RESEARCH PAPER | Zoology | Volume : 4 | Issue : 9 | September 2014 | ISSN - 2249-555X

Road Mortality of Migrant Butterflies [Nymphalidae: Danaiane] at National Highway-209 in Chamarajanagar District of Karnataka, India

KEYWORDS: Butterflies, NH-209, Road kill, Karnataka

SANTHOSH S.
Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore- 570 006, Karnataka, India

*** S. BASAVARAJAPPA**
Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore- 570 006, Karnataka, India * Corresponding Author

ABSTRACT *Systematic survey was conducted to record the road kills of butterflies on the National Highway-209 located amidst agri-horticultural ecosystems by employing Visual Count Method during 2013 at Chamarajanagar District of Karnataka. Total 2,843 butterflies traveled in west-east direction during 21 research hours. The swarm included mainly Tirumala septentrionis (79.2%), Euploea sylvester and E. core (20.8%). The light vehicles (e.g. Scooters and cars) claimed more butterfly life compared to heavy vehicles (e.g. Bus and lorry) due to catapulation and the death of butterflies indicated significant variation (F=6.48; P>0.01) during different hours of the day. In general, death of young adults and adult T. septentrionis, E. sylvester and E. core was in the ratio 1:0.58 that was followed by male, female and young adults 1:0.65:0.60 ratio. Chamarajanagar District has good road network, national highways located amidst agri-horticultural ecosystems have connectivity with Tamilanadu and Kerala states that could create a barrier during the normal movement of butterflies due to high vehicular traffic*

Introduction

Butterfly migration is not new to science from southern India. Since 19th century, several researchers (Evershed, 1910; Williams, 1930 and 1938; French, 1943; Fisher, 1945; Briscoe, 1952; Larsen, 1978; Chaturvedi and Satheesan, 1979; Chaturvedi, 1992; Bharos, 2000; Mathew and Binoy, 2002; Kunte, 2005; Ramesh et al., 2012) have reported butterfly migration. East-west migration of butterflies was documented in southern India by Larsen (1978) and Kunte (2005). Kunte (2005) has explained on east-west migration of Nymphalidae family members namely Tirumala septentrionis, Euploea sylvester and Euploea core with large swarms, travels a distance of 300-500 Km from east to west. It was a longitudinal migration, influenced by the monsoon, and occurred across the plains of southern India to the Western Ghats during October-November and towards the plains in April-May. However, migrant butterflies face numerous obstacles and die during their journey (Howard and Davis, 2012) due to natural and human associated disturbances (Brower et al., 2012). Among them highway roads act as barrier to butterfly movement (Munguira and Thomas, 1992; Samways, 1994; Pullin, 1995; McKenna et al., 2001; Rao and Girish, 2007; Skorka et al., 2013) and cause high mortality (Swamy, 1994) due to collisions with vehicles (Neumann et al., 2012). Munguria and Thomas (1992) have reported 7% butterfly road kill due to vehicles in England. McKenna et al. (2001), Rao and Girish (2007) have opined that butterflies are commonly killed on road during their movement. Similar types of studies were made in USA, England and European countries and emphasized the problem faced by migrant butterfly species. However, such types of reports are scanty at different parts of Indian sub-continent.

India has second largest road network after the United States of America. About 3.34 million kilometer road network including 65,569 Km National Highway (NH), 1,30,000 Km State Highway (SH) and 3.14 million Km major District roads, rural and urban roads (Anonymous, 2010) are established at different parts of India (Ramesh, 2011). Further, road network is growing at a rate of seven to 10% per annum, while the vehicle population growth is increasing 12% per annum (Anonymous, 2010). It results greater volume of traffic and probability of more collisions with butterflies. Consequently, many workers (Rajvanshi et al., 2001; Vijayakumar et al., 2001; Das et al., 2007; Boominathan et al., 2008; Sheshadri et al., 2009; Baskaran and Boominathan, 2010; Yamada et al., 2010) have reported the road and its traffic effects on the death of few species of amphibians, reptiles, birds and mammals from different parts of India. All these species death was occurred from collisions with vehicles by roads (Andrews, 1990). But, the reports on road kills of migrating butterflies from south India are fragmentary, and hence the present investigation was conducted.

