Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(6): 311-315

Received: 11-09-2019
Accepted: 15-10-2019

Rozy Rasool
Department of Entomology, FOA, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, India

Gh Mohammad Lone
Department of Entomology-Shalimar, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, India

Munazah Yaqoob
Department of Entomology, FOA, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, India

Kawsar Rasool
Department of Entomology, FOA, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, India

Corresponding Author:
Rozy Rasool
Department of Entomology, FOA, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, India

Biodiversity and microclimate divergence of flea beetles in North Kashmir

Rozy Rasool, GH Mohammad Lone, Munazah Yaqoob and Kawsar Rasool

Abstract
The biodiversity of flea beetles was worked out in major vegetable growing belts of North Kashmir. The study revealed the presence of six flea beetle species *viz*., *Phyllotreta striolata* (Fabricius), *Altica himensis* (Shukla), *Psylliodes tenebrosus* (Jacoby), *Psylliodes* sp. Indet., *Longitarsus* sp. Indet. and *Systena* sp. Indet. in cruciferous vegetable ecosystem. Turnip (*Brassica rapa* L.) and radish (*Raphanus sativus* L.) were found to host all the 6 species of flea beetles, however, only 2 species were found on cabbage (*B. oleracea* L. var. *capitata*). *P. striolata* was noted as the predominant species found on turnip and radish (77.54% on turnip and 79.44% on radish) followed by *A. himensis* (12.13% on turnip and 11.45% on radish). The two species reported on cabbage were *P. striolata* (86.42%) and *P. tenebrosus* (13.56%). Highest values of biodiversity indices and relative abundance of flea beetles were reported for Arampora (drier area) and lowest for Azadgunj (slightly cooler and humid area) among surveyed locations. This reflects local regional patterns, indicating their important role in species divergence at a microsite probably reflecting climatic adaptations. Thus, habitat heterogeneity and microclimate may be considered as important drivers of flea beetle diversity.

Keywords: Biodiversity, cruciferous crops; biodiversity indices, microclimate

1. Introduction
Climate change is having a plethora of impacts on living organisms worldwide e.g. impacts on phenology, species distribution and abundance physiology. Some of these changes, particularly those related to vegetation, feed back into broad-scale climate systems and local climatic conditions. These effects due to climate change may lead to outbreak or extinction of some species [21, 26, 27]. Indeed, forecasting the impacts of future climate change on organisms requires that we understand in a much more general way how microhabitats filter environmental fluctuations, and whether heterogeneity at small scales will be sufficient to allow organisms to find and exploit favourable conditions [13, 16]. Although the existence of microclimates is widely appreciated [20], but the roles that microclimates play in the ecology of small organisms remain understudied [24]. On the other hand, increasing economic activities and rapid expansion of population have resulted into a reduction in global biodiversity, resulting in significant disturbance to the ecosystems and overall living conditions [34]. However, greater resource availability may result in increase in insect species richness [14, 18, 25]. More complex interactions and higher diversity has been observed in open habitats as compared to closed habitats, potentially due to changes in microclimate conditions [5, 6].
The Chrysomelidae are a major component of arthropod diversity [31] and flea beetles (Alticinae) comprise the largest subfamily. These highly diverse, polyphagous insects have important roles as abundant herbivores, and many species have become agricultural pests that affect human welfare. Detailed knowledge of species-level diversity patterns is important for community ecology, natural product development; biodiversity monitoring, conservation biology and systematics research [9].
During last few years, the vegetable growers of Kashmir valley have been cautioned regarding the damage caused by flea beetles, earlier considered as minor pests on these crops. These beetles have been found to have increased their host range as these are now attacking other fruit crops like apple, grapes, apricot etc. [1]. There are reports of widening of host range of flea beetles even to solanaceous crops like egg-plants, tomatoes and pepper, thus delaying the establishment of seedlings or even killing them [12]. Hence, it becomes a highly important and valuable endeavour to carry out an analysis of such pests. In this paper we explore species

diversity and relative abundance of flea beetles in four different vegetable growing belts of North Kashmir.

