 1990, "Approaches to avian diet analysis". *Stud. Avian Biol.*, 13: 80-90.

22. Sillett, T.S., 1994, "Foraging ecology of epiphyte searching insectivorous birds in Costa Rica", *Condor*, 96: 863-877.

23. Sivakumaran, N. and K. Thiyagesan, 2003, "Population, diurnal activity patterns and feeding ecology of the Indian Roller *Coracias benghalensis*", *Zoos' Print J.*, 18(5): 1091-1095.

24. Swanson, G.A. and J.C. Bartonek, 1970, "Bias associated with food analysis in gizzards of Blue-winged Teal",. *J. Wildl. Manage.*, 34: 739-746.

25. Toor, H.S. and M. S. Saini, 1986, "Feeding ecology of the large grey babbler *Turdoides malcolmi*", *Proc. Indian Acad. Sci.* 95: 429-436.

26. Wheelwright, N.T., 1986, "The diet of American Robins: an analysis of U.S. Biological Survey records", *Auk*, 103: 710-725.

27. Wolda, H., 1990, "Food availability for an insectivore and how to measure it", *Stud. Avian Biol.*, 13: 38-43.

28. Yard, H.K., C. Van Riper III, B.T. Brown and M.J. Kearsley, 2004, "Diets of insectivorous birds along the Colorado River in Grand Canyon, Arizona", *Condor*, 106-115.

Conservation of Biodiversity in Tamil Tradition

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Abstract

In the southern part of the Indian sub continent, the ancient Tamil people worshipped the earth, the sun, the air, water, plants and animals. Sangam literature mentions the term "*thinai*" which encompasses five different types of landscapes and they are *Kurinji* (mountainous region), *Mullai* (forest track), *Marutham* (agricultural land), *Neithal* (coastal region) and *Paalai* (arid land). For example, the various trees were associated with different deities. Central among them are the sacred groves, dedicated to local deities and/or ancestral spirits. The report of Brandis (1897), on the `Sami Solai' (sacred groves) in the hill ranges of the Salem district in the Madras Presidency may be the first authentic report on the sacred groves. Originally, the conservation practice of sacred grove goes back to the Sangam period and the practice still exists in Tamil Nadu. Each grove is dedicated to the local deities and spirits (*vanadevathai*) and has folklore associated with either the deity or the grove. Due to cultural diffusion by rapid urbanisation, sacred groves are gradually disappearing in many parts of Tamil Nadu. This paper summarizes the history of nature conservation by Tamil culture drawing references from Sangam Tamil literature.

Key words: *sacred groves, plants, keystone species, biodiversity.*

Introduction

Traditional knowledge plays a very important role in the conservation and management of nature, natural resources and biodiversity. Every village temple had a sacred tree. The king, in times of war, appealed to the sacred tree to bloom in emerald verdure to presage victory (*purapporul vennpamalai*, 243). Devotees for its divine foreknowledge and unfailing prophecies also revered this tree. The king worshipped that tree and a healthy and sturdy tree reflected the prosperity of his rule. In Tamil Nadu, local practices of vegetation management are perhaps derived from the basic ecological concepts of local communities reflected in "bio-geographical zones like concepts in Tamil tradition" (Raman, 2005). Local knowledge systems have been found to contribute to sustainability in

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diverse fields such as conservation of sacred elements; some places named after plants and animals, sacred groves, sacred trees, remnant tree worship, sacred gardens and sacred animals. Traditional knowledge has also been found to be useful for their revival of folk traditions in Tamil Nadu and these traditions are essential for the conservation of biodiversity.

Ecological traditions and Place Names

Places named after animals and birds are numerous. Puliyur, Pulipakkam (Chengalpattu District) are named after the tiger, Karadipatti (Madurai District) is named after the bear, Aanaiyur, Aanaika after the elephant and Maanturai after the deer (Tiruchi District) have been named after animals. The culture and lifestyle of the ancient Tamils were deeply intertwined with trees, foliage and flowers. Seasonal behaviour like flowering, producing new leaves, or shedding of flowers and leaves was taken as an indication of future happenings.

Villages located on the banks of rivers have names with 'aarur' or'thurai' as either prefix or suffix (Thiruvarur, Thuraiyur, Arugatturai) and villages situated at the confluence of rivers had the term koodal as a suffix (Thimmukkoodal).

Villages near the lakes have yeri as a suffix (Maraneri, Murukkeri, Tiraineri, Thenneri, Pazhaveri, Kadapperi, Ponneri).

The names of villages with prominent tanks have the suffix kulam (Karungulam, Kattankulam, Malayankulam, Perumkulam, Ayyangarkulam, Veppangulam, Pammadhukulam, Thaneerkulam, Tiruvallikkeni) or the one with waterfalls, as Peraruvi in Tirunelveli District. Tiruvaiyaru, as the name aptly suggests, is located at the confluence of five rivers.

There are also numerous instances of places named after animals and birds. Puliyur, Pulivoy Pulipakkam, Thirupulivanam (Chengalpattu Dt.) are named after the tiger/leopard. Karadipatti (bear) (Madurai District); Aanaiyur,Aanaika (elephant); and Maanturai (deer) (Tiruchirappalli District); Mayiladuturai, Mayilapur (peacock); Koliyur (hen) (Tiruchi District); Kuyilkudi (cuckoo) (Madurai District), Tiru-kalugu- kunram (vulture) (Chengalpattu District.), Kalugumalai (vulture) bear the names of birds.

The names of places at times also reflect the nature of the soil as is evident from Semmanjeri (red soil), Karisikadu (black soil), Manalur (sandy village) and Sembulam (Red soil).

Quite a few names of places were associated with trees like Panaimarathupatti, Panaiyur (Indian palm); Veppampatti (neem), Alapakkam (banyan), Navalur (Indian black plum) and Iluppai (Indian butter tree).

Thiruppaalaivanam (Thiru + Paalai + vanam) once this place covered with Paalai (Ceylon iron wood) tree.

Arani denotes a place surrounded by a forest. Mangadu (Mango grove/forest), Chaaikadu (place once covered with

chaai or korai grass), Attikadu, Athipattu (Indian fig) and Alankadu (banyan) find reference in the Sangam literatures such as *Ahanaanooru*, *Puranaanooru* and *Aingkurunooru.*

History of Sacred Plants

Trees worshipped in the temple and which were associated with the temple or the deities came to be known as *sthalavrikshas* or sacred plants. Further, trees like *vembu* (neem), *vilvam* (Bengal quince) and *kontrai* (Indian laburnum) were sacred to a particular deity whose idol was installed beneath the tree (*purananuru*, 199-1; *agananuru*, 287-7; *paripadal*, 4-67). Later when temples were erected for the deities who had originally occupied places under the trees, devotees took special care not to remove or disturb those trees. In Tamil Nadu, there are a number of tree shrines and the prominent ones include the mango (*ekamra*) tree at Kanchi, a black plum (*jambu*) at Jumbukeswaram near Tiruchirappalli, the Indian palm (*panai*) at Tirupanaiyur and the "blinding' tree (*tillai*) at Chidambaram.