Materials and Methods

Study area: In Karnataka, Chamarajanagar District lies at $11^{0}40^{1}$ to $12^{0}48^{1}$ N latitudes and $74^{0}52^{1}$ to $76^{0}07^{1}$ E longitudes with an area 5,101sq kms on Deccan plateau in the south at southern tip of Karnataka State (Harish, 2011) (Fig. 1). The District has partly maidan and general table land along with undulating topography accompanied by lofty mountain ranges covered with 48.4% forest area on total land mass of the District. The March and April months experiences highest temperature (40^{0}C) while December and January has lowest temperature (9^{0}C). The relative humidity (RH) ranges from 60 to 80% in morning and 50 to 70% in the evening. The wind speed ranges from 8.4 to 14.1km/h (Anonymous, 2010). Further, wildlife protected areas such as Bandipura Tiger Reserve, Biligiri Ranganatha Tiger Reserve, Cauvery Wildlife Sanctuary and Male Mahadeshwara Protected Areas located amidst Chamarajanagar district, having a connectivity with Madhumali and Nilgiri mountain ranges towards Tamil Nadu state and Wayanad mountain ranges in Kerala state (Srinivasan and Prashanth, 2006). The 407 Km long NH-209 starts from Bangalore in Karnataka State and ends up at Dindigul District in Tamil Nadu State has 85 Km stretch in Chamarajanagar District, passes through protected areas amidst agri-horticulture ecosystems and getting connected with SH and other major district highways (Anonymous, 2010) (Fig. 1).

Volume : 4 | Issue : 9 | September 2014 | ISSN - 2249-555X

Methodology:
Survey was conducted at NH-209 by selecting three sites located 20 to 30 Km away from each sampling site (Fig. 1). At each site, 100 meter transect line was earmarked by adopting Visual Count Method (VCM). Dead butterflies were counted three times from morning to till evening i.e., 9.00 to 11.00 Hrs, 12.00 to 14.00 Hrs and 15.00 to 17.00 Hrs by walking slowly on both sides of the road as per McKenna et al. (2001) and Skorka et al. (2013). While counting, possibility of over counting was avoided carefully. Further, traffic load was recorded by counting all the vehicles between on three different hours of the day as per Skorka et al. (2013) and Rao and Girish (2007). Migrating swarm was estimated by taking 10 meter wide imaginary line (Kunte, 2005; Ramesh et al., 2012) for 10 minutes. Further, dead butterflies were closely observed as per Kunte (2005). Per cent kill of male, female and young adult butterflies due to Bus, Lorry, Car, Scooter and other vehicles were recorded by adapting 10 meter transect on road in front of the observer and counts were made for 15 minutes and per cent kill was calculated by following standard methods.

Results
Movement of migrant butterflies: Altogether 2,843 migrant butterflies traveled in west-east direction during 21 research hours on NH-209 (Table 1). The migrating swarm included Dark Blue Tiger, Tirumala septentrionis (79.2%), Double-banded Crow, Euploea sylvester and Common Indian Crow, E. core (20.8%). The butterfly's movement started from 9.00 Hrs at three to five feet elevation and their number gradually increased to till 13.00 Hrs with maximum number at 13.00 to 14.00 Hrs and the number declined gradually from 14.00 Hrs onwards (Fig. 2). Further, the movement of butterfly species during different hours during three days at NH-209 indicated no significant variation between the days (Table 1).

Butterfly mortality: Total 214 butterflies have died during three different time intervals on three different days at NH-209 (Table 2). Butterfly mortality varied considerably with a male: female ratio 6: 5.88, 6:2.91 and 6: 4.61 during three different days. The mortality was more during afternoon compared to morning and evening hours. Further, butterflies mortality was high at Kollegal on 12th March compared to Mangala and Chikkahole Dam (Table 2). In general, males have died more (59.8%) compared to females (40.2%) at all the sampling sites. However, young adults and adult butterflies mortality was more at Kollegal compared to Mangala and Chikkahole Dam (Fig 3). The adults died more (45.0 ± 12.5) than that of young once (26.0 ± 8.2) and there existed no significant variation between the death of young adults and adults (Table 3). Males, females and young adults' mortality due to vehicles was 44.3, 29.1 and 26.7% respectively at three sampling sites in Chamarajanagar District (Fig. 3). Since, Euploea sylvester and E. core look alike by distance (e.g. 10 meter distance) it was decided to put their mortality values together in the name of Euploea species.