2. Materials and Methods

2.1 Study area

The species diversity of flea beetles was studied in vegetable ecosystem during the cropping season, 2016. The crops covered were turnip (*Brassica rapa* L.), radish (*Raphanus sativus* L.) and cabbage (*Brassica oleracea* L. var. *capitata*). Only adult flea beetles were observed for the study. The study covered major vegetable growing belts of district Baramullah with different microclimates. Locations selected were Arampora (34º16′ N and 74º37′ E, altitude; ca 1600 m); Azadgunj (34º06′ N and 74º46′ E, altitude; ca 1610 m); Seelu (34º19N′; 74º21′ E, altitude; ca 1590 m) and Wadura (34º20′ N and 74º23′ E, altitude; ca 1580 m). Arampora is a major vegetable growing belt of North Kashmir and is slightly drier as compared to Azadgunj which is enveloped by hills on three sides and has a large river flowing nearby keeping it cooler and humid as compared to other surrounding areas.

2.2 Sampling

Sampling was carried out from last week of August (35th Standard Meteorological Week) till second week of November (45thStandard Meteorological Week) at weekly intervals (11 weeks). Three fields from each location were selected to reduce the spatial heterogeneity existing in the distribution of flea beetle fauna. Flea beetles were collected by using aspirator and vials. The collected adult flea beetles were transferred to killing bottles containing cotton swabs with ethyl-acetate for instant killing. The flea beetle specimens were carried in duly labelled plastic vials (labels containing all pertinent information *viz.*, date of collection, location and crop etc.) to the laboratory. The specimens were finally identified and confirmed from National Bureau of Agricultural Insect Resources (NBAIR), Bangalore.

The data collected from the field sampling of flea beetles was analyzed to work out the various parameters of biodiversity as follows: Species diversity for each crop and location was worked out by adding up the total number of species found in each community; relative abundance for each crop, location and type of ecosystem was worked out by dividing the number of individuals of a species to the total number of individuals of all species for each community, expressed in percentage; and to study the proportion of each species within the local community, species diversity index was computed based on Shannon-Wiener formula, also called the Shannon index or Shannon- Wiener index [29]:

Species diversity Index (H) = $-\sum_{i=1}^{s}(P_i \log_e P_i)$

Where,

H = Shannon-Wiener biodiversity index

P_i = Proportion of each species in the community

Log*e* Pi = Natural log of Pi

S = Number of species in the community.

Species richness index (Ma) was calculated to assess the distribution or organization of diversity of the population among the respective species [23].

Species richness index (Ma) = S-1/$\log_e$ N

Where,

S = Total number of species collected

N = Total number of individuals in all the species.

Species evenness index (J) was calculated to estimate the equitability component of diversity i.e., to understand the measure of similarity in the abundance of different species [22].

Species evenness index (J) = H/ $\log_e$S

Where,

H = Shannon-Wiener biodiversity index

S = Number of species in the community.

4.3 Statistical analysis

Data generated from the experiments was statistically analysed using the Statistica-AG Software licensed to Faculty of Agriculture, SKUAST-K, Wadura.

5. Results and discussion

The sampling of flea beetles in various vegetable growing belts of district Baramullah *viz.*, Arampora, Azadgunj, Seelu and Wadura on turnip, radish and cabbage revealed the presence of six species of flea beetles *viz.*, *P. striolata* (Fabricius), *A. himensis* (Shukla), *P. tenebrosus* (Jacoby), *Psylliodes* sp. Indet., *Longitarsus* sp. Indet. and *Systena* sp. indet.(Table 1). Turnip and radish supported all the six species of flea beetles, however, cabbage supported only two species. Burkness and Hahn [7] reported flea beetles as common pests on radish, broccoli, cabbage, turnip, egg-plants, peppers, tomatoes, potatoes, spinach and melons, and the most common species included crucifer flea beetle, *Phyllotreta cruciferae*, striped flea beetle, *P. striolata*, western black flea beetle, *Phyllotreta pusilla*, potato flea beetle, *Epitrix cucumeris* and the spinach flea beetle, *Disonycha xanthomelas*. Flea beetle species, *P. tenebrosus* Jacoby and *A. himensis* Shukla infesting oilseed crops, *Brasssica campestris* and *Brassica juncea* were reported by Samoon [28] in different locations of Kashmir valley. Yadav *et al*. [33] also found six species of flea beetles *viz*., *Phyllotreta chotanica*, *P. oncera*, *Chaetocnema basalis*, C. sp. nr. *minuta*, C. sp.nr. *belli* and C. sp. nr. *kanika* on mustard and radish. Metspalu *et al*. [19] recorded six species of flea beetles *viz*., *Phyllotreta undulata*, *Phyllotreta nigripes*, *Phyllotreta nemorum*, *P. striolata*, *Phyllotreta atra* and *Chaetocnema concinna* on various cruciferous crops.