The sacred trees are symbolic of a single genetic resource and play a pivotal role in the conservation of local floral wealth and biodiversity. Every tree has a legend of its own. For example, Thillai (Chidambaram) is derived from the *tillai (excoecaria agallocha*) the mangrove tree. The Tamils consider the tree sacred and worthy of worship. Even if the sacred tree happened to fade away or perish, it did not cease to be sacred and worship was continued. A *kadamba* tree (*Anthocephalus cadamba*) once

flourished in the Meenakshi Sundareswarear temple at Madurai. There are several examples of trees found in sculptures: in Kutralam, people worship the *lingam* under the *kurumpala;,* in Kurukkai, the tree is worshipped by the goddess and *rishis;* in Tirukuvalai, the *lingam* under a tree is worshipped by the king and others; in Anbilalandhurai, the *lingam* under the tree is worshipped by a king; in Tirukottai, a *rishi* sits under the *kottai chedi* (*Ricinus communis*) and in the five metal sculptures of the Tirumangalam temple, one of the *nayanars* is seen under the *kontrai* tree. The social, economic, medicinal and environmental importance of these trees was recognised and the sacred tree concept evolved as a means of conserving the land's rich plant diversity. The sacred trees represent various geo-climatic habitats. For instance, the banyan (*Ficus benghalensis*), the pipal (*Ficus religiosa*) and the Indian fig (*Ficus glomerata*) afforded total protection in India. Trees came to be regarded as abodes of certain deities: the *asvatha* or *pipal* tree, the *vathapathra* (banyan) and the *thulasi* (basil) symbolizes Vishnu; the *vilva* tree symbolizes Shiva and the *kadambu* tree symbolizes Muruga. Some temples were erected in places where such trees were worshipped and, in course of time, they came to be associated with the temples as *sthala vrikshas: jambu* tree with Jambukesvaram, mango tree with Ekambareswarar temple and the fig (*athi*) tree with Attiyur (Varadaraja Perumal temple, Kanchipuram). The Alexandrian laurel tree (*punnai* tree) is the *sthala vriksha* of the Mylapore Kapaleeswarar temple. *Alwar* Tirunagari

in Tirunelveli district has the tamarind tree as its *sthala vriksha,* because the saint *Nammalvar* did penance under it and the sacred tree itself is worshipped as Thiru-pali-Alwar. The sacred trees are symbolic of a single genetic resource and thus play an important role in the conservation of biodiversity. The social, economic, medicinal and environmental importance of these trees has been recognised and the sacred tree concept has evolved as a means of conserving the land's rich plant genetic diversity. The sacred trees therefore represent various geo-climatic habitats.

Sacred plants play a very important role in ecology. The red flowers of the Indian coral tree are used in the worship of Lord Vishnu and Lord Siva; *Alari* (*Nerium indicum*) in the worship of Lord Siva and the Sun-god; ketaki (*Yucca gloriosa*) in the worship of Lakshmi, and *pala* or breadfruit (*Artocarpus integrifolia*) in the worship of Lord Vishnu. The use of some flowers is prohibited in the religious rites like *vaagai* (sirisa or parrot tree/*Albizzia lebbeck*) in the worship of Lord Ganesha and *vengai* (*Pterocarpus marsupium*) in the worship of Lord Siva. Most of the roadside shrines in Tamil Nadu are associated with reservoirs, ponds, rivers, springs or streams.

Sacred plants and biodiversity

This religious practice plays a vital role in the conservation of certain native plant species. Based on a thorough review of literature, temples have been selected and surveyed to document the sacred plant (*sthalavriksha*) species and the associated cultural practices and religious faiths. Of the 500 temples

surveyed, "*Sthalavrikahas*" are found in 306 temples. Sixty (60) plant species belonging to 33 families were recorded including 30 dicots (30 families) and 3 monocots (3 families). The majority (81%) of the sacred plants species are trees, followed by shrubs (8%).

Tamil tradition and culture have successfully preserved biodiversity through the ages. The sacred trees are symbolic of a single genetic resource and play an important role in the conservation of biodiversity. The social, economic, medicinal and environmental importance of these trees has been recognised and the sacred tree evolved as a means of conserving the land's rich genetic plant diversity. The sacred trees thus represent various geo-climatic habitats.

Rare plant species are also preserved and worshipped as sacred plants. The process of conserving economically, ecologically and medicinally important plants by declaring them as sacred has also protected the genetic value of several plant species. Thus, the preservation of sacred trees may also help in the conservation of local floral wealth. As a result, the sanctity attached to several contemporary sacred trees remains unexplained or untraced.

Sacred plants and Ecology

Sacred plants play a very important role in ecology. Sacred plants provide food, shelter and nesting substratum for several species of birds and squirrels. For instance, the banyan (*Ficus benghalensis*), the pipal (*Ficus religiosa*) and the Indian fig (*Ficus glomerata*)) are

afforded total protection in India. The five most sacred leaves of peepal, cluster fig, white fig (*Ficus lacor*), banyan and mango are invariably employed in making prayers and offerings. The red flowers of the Indian coral tree are used in the worship of Lord Vishnu and Lord Siva; *Alari* (*Nerium indicum*) in the worship of Lord Siva and the Sun god; ketaki (*Yucca gloriosa*) in the worship of Lakshmi, and *pala* or breadfruit (*Artocarpus integrifolia*) in the worship of Lord Vishnu. The use of some flowers is prohibited in the religious rites like *vaagai* (sirisa or parrot tree/*Albizzia lebbeck*) in the worship of Lord Ganesha and *vengai* (*Pterocarpus marsupium*) in the worship of Lord Siva. During the sacred thread ceremony, the brahmacarin has to perform the sacrifice using pipal twigs called *samit*.

Keystone species

Keystone species play a crucial role in biodiversity conservation through key functions that they perform in an ecosystem (Ramakrishnan, 1992). Sacred groves, sacred trees and sacred animals teach us the rudiments to be learnt in the evolution of conservation system in the wider fabric of the cultural pattern of India (Amirthalingam, 2007).

The social anthropologists and ecologists draw a distinction between the phenomenon of sacred groves and sacred plants and the worship of some keystone plant and animal species which are important from communal and environmental point of view. It is stated that the sacred groves are protected by the local communities, usually through customary taboos and sanctions that have cultural and ecological implications (Malhotra et al. 2001). Thus sacred groves are part of the landscape consisting of vegetation and other life forms and topographical feature that are clearly demarcated and protected by the indigenous communities. This is done in the belief that keeping them in a pristine state expresses a basic human need of relationship with the divine and nature (Hughes and Chandran, 1998).