Butterfly mortality due to different vehicles: The mortality was more due to Car fallowed by Scooter (Fig. 4). The heavy vehicles like Bus and Lorry have caused less mortality compared to light vehicles. However, Scooter traffic was more compared to other vehicles at all the sampling sites (Fig. 4).

Correlation coefficient between vehicular density and migrant butterfly's mortality: Table 4 shows the correlation coefficient between the vehicles and death of T. septentrionis and Euploea species at different sites of NH-209. Data from the Table 4 clearly revealed that, the value of 'r' (excepting Bus and Car for the death of T. septentrionis and Euploea sp.) showed a positive correlation between vehicles and death of migrant butterflies at NH- 209. Moreover, values of r^2 showed highest (>24%) influence to bring death of T. septentrionis and Euploea species (excepting T. septentrionis due to Scooter, Euploea sp. due to Car and Lorry) by vehicular collision during their migration at NH-209. Further, there was a significant influence existed between the vehicles and road kill of migrant butterflies (Table 4).

Discussion
Total three butterfly species namely T. septentrionis, E. sylvester and E. core (Family: Nymphalidae) were migrated enroute NH-209 in west-east direction amidst agri-horticultural ecosystems and protected areas of Chamarajanagar District. They showed longitudinal movement at four to five feet elevation. Similar type of observations was recorded by Kunte (2000). However, certain butterfly species show unique migratory behaviour and the reason for their migration is not understood properly. Interestingly, migration of T. septentrionis, E. sylvester and E. core was influenced by north-east and south-west monsoons and traveled from plains to Western Ghats during October-November and from Western Ghats to plains in April-May (Kunte, 2005). During the present study, T. septentrionis, E. sylvester and E. core migration was recorded during early March perhaps due to the indication of early onset of north-east monsoon at Western Ghats. Accordingly, these migrants might have initiated their journey early to their normal migration period. Kunte (2005) and Ramesh et al. (2012) have reported highest density of migratory butterflies during afternoon. Rao and Girish (2007) have reported increased death of butterflies on roads during afternoon. Obviously, more dense population of migratory butterflies during afternoon was coincided with the high vehicular movement and that caused more kills of butterflies due to increased collision with vehicles. Since, Kollegal is connected to Male Mahadeshwara Temple Road (MMT), it is a holy place, pilgrims are visiting this place by using more light vehicles (e.g. Cars and Scooters) causing increased vehicular traffic. Whilst Rao and Girish (2007), Seshadri and Ganesh (2011) have reported faunal mortality on roads due to tourism, whereas heavy vehicles (e.g. Bus and Lorry) density was less on NH-209 nearby MMT compared to light vehicles. Moreover, chances of butterfly collision with heavy vehicles are very less because of their mass. The butterflies are caught into wind current and pushed over the roof, either side and it is called Catapulation (McKenna et al., 2001), perhaps this might have avoided the collision with heavy vehicles. However, few butterflies which met with the process of catapulation could collide again with light vehicles that were moving behind the heavy vehicles. Further, some butterflies collide with heavy vehicles and later manage to fly off even after their wings damage (Rao and Girish, 2007), but heavily damaged individuals unable to fly and succumb to an accident and finally killed. The highways amidst agri-horticultural ecosystems and protected areas have 'Barrier effect' for migrating animals (Jackson and Fahrig, 2011). Goosem et al. (2010) and Balkenhol and Waits (2009) have reported that death of adults in general and the females in particular. It could cause genetic alteration due to reduced exchange between populations and leads to lower effec-

Volume : 4 | Issue : 9 | September 2014 | ISSN - 2249-555X

tive population size, this effect on migrating population need to be checked, because these are the individuals migrating for their reproduction (Kunte, 2005). Since, the migration of these butterflies is not cent per cent successful, successfully migrating butterflies are impacted with barrier effect enroute and therefore habitats at the vicinity of NH shouldn't be altered further. Emphasis should be given to undertake management practices to reduce the traffic volume during peak hours of butterfly migration amidst diversified ecosystems so as to conserve migratory butterflies.