Cultural Keystone species

The sacred groves are the only remnants of the original forest maintained in many parts of Tamil Nadu. As such, these groves now play a vital role in the conservation and preservation of Tropical Dry Evergreen Forest species diversity.

Keystone species play an important role in the conservation of sacred groves. It is believed that the people of villages preserve the sacred groves by means of tradition customs and beliefs. Legends and myths say that there is recompense and blessing for maintaining the groves and punishment for those who do not adhere to the rules of behaviour. Many such legends and stories are associated with the life and ethos of the people.

Konjkuppam sacred grove is situated between Panruti and Neyveli. The grove is associated with Aiyanar, the protecting deity of the villages. It is interesting to note that the village name Konjikuppam is named after a plant Konji (Orangeberry / *Glycosmis mauritiana*), which is predominant in this region. Mudhanai is a small village

situated north west of Neyveli town. There is a grove dedicated to Sir Sembiyanar. Illuppa, the Indian butter tree is the predominant tree of the sacred grove.

People believe that they will be blessed with a child if they circumambulate the *Azhinjil* (*Alangium salviflorum*) tree in the grove dedicated to *Poomudai Aiyanar* at Siruvathur near Panruti.

Mavuthu is a tribal village near Theppampatti which is 19 km from Aandipatti of Theni district and occupied by the Paliyars. Here the Velappar temple is situated on a mountain. There is a spring which flows from below the mango tree from time immemorial. This spring has never dried up. This is called *Mavuthu* by the villagers. They believe that all serious ailments of the skin would be cured by taking a bath in this spring.

The sacred *Puthu* (termite mount) is situated under an ironwood tree *(Memexylon umbellatum)*, on which numerous cradles are tied with a cloth. Tying a cradle on the Indian Cherry tree in the grove is a common practice. Since Amman incarnated as a parrot on a banyan tree, the goddess got the name 'Kilialamman' (Kili + aal + amman) and the sacred grove is known as 'Kilialamman thoppu' (Amirthalingam, 2011). The grove is also populated by parakeets (*kili*) which live on the banyan tree. Mudhanai is a small village situated north west of Neyveli town. Illuppa, the Indian butter tree is the predominant tree of the sacred grove. People believe that they will be blessed with a child if they circumambulate the *Azhinjil*

(*Alangium salviflorum*) tree in the grove dedicated to *Poomudai Aiyanar* at Siruvathur near Panruti. There is a mango tree near the temple. In Tiruvothamman grove of Azhaka-nandhal, people tie a wooden or cloth cradle on the branch of a Konrai (*Cassia fistula*) tree. In Tiruvarur district, offerings like twining, hung girdles, cloths with some object and tied bangles are made on a neem tree (*Azadirachta indica*). In Soimuthu Aiyanar grove at Papanasam, people tie cloths with some object on a Iluppai tree (*Madhuca longifolia*). A strip of cloth is tied with a stone on the branch of the Yellow Oleander tree (*Thevitia peruviana*) inorder to get a male child. In the Aiyanar grove in Kallagam they tie a bell in chain to the branches of a neem tree and in Kanappadi Thottikal karuppuswami grove the bells are tied in chain to the branches of the tamarind tree for family welfare and fertility. In Kuruvayiamman grove at Puliyancholai, a strip of cloth is tied with a stone on the branches of the *Writia tinctoria* tree. In Shobanapuram Poonjolaiamman grove, a wooden/ cloth cradle is tied to the neem tree.

In Pudhuvaikattu Aiyanar grove in Pudukkottai district, the worship of Aiyanar is by performing puja with the leaves of Thanaka maram (*Gyrocarpus asiaticus*). In Kaliamman grove at Kattipattu village, the people offer deer to the goddess. Before the festival, the devotees go for deer hunting. If they are not able to hunt deer, they postpone the festival for three years (Amirthalingam, 2000).

On the whole some of the species are considered to be a cultural keystone

species. They are banyan, oil cake tree, neem, poison nut tree, helicopter tree, tamarine, sage-leaved alangium, hedge boxwood, Bengal quince, wild lime, hill mango, Gamboge tree, Indian ash tree, ironwood tree, Indian mulberry, common Burbush irula, Palmyra palm, Indian black plum, Cork-leaved bayur offering made on these trees like twining, hung girdles, cloths with some objects to fulfil their vows.

Conclusion

The ancient Tamils attached great importance to the preservation of natural resources and biodiversity. These resources were considered not only a source of material well being but also a reflection of the character of the state and the citizens. In this article, I have made an attempt to explore the importance of the sacred elements such as sacred plants, groves, gardens and animals and their role in biodiversity conservation. Biodiversity conservation is very important to mankind and ecological sites have played a key role in regulating various functions such as hydrological cycles, rainfall, temperature, local climatic conditions and support to bio-diversity. Unfortunately, sacred elements have been subjected to severe biotic pressures with indiscriminate exploitation, excessive demands for commercial purposes and various other such causes. It is time we revived the ecological traditions and realise the role they play in conservation of biodiversity. The role of keystone species in conserving and enhancing biodiversity and indeed in manipulating ecosystem functions is a critical area

that has not been adequately explored. Keystone species play a crucial role in biodiversity conservation, through key functions that they perform in an ecosystem. Individual species such as the banyan (*Ficus benghalensis*), the pipal (*Ficus religiousa*) and the Indian fig (*Ficus glomerata*) are keystone species in an ecological sense that perform key functions of nutrient conservation in this protected ecosystem. Through their role in ecosystem function, they contribute towards supporting biodiversity in these sacred plants often protected by local people for religious and cultural reasons.

Reference

- *Agananuru*, 287-7
- Amirthalingam, M. (2016). Sacred groves of India – An overview, Int. J. Curr. Res. Biosci. Plant Biol., 3(4), 64-74.
- Amirthalingam, M.,2011. 'The story of Kili-aal-amman', Eco News, Vol. 17, No.2, pp. 5-7; *http://enviscpreec.blogspot.in/*.
- Amirthalingam, M. (2007). Conservation of sacred groves through cultural beliefs, Eco News, 13 (1): p.13.
- Amirthalingam, M., 2000. Folklore of sacred groves, *Folklife*, Vol. 1, Issue 3, pp.8-9.
- Brandis, D. (1897). Indigenous Indian forestry: Sacred groves. In: *Indian Forestry*. Working, Oriental Institute, pp.12-13.
- doi: http://dx.doi.org/10.20546/ijcrbp.2016.304.011.
- Hughes, J.D. and Subash Chandran, M.D. 1998. Sacred groves around the earth: An overview, In: Ramakrishnan, P.S. Saxena, KG. and

Chandrashekara, U.M. (eds.) Conserving the Sacred for Biodiversity Management, Oxford and IBH Publishing Co., New Delhi, pp.69-46.

❖ Kurunthogai, 282; *Paripadal*, 4-67; *Puranauru*, 199-1; *Purapporul vennpamalai*, 243.

❖ Ramakrishnan, P.S. (1992). *Shifting agriculture and sustainable development: An interdisciplinary study from north-eastern India*, UNESCO–MAB Series, Paris and Parthenon Publ, Carnforth, Lancs., UK (republished by Oxford University Press, New Delhi 1993).

❖ Raman, K.V. (2005). The Ecological Tradition in Tamil literature and Epigraphy. In: Ecological traditions of Tamilnadu (Nanditha Krishna, Eds.), Chennai, CPR Environmental Education Centre, pp16-24.

Understanding of Sustainability amongst Students of Management – A Case of Indian Institute of Management, Raipur, State of Chhattisgarh, India

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Abstract

India has compulsory teaching and learning of Environmental Education at all levels of formal education. This was mandated through a Supreme Court directive. This study was conducted using a survey instrument that was used as a proxy of sustainability literacy. The instrument had open-ended questions to gauge the respondent's perspectives, close ended knowledge-based questions, statements to understand attitudes and their awareness of eco-labelling/certification. The target group of study was the entire batch of 90 students (15 Female and 75 Male) that had joined the postgraduate programme in 2014. The students came with about of year of work experience. The major background was engineering and science with only eight percent with commerce background. All were found to be high achievers in their previous education in school and graduation.

Content analysis of the open ended question showed that 24 percent of the students agreed that economic development at the cost of environment is a short term solution, followed by 16 percent each saying that there is a need to have a balance or economic development should be at the least environmental cost. About seven percent said that economic profit can improve the environment and there is no option left if we need economic development. Only six percent putting comfort over the environment. Although the attitude was very positive, about 62 percent of the students were not able to articulate the difference between the quality of life and standard of living. 75 percent of the respondents supported the compulsory

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CSR act. 71 percent were in favour of extended producer responsibility. There seems to be a limited understanding of sustainable development and equates it to environmental conservation as any lay person who is informed by mass media. 72 percent did not understand the term Green Washing. The awareness was found to be moderate. Profit maximisation was the understanding as the goal of a business. Nearly half of them were of the opinion that consumers will not pay for environmentally friendly products. Although a high of 89 percent said that eco-labelling has an influence on consumer behaviour, very few of them were aware of eco-labels. Almost all agreed that polluters should pay 67 percent of them also believe that environmental clearances are an impediment to economic growth and 64 percent believe that privatisation leads to better utilisation of resources.

The study shows a pro environment attitude but at the same time a limited understanding of the depth of issues and only the economic centric perspective of sustainable development. Only 16 percent gave some hint of social dimension to sustainable development. Awareness of HDI and GDP was high but connection to quality of life was missing. The environment was high on priority as 24 percent of the students agreed that economic development at the cost of environment is a short term solution, followed by 16 percent each saying that there is a need to have a balance or economic development should be at the least environmental cost. There seems to be a limited understanding of sustainable development and equates it to environmental conservation as any lay person who is informed by mass media.

Also it was found that students were influenced by common business perspective being projected in Indian media. Business is becoming a major driver of sustainable development with increasing production and consumption along with population as a major reason for environmental degradation. It is recommended that social and environment be part of ethical framework of business education. It would be useful if details sustainability literacy assessments are done to inform the business management curriculum for the need to include environmental / sustainability management. The impact of undergraduate discipline was found to influence awareness and perception and hence it is important that the management curriculum removes the gap in sustainability literacy amongst students.

Key words: *Sustainability Education, Environmental Education, Management Education, Education for Sustainable Development, MBA, Sustainability Literacy.*

Introduction

The crisis of environment is now well understood and for the same reason, teaching and learning about the environment have been made compulsory at all level of education in India through a Hon. Supreme Court Directive. University Grants Commission has introduced a compulsory six months core module for implementations in all the University colleges of India (Bharucha E. Textbook for Environmental Studies, UGC and BVIEER, 2004).The students who have taken admission in the 2014 batch of Post Graduate Programme in Management would have gone through the compulsory module and are expected to have a basic understanding of environmental sustainability issues.

The knowledge of environmental sustainability is also important for would be business managers as they are at the core of production and consumption practices that can have a big impact. The current government through its Make in India Campaign has also highlighted the need to conscious of conserving the environment through the pronouncement of Zero Defect and Zero Effect as the strategy. To reflect business reality, schools of management must make it clear to students that they can be good managers and good environmentalists at the same time. As the research across faculties suggest that the management profession remains the last among professional fields to acknowledge the fact (Hoffman 2000). Empirically, as the world becomes more globalised, and the impact of industrial and commercial activities become more extreme, no solution to the environmental problems society faces will be solved without the involvement of business. (Hoffman 2004).

Literature Review

According to the American Marketing Association, green marketing is the marketing of products that are presumed to be environmentally safe. Thus green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Yet defining green marketing is not a simple task where several meanings intersect and contradict each other; an example of this will be the existence of varying social, environmental and retail definitions attached to this term. Other similar terms used are Environmental Marketing and Ecological Marketing.

It is assumed that academic institutions, especially business schools, have a key part to play in helping achieve more sustainable modes of economic activity (Coopey, 2003), but most business students are not trained to consider the environment as a key factor in business decision making (Hoffman, 2000), while paying attention to environmental issues has become an integral part of the way business practitioners do their job. Several studies were conducted to examine the question of socially and environmentally responsible management education. Though

business students may need training in social, environmental and moral reasoning more than most other students, as they face these challenges and dilemmas in managing, they do not always receive such education, and if they do it is usually not mandatory. Matten and Moon (2005) studied the social and environmental education – including teaching and research – in Europe. They found that 47% of their respondents offered subjects in these areas, or related fields as optional subjects and 38% embedded the concepts in existing subjects. A more recent study by Nicholson and DeMoss (2009) showed that from the perspective of curriculum coordinators, there was a significant gap between current and normative levels of instruction on social, ethical and environmental responsibility in business school curricula. Social and environmental responsibility was rated lower than ethics by all department coordinators. Furthermore, a study of top business schools in the United States found that business school education not only fails to improve the moral character of students but may also potentially weaken it (Segon & Booth, 2009).

In a study by Contreras (2014), it was found that students have imbibed the proper values on environmental protection and preservation. The Greater concern is also evident more on females over males, the older respondents over the younger ones. High education level had a positive effect on environmental concern. It is assumed that academic institutions, especially business schools, have a key part to play in helping achieve more sustainable modes of economic activity

(Coopey, 2003), but most business students are not trained to consider the environment as a key factor in business decision making (Hoffman, 2000). One major impediment to increasing student interest is the fact that environmental management is generally perceived as part of "socially responsible business". As such, it lies on the periphery of "real" business decision-making and is thus outside the standard business curriculum (Hoffman, 1999). According to Gardiner and Lacy (2005), there is a growing need for business educators to grab this issue by the horns.