Acknowledgement
The authors are thankful to The Chairman, Department of Studies in Zoology, University of Mysore, Mysore for the facilities.

Fig 1. Map showing the National Highway-209 and sampling sites at Chamarajanagar district

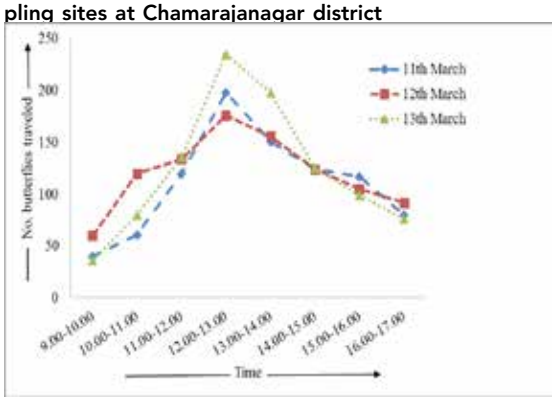

Fig 2.Migration of butterflies during different hours at National Highway- 209

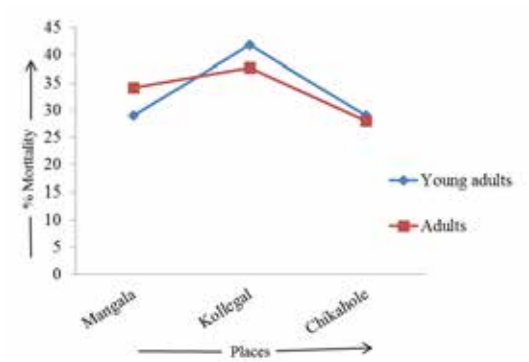

Fig 3. Young and adult butterfly's mortality at National Highway-209

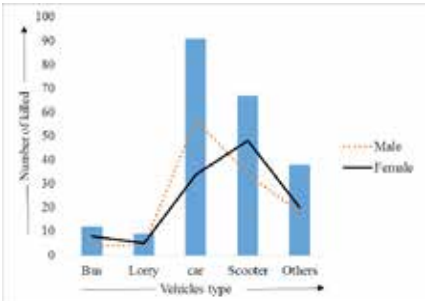

Fig 4. Mortality of migrant butterflies due to vehicles movement at National Highway-209

Table 1. Movement of butterflies on NH-209 at Chamarajanagar District

Sl. No	Observed at	Species	Observed on			Total	Mean ± SD
			11th March	12th March	13th March		
1	9.00 to 10.00Hrs	A. B.	28.0 12.0	42.0 18.0	24.0 12.0	94 42	31.3 ± 9.5 14.0 ± 3.5
2	10.00 to 11.00 Hrs	A. B.	48.0 13.0	97.0 23.0	56.0 24.0	201 60	67.0 ± 26.3 20.0 ± 6.1
3	11.00 to 12.00 Hrs	A. B.	97.0 23.0	108.0 26.0	103.0 33.0	308 82	102.7 ± 5.5 27.3 ± 5.1
4	12.00 to 13.00 Hrs	A. B.	165.0 33.0	138.0 38.0	192.0 43.0	495 114	165.0 ± 27.0 38.0 ± 5.0
5	13.00 to 14.00 Hrs	A. B.	124.0 27.0	122.0 34.0	162.0 36.0	408 97	136.0 ± 22.5 32.3 ± 4.7
6	14.00 to 15.00 Hrs	A. B.	102.0 22.0	93.0 31.0	96.0 29.0	291 82	97.0 ± 4.6 27.3 ± 4.7
7	15.00 to 16.00 Hrs	A. B.	98.0 19.0	81.0 24.0	78.0 21.0	257 64	85.7± 10.8 21.3 ± 2.5
8	16.00 to 17.00 Hrs	A. B.	64.0 16.0	73.0 19.0	61.0 15.0	198 50	66.0 ± 6.3 16.7 ± 2.1
Total			891	967	985	2843	947.7 ± 49.9
Mean ± SD			111.4 ± 50.7	120.9 ± 36.4	123.1 ± 65.1	-	-
'F' Value			0.069*			-	