Jóhannsdóttir (2009), reports the main result of the research, which is the limited environmental literacy of MBA and Masters Students. According to the author, this does not come as a surprise. To some degree, this can be attributed to a lack of environmental education. The majority of the students (85-90%) claim that they have not acquired such training. What came as a surprise was that 2.6-6% of the students did not know whether or not they had received environmental or sustainability education. What is also of interest is the list of environmental terms which students claim to know best, which includes climate change and greenhouse gas emissions. The explanation might be that those terms are frequently employed by the media. Still, the knowledge is neither good nor limited. It is also of interest that there is a passable knowledge about corporate social responsibility or social responsibility, but the students do not seem to relate the term to triple bottom line (TBL) which ranks very low in the research (1.2) despite the fact that the

term includes economic, environmental and sociological elements, i.e. CSR can be regarded as one dimension of the TBL concept.

Hoffman et.al. (2014), opined that environmental protection, as an issue of corporate concern, has become much more complex and requires a more sophisticated view to be managed effectively. To treat environmental and business issues as separate and distinct leaves at a strategic disadvantage, unable to efficiently recognise the reality of a changing society – one that will demand even greater corporate responsibility for protecting the environment. Technical fixes arising from our existing knowledge base can only, at best, slow the advances of unsustainability. The root problem arises from outmoded beliefs deeply embedded in our political economy and most of our societal institution. Sivamoorthy et.al. (2013) found that the level of awareness is high among the respondents irrespective of gender difference but in practice level, there is the difference between genders i.e. males practising more than females. In another study, Sengupta et.al. (2010), observed that unlike other findings, science students scores on environmental awareness and behaviours were less than that of art students. This is inconsistent with other findings of Yilmaz et.al. (2004), Simmons (1998), Sebastian and Nima (2005). The girl students are observed to be more environmentally aware although the gender has no effect on environment related behaviour.

Nicholson & DeMoss (2009) asked why business schools do not change their curricula to become more socially responsible and answered that in market-driven MBA programs, curriculum size (i.e. the number of required courses) is cut to make a program more competitive (i.e. allow students to complete the curriculum faster), with the ethics course as one of the casualties. Another reason is that business schools believe that their stakeholders (including students) are indifferent to the subject matter beyond superficial inclusion or review (Nicholson & DeMoss, 2009). In their study, Luthar and Karri (2005) asked students if the social and environmental cause is good business and if it yields higher performance and market position for the firm. It was found that students saw a significant disconnect between these and professional performance or rewards (i.e. it does not pay to be good). However, exposure to these in the curriculum had a significant impact on student perceptions of what should be the ideal linkages between organisational ethical practices and business outcomes. Gender-based differences were found with female students having a higher expectation of what should be the ethics practices and business outcomes link. Some more recent studies indicate a change occurring in students' attitudes, particularly among females. Sleeper et al. (2006) found that business students, particularly women, are indeed interested in social and environmental education. A substantial sample of business students reacted very positively to business school education on corporate conduct affecting social and environmental issues. Female students exhibited

significantly higher scores, reflecting a stronger tendency among women than men to agree that business schools should address social and environmental issues in their curricula. The authors further found a strong but non-cumulative relationship between donating, volunteering and organisational membership of respondents and their propensity to believe that social and environmental issues are appropriate content for business courses (Sleeper et al., 2006).

In 2009, Segon and Booth studied attitudes of part-time MBA students on Business Ethics, Social and Environmental Responsibility. The majority of respondents (73.5%) identified these as a fundamental requirement for good business and a civil society.

Research Methodology

A survey instrument that served as a proxy of their sustainability literacy was designed that had

a. Eight statements to gauge the respondent's perspectives through open-ended responses.

b. Testing their knowledge through eight true-false statements.
c. Fifteen statements to understand attitudes as agree / disagree response.
d. Awareness of Eco-Labeling programmes/certification.

The instrument was shared with four colleagues for feedback and finalised after incorporating the comments. The survey purpose was explained to the students and administered to the 90 students for the first year of Post Graduate Diploma Programme in the month of July 2014 i.e. just after their admission.

Findings

Descriptive analysis of sample

A total of total 90 students participated in the survey. As we see in Table 1, most of the students are with less than 6 months of experience. The students had a mean of 11.5 months of work experience. Since most of them graduated after the Supreme Court directive, all of them have gone through the compulsory module introduced in 2004.

Table 1: Summary profile of students

Work Experience (Months)	Male	Female	Total
0 to 6	34	13	47
7 to 12	2	2	4
13 to 18	7	0	7
19 to 23	4	0	4
24 to 35	13	0	13
36 and above	7	0	7
Not Known/provided			7

Most of the students are engineers and with science students constitute the majority. Only about 8 percent of the students are from commerce background. The students are also high performers (Table 3) as the average is above distinction i.e. 75 percent in school and a very high 73 percent at graduation level. This is expected as the selection examination is highly competitive.

Table 2: Background as per their undergraduate/bachelor's degree

Bachelor Degree	Male	Female	Total
Science/Engineering	61	14	75
Commerce	6	1	7
Not provided	-	-	7

Table 3: Average achievement in percentage at different levels of education

Level of Education/Examination	Average Score/Percentage
Secondary Level	82
Higher Secondary Level	78
Bachelors	73

Analysis of responses to the perspectives

Students were given eight statements to share their perspectives.

Table 4: Summary perspective to Statement 1 "Economic development at the cost of environment is sustainable"

Perspective Shared	No. of Students	Percentage
Only short term solution	22	24%
Have to make a balance and/or both have to co-exist/ both should go hand in hand	14	16%
Economic development shall be without harming the environment and/or economic development should be at the least environmental cost /economic development harms environment	14	16%

Perspective Shared	No. of Students	Percentage
Economic development depends on environment and/or clean environment is necessary	10	11%
Damaging environment leads to disasters and/or damage done is already too big	10	11%
We have to take care of environment and/or environment has to be kept in mind/first environment than economic development/we have to love our nature more than ourselves	5	6%
Economics profit shall be used to maintain environment and/or economic damaging environment should compensate anywhere else	4	4%
Find ways to sustain development and environment and/or more research will stop environmental degradation	3	3%
Yes, if there are no other options left to develop economy and/or resources need to be consumed to increase economic development/environment degrading has to be done to build up industry	3	3%
Others	5	6%

The majority shared the need to keep environment in mind. 24 percent mentioned that this is a very myopic thinking and believed that economic development has to factor in environmental conservation. 58 percent of the respondent more or less gave a perspective that for sustainable development environment is a key element and we have to be conscious of it with about 6 percent stating that environment is more important than economic development. 16 percent talked about balancing the two and 10 percent made a point of looking at some compromises. The response shows that the students are aware of the challenges being faced and had

some understanding of the conflict. This pro-environment attitude is also reflected in Statement 2 (Table 5) with only 6 percent putting comfort over the environment. Although the attitude was very positive, about 62 percent of the students were not able to articulate the difference between the quality of life and standard of living.