Note: A: Tirumala septentrionis ; B: Euploea. sp. * = Not significant

Volume : 4 | Issue : 9 | September 2014 | ISSN - 2249-555X

Table 2. Road kills of migrant butterflies during different hours of the day at NH-209

Site	Observed on	Species	Observation at									Total	Mean ± SD	'F' value
			9.00 to 11.00 Hrs (Morning)			12.00 Noon to 14.00 Hrs (Afternoon)			15.00 to 17.00 Hrs (Evening)					
			Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio			
1	11th March	A	7.0	5.0	1: 0.70	11.0	6.0	1:0.54	10.0	13.0	1:1.30	52.0	8.67 ± 3.1	14.976**
		B	2.0	1.0	1 :0.50	6.0	3.0	1:0.50	4.0	1.0	1:0.25	17.0	2.83 ± 1.9	
2	12th March	A	6.0	7.0	1:1.60	13.0	9.0	1:0.69	8.0	11.0	1:1.37	54.0	9.00 ± 2.6	7.742**
		B	4.0	2.0	1:0.50	7.0	6.0	1:0.85	8.0	3.0	1:0.37	30.0	5.00 ± 2.4	
3	13th March	A	7.0	4.0	1:0.50	15.0	5.0	1:0.33	9.0	6.0	1:0.66	46.0	7.67 ± 3.9	7.358**
		B	1.0	2.0	1:2.00	7.0	0.0	1:00	3.0	2.0	1:0.66	15.0	2.50 ± 2.4	
Total			27.0	21.0	6:5.88	59.0	29.0	6:2.91	42.0	36.0	6:4.61	214	-	-
Mean ± SD			4.5 ± 2.6	3.5 ± 2.3	-	9.8 ± 3.7	4.8 ± 3.1	-	7.0 ± 2.8	6.0 ± 4.7	-	35.7 ± 17.4	-	-
'F' value			0.508*		-	6.484**		-	0.183*		-	-	-	-

Note: Specie: A: Tirumala septentrionis (Dark Blue Tiger); B: Eupolea sp. Site: 1: Mangala 2: Kollegal and 3: Chikohale Dam ** Values are significant at 1% level; *: Value is not significant

Table 3. Mortality of adult and Young adult butterflies at National Highway-209

Site	Stage	Mortality observed on			Mean ± SD	'F' value
		9.00 to 11.00 Hrs (Morning)	12.00 Noon to 14.00 Hrs (Afternoon)	15.00 to 17.00 Hrs (Evening)		
1	Young adult	3.0	8.0	12.0	7.66 ± 4.5	0.746*
	Adult	12.0	18.0	16.0	15.33 ± 3.1	
2	Young adult	9.0	14.0	10.0	11.0 ± 2.6	1.340*
	Adult	10.0	21.0	20.0	17.0 ± 6.1	
3	Young adult	5.0	11.0	7.0	7.66 ± 3.1	1.649*
	Adult	9.0	16.0	13.0	12.66 ± 3.5	
Total	Young adult	17.0	33.0	29.0	26.0 ± 8.2	-
	Adult	31.0	55.0	49.0	45.0 ± 12.5	
Mean ± SD		8.0 ± 3.3	14.6 ± 4.7	13.0 ± 4.5		
Adult :Young adult ratio		1:0.54	1:0.66	1:0.59	1:0.59	
'F' value		3.99** (P > 0.05)			-	

Note:1. Mangala Main Road; 2: Male Mahadeshwara Hills Main Road; 3: Sathyamangal Main Road. Young: Adult = 1: 0.58 * Values are not significant; **Value is significant at 5% level.