Table 5: Summary perspective to Statement 2 "We should be willing to tolerate environmental degradation for comfortable lifestyles"

Perspective Shared	No. of Students	Percentage
We should not destroy long term future	26	**29%**
Comfortable lifestyles should not be preferred over environment and/or economics depend on a healthy population, through clean environment	16	**18%**
A comfortable lifestyle is not achievable without environment	15	**17%**
We should promote eco-friendly living	8	**9%**
We have to limit environmental degradation and/or degradation due to increase of lifestyle has to be compensated	7	**8%**
We should always keep environment in mind and/or we have to make both simultaneously/ research will discover ways to make everything non-environment degrading	6	**7%**
Environmental degradation will lead to disasters and/or damage done to environment is already too big	5	**6%**
Damage not endangering human lives is acceptable and/or it's okay to a certain extent, then there should be programs tackling it/we cannot have both-environment and comfortable lifestyles	3	**3%**
Comfortable lifestyles can be achieved by controlling environmental degradation and/or environmental degradation is sometimes acceptable, but never tolerable	3	**3%**

Table 6: Statement 3 "Quality of life and Standard of living"

Perspective Shared	No. of Students	Percentage
Understood the difference between the two and made an argument for quality of life	34	38%
Did not understand the meaning at all	56	62%

One major impediment to increasing student interest is the fact that environmental management is generally perceived as part of 'socially responsible businesses. As such, it lies on the periphery of 'real' business decision making and is thus outside the standard business curriculum. (Hoffmann, 2009). According to Porter and Reinhardt (2007) companies that persist in treating climate change and other environmental issues, solely as a corporate social responsibilities issue, rather than business problems will risk the direct consequences. 75 percent of the respondents (Table 7) supported the compulsory CSR act. Rest of them felt that it should be voluntary and 2 of them event stating that it may lead to wrong practices. The sentiments also reflected a similar trend for sustainable development (Table 8). When asked about extended producer responsibility, 71 percent (Table 10) gave the perspective that the business should be responsible for the product and to some extent brought the concept of Life Cycle Analysis.

Table 7: Statement 4 "Compulsory corporate social responsibility"

Perspective Shared	No. of Students	Percentage
CSR is a good instrument for companies to give back to society	56	63%
CSR act was right	11	12%
CSR should not be forced, we should do it out of own purpose	9	10%
Few companies do it on their own	9	10%
Compulsory CSR may lead wrong practices	2	2%
Should be depending on companies economic sector	1	1%
CSR money should be spent on expanding, ensuring new jobs	1	1%

Table 8: Statement 5 "Sustainable development (SD)"

SD is the need of the hour/ is important	**26**	**30%**
Sustainable development = long term development, securing the future	**22**	**25%**
Development should not be done at the cost of environment/or compensate damage done	**19**	**22%**
It's important to start managing (renewable) resources	**14**	**16%**
Balance in the economy is the key to SD	**4**	**5%**
Have to make a balance between created products and natural resources	**1**	**1%**
SD is done by research	**1**	**1%**

Although nearly all of them were positive to sustainable development and seemed to understand it in terms of time and balance perspective, but were off the mark on the understanding of sustainable development as a concept. Only 14 percent brought **(Table 9)** the issues of health. Rest only looked it at from the perspective of environmental resource consumption and argued for its sustainability. There seems to be a limited understanding of sustainable development and equates it to environmental conservation as any person who is informed by mass media.

Table 9: Statement 6 "Tribal way of life (TL) is most sustainable"

TL is sustainable because it exerts negligible load on the resources	**28**	**32%**
We have to be aware of differences between tribal life and life in modern society with way more people live	**27**	**31%**
We can learn from them on how to make our lifestyle sustainable	**15**	**17%**
TL is not always sustainable, i.e. diseases (no medical), hunting down species	**12**	**14%**
TL focuses on Quality of life, not on Standard of Living	**4**	**5%**
Tribes shall be conserved for the tradition	**1**	**1%**
We can learn from each other to improve our lifestyles	**1**	**1%**

Table 10: Statement 7 "Companies should adhere to extended producer responsibility"

It's a company's responsibility to care for everything about their products, especially to secure environment	**51**	**71%**
Yes, they should be made able to held liable for their policy	**8**	**11%**
Yes	**5**	**7%**
Yes, it will increase consumers faith in a brand	**3**	**4%**
Producer responsibility has to be limited to keep the company competitive	**2**	**3%**
No	**2**	**3%**
Companies should follow guidelines reducing consumption of resources	**1**	**1%**

On asking whether Green Washing increases footprint, 72 percent of the respondents did not understand the term. Most of the people who understood it agreed to the statement.

Analysis of responses to the quiz

On the quiz, three questions had a response of around 50 percent which is a result very close to guessing work probability. The results are summarised in Table 11. The average right answers were 5 from best possible 8. Nearly 40 percent got more than 6 correct and only 16 percent of the respondents got 3 or less ass right answers, with 3 of them only getting one statement correct. Overall it shows a fair awareness amongst the students.

Table 11: Summary of the response to the true/false quiz.

S. No.	Questions/Statements	Correct response	Wrong response	No response
A	The water footprint of a cup of tea is anywhere between 30-35 litres	48%	39%	13%
B	The theme of world environment day 2013 was Think; Eat; Save	69%	24%	7%
C	40 litres per capita per day (LPCD) is the estimation of water required for humans in rural areas in India and about 140 litres in urban areas	53%	42%	6%
D	Ozone depletion or Ozone hole is one of the causes of global warming.	75%	23%	2%

S. No.	Questions/Statements	Correct response	Wrong response	No response
E	As per UNDP 2013 report, India is ranked 137 among 186 countries on Human Development Index that progress in life expectancy, access to knowledge/education and a decent standard of living or gross national income per capita.	87%	8%	4%
F	India is the 3rd largest economy by purchasing power parity and 10th largest by nominal GDP	79%	17%	3%
G	Up to 150 species are lost every day	63%	33%	4%
H	It now takes the Earth one year and six months to regenerate what we use in a year	48%	44%	8%

The awareness level of human development index and GDP can also be attributed to the preparation to the entrance examination. The same did not link to their understanding of sustainable development.