Table 4. Correlation coefficient between the vehicles and death of migrant butterflies

Type of vehicle		Species	Value of		
			'r'	'r2'	't'
Light vehicle	Scooter	T. septentrionis	0.102	0.01	2.438*
		Euploea sp.	0.491	0.24	2.777**
	Car	T. septentrionis	-0.726	0.52	3.511**
		Euploea sp.	-0.391	0.15	2.623*
Heavy vehicle	Bus	T. septentrionis	-0.889	0.79	5.270**
		Euploea sp.	-0.997	0.99	0.416NS
	Lorry	T. septentrionis	0.706	0.48	3.409**
		Euploea sp.	0.365	0.13	2.592*

Note: Data is based on Table 1. NS: Not Significant, * Values are significant at 5% level; ** Values are significant at 1% level

Volume : 4 | Issue : 9 | September 2014 | ISSN - 2249-555X

REFERENCE

1. Andrews, A. 1990. Fragmentation of habitat by road and utility of corridors: A review. Australian Zool., 26: 130-141. | 2. Anonymous. 2005. Findings of road user satisfaction survey report. Government of Karnataka. Project Implementation Unit. Karnataka State Highway Improvement Project. Wilbur Smith Association Pvt. Ltd., pp: 10-58. | 3. Anonymous. 2010. Statistical data of Chamarajanagar. District Statistical Office, Chamarajanagar. pp: 21-75. | 4. Baskaran, N. and D. Boominathan. 2010. Road kills of animals by highway traffic in the tropical forests of Mudumalai Tiger Reserve, Southern India. J. Threatened Taxa. 2(3): 753-759. | 5. Balkenhol, N. and L. P. Waits. 2009. Molecular road ecology: exploring the potential of genetics for investigating transportation impact on wildlife. Molecular Ecol. 18: 4151-4164. | 6. Bharos, A. K. M. 2000. Large scale emergence and migration of the common emigrant butterflies Catopsilia pomona (Family: Pieridae). JBNHS. 93: 301-305. | 7. Boominathan, D., S. Asokan, A. Desai, and N. Baskaran. 2008. Impact of highway traffic on vertebrate fauna of Madumalai Tiger Reserve. Southern India. Convergence. 10(4): 52-63. | 8. Briscoe, M. V. 1952. Butterfly migration in the Nilgiris. JBNH. 50: 417-418. | 9. Chaturvedi, N. 1992. Northward migration of the Common Indian Crow butterfly, Euploea core (Cramer) in and around Bombay. JBNH. 90: 115-116. | 10. Chaturvedi, N. and S. M. Satheesan. 1979. Southward migration of Euploea core at Khandala, Western Ghats. JBNH. 76: 534-535. | 11. Das, A., M. F. Ahmed, B. P. Lahkar. and P. Sharma. 2007. A preliminary report on reptilian mortality on road due to vehicular movements near Kaziranga National Park, Assam, India. Zoos' Print J. 22(7): 2742-2744. | 12. Evershed, J. 1910. Note on migration. JBNH. 20: 390-39. | 13. Fisher, K. J. 1945. Four butterfly migration in India and Ceylon. Proc. Royal Entomol. Soc. London. 20(10-12): 110-116. | 14. Forman, R. T. T., D. Sperling, J. Bissonette, A. Clevenger, C. Cutshall, V. Dale, L. Fahrig, R. France, C. Goldman, K. Heanue, J. Jones, F. Swanson, T. Turrentine. and T. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D. C. | 15. French, W. L. 1943. Butterfly migration (Dana is melissa dravidarum and Euploea core). JBNH. 44: 310. | 16. Jackson, N. D. and L. Fahrig. 2011. Relative effects of road morality and decreased connectivity on population genetic diversity. Bio. Conser. 144: 3143-3148. | 17. Kunte, K. 2000. Butterflies of Peninsular India. Indian Academy of Sciences, Bangalore Uni. Press. pp: 143-149. | 18. Kunte, K. 2005. Species composition, sex-ratio and movement patterns in Danaiane butterfly migration in Southern India. JBNH. 102(3): 280-286. | 19. Larsen, T. B. 1978. Butterfly migrations in the Nilgiri Hills of South India. JBNH. 74: 546-549. | 20. Mathew, G. and C. F. Binoy. 2002. Migration of butterflies (Lepidoptera: Rophalocera) in the new Amarambalam Reserve Forest of the Nilgiri Biosphere Reserve. Zoo's Print J. 17(18): 844-847. | 21. Mckenna, D. D., S. B. Malcom. and M. R. Berenbaum. 2001. Mortality of Lepidoptera along roadways in Central Illinois. J. Lepidopterists Soc. 55: 63-68. | 22. Munguira, M. L. and J. A. Thomas. 1992. Use of road verges by butterfly and burnet populations, and the effect of road on adult dispersal and mortality. J. App. Ecol. 29: 316-329. | 23. Nowicki, P. and V. Vrabec. 2011. Evidence for positive density-dependent emigration in butterfly metapopulations. Oecologia. 167: 657–665. | 24. Palot, M. J., C. Radhakrishnan, V. C. Balakrishnan, and B. Kambrath. 2002. A report on the migration of butterflies in Aralam wildlife sanctuary, Kerala. Zoo's Print J. 17(2): 722-723. | 25. Rajvanshi, A., V. B. Mathur., G. C. Teleki. and S. K. Mukherjee. 2001. Roads, sensitive habitats and wildlife: environmental guidelines for India and South Asia. Wildlife Institute of India, Dehradun. | 26. Rameh, T., J. K. Hussain., K. K. Satpathy. and M. Selvanayagam. 2012. A note on annual bidirectional movement of butterflies at South-Eastern plains of India. Res. in Zoo. 2(2): 1-6. | 27. Ramesh, T. R. S. 2011. Framing ecologically sound policy on linear intrusion affecting wildlife habitats. Background paper for the Natural Broad for Wildlife. pp: 5-26. | 28. Rao, R. S. P. and M. K. S. Girish. 2007. Road kills: Assessing insect casualties using indicator taxon. Curr. Sci. 92: 832-837. | 29. Ries, L., D. M. Debinski. and M. L. Wieland. 2001. Conservation value of road side prairie restoration to butterfly communities. Conser. Bio. 15: 401-411. | 30. Seshadri, K. S., Y. Amit. and K. V. Gururaja. 2009. Road kills of amphibians in different land use areas from Sharavathi river basin, central Western Ghats, India. J. Threatened Taxa. 1(11): 549-552. | 31. Seshadri, K. S. and T. Ganesh. 2011. Faunal mortality on roads due to religious tourism across time and space in protected areas: A case study from South India. Forest Eco. Management. 262: 1713-1721. | 32. Skorka, S., M. Lenda., D. Moron., K. Kalarus. and P. Tryjanowski. 2012. Factors affecting road mortality and suitability of road verges for butterflies. Bio. Conser. 159: 148-157. | 33. Spellerberg, I. F. 2002. Ecological effects of roads. Science Publishers, Enfield, New Hampshire. | 34. Srinivasan, U. and N. S. Prashanth. 2003. Preferential routes of birds' dispersal to the Western Ghats in India: An explanation for the avifaunal peculiarities of the Biligirrangana Hills. Indian Birds. 2(5): 114-119. | 35. Vijayakumar, S. P., K. Vasudevan. and M. N. Ishwar. 2001. Herpetofaunal mortality on roads in the Anamalai Hills, southern Western Ghats. Hamadryad. 26: 265–272. | 36. Williams, C. B. 1930. The migration of butterflies. Oliver and Boyd, Edinburgh and London. pp: 473 | 37. Williams, C. B. 1927. A study of butterfly migration in south India and Ceylon based largely on records by Mssrs, G., E. E. Evershed., J. C. F. Green., Fryer, and W. Ormiston. Transaction of Royal Entom. Soc. London. 75: 1-33. | 38. Williams, C. B. 1938. The migration of butterflies in India. JBNH. 40: 439-457. | 39. Yamada, Y., H. Sasaki. and Y. Harauchi. 2010. Composition of road-killed insects on coastal roads around lake Shikotsu in Hokkaido, Japan. J. Rakuno Gakuen Uni. 34(2): 117-184.