Table 12: Response to the environmental debates

Statements	% agree	% disagree
a. Organic farming cannot meet the food need of growing population	**53%**	43%
b. The States with high economic growth have high human development index (HDI)	**41%**	57%
c. The business cannot make profits if the cost of environmental mitigation is factored.	**20%**	73%
d. Increasing population alone is the cause of environmental degradation.	**13%**	85%
e. High debt countries are using natural resources in order to pay off the debts and the interest.	**82%**	16%
f. Technological advancement will take care of the environmental problems.	**42%**	58%
g. Consumers are not willing to pay for environment-friendly products.	**47%**	52%

Statements	% agree	% disagree
h. Eco-labelling has an influence on consumer behaviour.	**89%**	10%
i. Polluters should pay.	**97%**	3%
j. High economic growth will lead to sustainable development.	**31%**	66%
k. Environmental Impact Assessment and Approvals delay are leading to declining economic growth.	**67%**	25%
l. Slums contribute to GDP of a city.	**68%**	30%
m. Tourism that encourages visits to slums and the tribal area is ethical.	**66%**	33%
n. Higher education leads to sustainable consumption.	**70%**	27%
o. Privatisation will lead to better utilisation and management of resources.	**64%**	36%

67 percent seem to be influenced by the business perspective being reported in media that regulatory framework are impediments in economic growth. Also most of them 65 percent are in favour of privatization for netter utilisation and management of resources. They seem to be unaware of the population in slums contributing to GDP.

Statistical analysis of some awareness level questions and perception on gender and faculty/discipline of study at under graduate level

H1: There is association between the gender of the respondent and their Awareness level regarding the theme of World Environment Day 2013 being Think; Eat; Save

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.438[a]	2	.803
Likelihood Ratio	.456	2	.796
Linear-by-Linear Association	.213	1	.645
N of Valid Cases	83		

At the 5% level, the hypothesis is rejected and we can conclude that awareness level regarding the theme of World Environment Day 2013 being Think; Eat; Save is not associated with the gender of the respondents. It suggests that gender does not have any role to play with respect to people's perception about awareness level.

H2: The Awareness level regarding the theme of World Environment Day 2013 being Think; Eat; Save is associated with graduation discipline of the respondent.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.927[a]	14	.004
Likelihood Ratio	26.284	14	.024
Linear-by-Linear Association	5.693	1	.017
N of Valid Cases	83		

At the 5% level, we accept our hypothesis (p<0.05). And can conclude that Awareness level regarding the theme of World Environment Day 2013 being Think; Eat; Save is associated with graduation discipline of the respondent.

H3: There is an association between the gender of the respondent and their perception about Ozone depletion or Ozone hole as the cause of global warming.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.583[a]	2	.453
Likelihood Ratio	1.266	2	.531
Linear-by-Linear Association	.735	1	.391
N of Valid Cases	83		

At the 5% level, we reject our hypothesis and conclude that there is no association between the gender of the respondent and their perception about Ozone depletion or Ozone hole as the cause of global warming.

H4: There is an association between graduation discipline and perception for Ozone depletion or Ozone hole as the cause of global warming.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.569[a]	14	.001
Likelihood Ratio	17.083	14	.252
Linear-by-Linear Association	1.858	1	.173
N of Valid Cases	83		

At the 5% level, we accept our hypothesis. We can say that there is an association between graduation discipline and perception for Ozone depletion or Ozone hole as the cause of global warming.

H5: There is an association between gender and awareness level about 150 species being lost every day.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.748[a]	2	.417
Likelihood Ratio	2.411	2	.299
Linear-by-Linear Association	1.614	1	.204
N of Valid Cases	83		

At the 5% level, we do not accept our hypothesis and conclude that there is no association between gender and awareness level about 150 species being lost every day.

H6: There is an association between graduation discipline and awareness level about 150 species being lost every day.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.606[a]	14	.029
Likelihood Ratio	21.143	14	.098
Linear-by-Linear Association	1.319	1	.251
N of Valid Cases	83		

At the 5% level, we accept our hypothesis. There is an association between graduation discipline and awareness level about 150 species being lost every day.

H7: There is an association between gender and perception about Organic farming not meeting the food need of growing population.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.166[a]	2	.558
Likelihood Ratio	1.186	2	.553
Linear-by-Linear Association	1.093	1	.296
N of Valid Cases	83	-	-

At the 5% level, we do not accept our hypothesis and conclude that there is no association between gender and perception about Organic farming not meeting the food need of growing population.

H8: There is an association between graduation discipline and perception about Organic farming not meeting the food need of growing population.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.004[a]	14	.165
Likelihood Ratio	13.864	14	.460
Linear-by-Linear Association	1.260	1	.262
N of Valid Cases	83	-	-

At the 5% level, we do not accept our hypothesis. There is no association between graduation discipline and perception about Organic farming not meeting the food need of growing population.

H9: There is an association between gender and perception about increasing population alone being the cause of environmental degradation.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.782[a]	2	.020
Likelihood Ratio	6.290	2	.043
Linear-by-Linear Association	6.859	1	.009
N of Valid Cases	83		

At the 5% level, we accept our hypothesis. And conclude that there is an association between gender and perception about increasing population alone being the cause of environmental degradation.

H10: There is an association between graduation streams and perception about increasing population alone being the cause of environmental degradation.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.969[a]	14	.529
Likelihood Ratio	10.543	14	.722
Linear-by-Linear Association	.157	1	.692
N of Valid Cases	83	-	-

At the 5% level, we do not accept our hypothesis. There is no association between graduation streams and perception about increasing population alone being the cause of environmental degradation.

H11: There is an association between gender of the respondents and mindset for Technological advancement will take care of the environmental problems.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.085[a]	1	.771
Continuity Correction[b]	.000	1	.997
Likelihood Ratio	.085	1	.770
Fisher's Exact Test			
Linear-by-Linear Association	.084	1	.772
N of Valid Cases	83	-	-

At the 5% level, we do not accept our hypothesis. There is no association between gender of the respondents and mindset for Technological advancement will take care of the environmental problems.

H12: There is an association between graduation stream of the respondents and mindset for Technological advancement will take care of the environmental problems.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.353[a]	7	.393
Likelihood Ratio	10.323	7	.171
Linear-by-Linear Association	3.607	1	.058
N of Valid Cases	83		

At the 5% level, we do not accept our hypothesis. And conclude that there is no association between graduation stream of the respondents and mindset for Technological advancement will take care of the environmental problems.

H13: There is a relationship between the discipline of the respondents and their perception about slums contributing to GDP of a city.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.862[a]	7	.997
Likelihood Ratio	1.498	7	.982
Linear-by-Linear Association	.658	1	.417
N of Valid Cases	83		

At the 5% level, we do not accept our hypothesis. We can conclude that there is no relationship between the discipline of the respondents and their perception about slums contributing to GDP of a city.

H14: There is relationship between the gender of the respondents and their perception about Higher education leading to sustainable consumption.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.508[a]	2	.064
Likelihood Ratio	5.418	2	.067
Linear-by-Linear Association	5.357	1	.021
N of Valid Cases	83		

At the 10% level of significance, we accept our hypothesis and conclude that there is a relationship between the gender of the respondents and their perception about Higher education leading to sustainable consumption.

H15: There is a relationship between the different graduation streams of the respondents and their perception about higher education leads to sustainable consumption.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.454[a]	14	.801
Likelihood Ratio	11.058	14	.682
Linear-by-Linear Association	.626	1	.429
N of Valid Cases	83		

At the 5% level, we do not accept our hypothesis. There is no relationship between the different graduation streams of the respondents and their perception about higher education leads to sustainable consumption.

H16: There is an association between graduation disciplines and the perception that privatisation will lead to better utilisation and management.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.667[a]	7	.112
Likelihood Ratio	13.624	7	.058
Linear-by-Linear Association	3.658	1	.056
N of Valid Cases	83	-	-

At the 5% level, we reject our hypothesis and conclude that there is no association between graduation disciplines and the perception that privatisation will lead to better utilisation and management.

Conclusion and recommendation

The study shows a pro environment attitude but at the same time a limited understanding of the depth of issues and only the economic centric perspective of sustainable development. Only 16 percent gave some hint of social dimension to sustainable development. Awareness of HDI and GDP was high but connection to quality of life was missing. The environment was high on priority as 24 percent of the students agreed that economic development at the cost of environment is a short term solution, followed by 16 percent each saying that there is a need to have a balance or economic development should be at the least environmental cost. There seems to be a limited understanding of sustainable development and equates it to environmental conservation as any lay person who is informed by mass media.

Only six percent putting comfort over the environment. Although the attitude was very positive, about 62 percent of the students were not able to articulate the difference between the quality of life and standard of living. The common belief amongst them was that consumers will not pay for environmentally friendly products. Although a high of 89 percent said that eco-labelling has an influence on consumer behaviour, very few of them were aware of eco-labels. Almost all agreed that polluters should pay 67 percent of them also believe that environmental clearances are an impediment to economic growth and 64 percent believe that privatisation leads to better utilisation of resources.

This is a common business perspective being projected in Indian media.

Business is becoming a major driver of sustainable development with increasing production and consumption along with population as a major reason for environmental degradation. One way that business schools can meet their obligation to society is by ensuring that graduates are environmentally literate (Lillah R.). It is recommended that social and environment be part of ethical framework of business education. The paper only gives some overview of the status of the sustainability awareness of the students entering a management course. It would be useful if details sustainability literacy assessments are done to inform the business management curriculum for the need to include environmental / sustainability management. The impact of undergraduate discipline was found to influence awareness and perception and it is hence important the management curriculum removes the gap in sustainability literacy amongst students. The environment day theme recall is high and hence the institutions can weave those days in the curriculum.

According to Hoffamn (2004) following justify the need to have an environmental course as part of management education.

1. The business decision about what inputs to use and how to manage outputs ultimately determine environmental quality.
2. Firms, in general, are the sources of technological evolution within society.

3. Governments no longer possess the full array of resources and knowledge necessary to dictate environmental solutions to business.

4. The power of business organisations to determine the structure of our social, economic and political activity has grown to such enormous proportions that industry now possesses the most resources both individually and through markets to create a more efficient coordinating mechanism.

Bibliography

1. Bharucha, E. (2004). Textbook for Environmental Studies, UGC and BVIEER, 2004 Available on www.ugc.ac.in.
2. Contreras, L. E. (2003). A sustainable university: What can be the matter? CITA conference on education for sustainable development.
3. Coopey, J. (2003). Sustainable development and environmental management: The performance of UK business schools. Management Learning, 34, 5–26.
4. Debbie, H. (2012), Principles for Responsible Management Education (PRME). Macquarie Graduate School of Management. Available online http://www.unprme.org/resource-docs/PRMEMBAStudentStudy.pdf.
5. Gardiner, L. & Lacy, P. (2005). Lead, respond, partner or ignore: the role of business schools on corporate responsibility. Corporate Governance, 5(2), 174-185.
6. Hoffman A J., (October 2004), Business Decisions and the Environment: Significance, Challenges, and Momentum of an Emerging Research Field. Michigan Ross School of Business Working Paper Series Working Paper No. 904 Version 5.0.
7. Hoffman, A. J. (2000a). Competitive environmental strategy. A guide to the changing business landscape. Island Press: Washington, D.C. and Covelo, California.
8. Hoffman, Andrew J, (1999), Environmental Education in Business School
9. http://www.indiaenvironment portal.org.in/files/fileEIA%20 Report %20Final_151013.pdf
10. Johannsdottir L, (2009), Environmental Literacy of Business Students, Institute of Business Research – the University of Iceland,Working Paper Series (W09:03), ISSN 1670-7168
11. Lillah R., Viviers S., Venter E. Environmental Literacy: A Case Study at A South African University.
12. Luthar, H. K., & Karri, R. (2005). Exposure to ethics education and the perception of linkage between organizational ethical behavior and business outcomes. Journal of Business Ethics, 61, 353–368.
13. *McKeown R.* May 2002. ESD Toolkit, Version 2.0 accessed from http://www.esdtoolkit.org/discussion/default.htm.
14. Moon, J., Crane, A., & Matten, D. 2005. Can corporations be citizens? Corporate citizenship as a metaphor for business participation in society. Business Ethics Quarterly, 15: 427– 451.
15. Nicholson, C. Y. & DeMoss, M. (2009). Teaching ethics and social responsibility: An evaluation of

undergraduate business education at the discipline level. Journal of Education for Business, 84(4), 213–218.

16. Porter, M. E., & Kramer, M. R. (2011). Creating shared value. Harvard Business Review, January 2011, 62-77.

17. Segon, M and Booth, C 2009, 'Business ethics and CSR as part of MBA curricula: An analysis of student preference', International Review of Business Research Papers, vol. 5, no. 3, pp. 72-81. Available at https://www.research gate.net/publication/ 303698702_Segon_M_and_ Booth_C_2009_'Business_ethics_ and_CSR_as_part_of_MBA _curricula_An_a nalysis_of_student _preference'_International_ Review_of_Business_Research _Papers_vol_5_no_3_pp_72-81.

18. Segon, M., & Booth, C. (2009). Business ethics and CSR as part of MBA curricula: An analysis of student preference. International Review of Business Research Papers, 5(3), 72-81.

19. Sengupta, M., Das, J. and Maji, R.K., 2010. Environmental awareness and environmental related behaviour of twelfth grade students in Kolkata: effects of stream and gender. Anwesa5, 1-8

20. Singh, R. 2016. Environmental awareness among undergraduate students in relation to their stream of study and area of residence. ISSN 22788808. SRJIS SEPT-OCT 2016, VOL-4/26 Available on www.srjis.com.

21. Sivamoorthy M, Nalini R, Satheesh Kumar C (2013). Environmental Awareness and Practices among College Students. International Journal of Humanities and Social Science Invention, 2(8): 11-15.

22. Sleeper, B. J., Schneider, K. C., Weber, P. S., & Weber, J. E. (2006). Scale and study of student attitudes toward business education's role in addressing social issues. Journal of Business Ethics, 68, 381–391.

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