Table 1: Biodiversity of flea beetles on cruciferous vegetable crops in district Baramullah

Location	Crop	Species						Total no. of species
		P. striolata	*A. himensis*	*P. tenebrosus*	*Psylliodes* sp. indet.	*Longitarsus* sp. Indet.	*Systena* sp. Indet.	
Arampora	Turnip	+	+	+	+	+	+	**6**
	Radish	+	+	+	+	+	-	**5**
	Cabbage	+	-	+	-	-	-	**2**
Azadgunj	Turnip	+	+	+	+	-	+	**5**
	Radish	+	+	+	+	-	+	**5**

	Cabbage	+	-	+	-	-	-	**2**
Seelu	Turnip	+	+	+	+	-	-	**4**
	Radish	+	+	+	+	-	-	**4**
	Cabbage	+	-	+	-	-	-	**2**
Wadura	Turnip	+	+	+	+	-	-	**4**
	Radish	+	+	+	+	-	-	**4**
	Cabbage	+	-	+	-	-	-	**2**

+ = present, - = absent

P. striolata was the most abundant (77.54%) flea beetle species on turnip during the entire growing season followed by *A. himensis* (12.13%), *P. tenebrosus* (5.80%), *Psylliodes* sp. Indet. (3.46%), *Systena* sp. indet. (0.70%) and *Longitarsus* sp. Indet. (0.34%) (Table 2).The trend was similar for radish with the exception that *Longitarsus* sp. indet. (0.51%) was more abundant than *Systena* sp. indet. (0.26%). On cabbage, *P. striolata* (86.42%) was the most abundant followed by *P. tenebrosus* (13.56%). This is in conformity with the findings of Yadav *et al.* [33] who reported *Phyllotreta* as the dominant genera of flea beetles on radish and mustard followed by *Chaetocnema*. Gavloski *et al.* [11] also observed *P. striolata* as one of the dominant species found on *Brassica* crops in Canadian Grasslands. The possible reason for dominance of *Phyllotreta* is its cosmopolitan distribution and wide range of host plant preference than most of the Alticinae genera [10, 30]. During present study, *A. himensis* was the second most dominant species which is in conformity with the results of Samoon [28] who recorded *A. himensis* as second most dominant species of flea beetle after *P. tenebrosus* under temperate conditions. Furth (1980) [10] also reported *Phyllotreta* as the most dominant genus in different surveyed sites.

Table 2: Relative abundance of flea beetles on cruciferous vegetable crops in District Baramullah

Crop	Location	Relative abundance (%)							
		Phyllotreta striolata	***Altica himensis***	***Psylliodes tenebrosus***	***Psylliodes* sp. Indet.**	***Longitarsus* sp. Indet.**	***Systena* sp. Indet.**	**N**	**S**
Turnip	Arampora	75.03	12.17	6.21	4.06	1.39	1.14	789	6
	Azadgunj	79.22	11.77	5.40	1.94	-	1.66	722	5
	Seelu	78.39	12.62	5.64	3.35	-	-	745	4
	Wadura	77.53	11.97	5.98	4.52	-	-	752	4
	Mean	77.54	12.13	5.80	3.46	0.34	0.70	3008	
Radish	Arampora	76.67	11.87	3.68	5.73	2.05	-	733	5
	Azadgunj	81.95	10.83	4.06	2.11	-	1.05	665	5
	Seelu	80.56	11.55	3.65	4.24	-	-	684	4
	Wadura	78.59	11.55	4.79	5.07	-	-	710	4
	Mean	79.44	11.45	4.04	4.28	0.51	0.26	2792	
Cabbage	Arampora	87.26	-	12.73	-	-	-	157	2
	Azadgunj	84.87	-	15.12	-	-	-	112	2
	Seelu	87.40	-	12.59	-	-	-	135	2
	Wadura	84.80	-	15.20	-	-	-	125	2
	Mean	86.08	-	13.91	-	-	-	529	

'N' = Total number of individuals of species collected;
'S' = Total number of species identified

For turnip, value of species diversity index was highest, 0.885 at Arampora and lowest, 0.728 at Seelu. Similarly, for radish the value was highest, 0.821 at Arampora and lowest, 0.663 at Azadgunj, however, for cabbage it was highest, 0.426 and lowest. 0.321 at Wadura and Azadgunj, respectively (Figure 1, 2 and 3). The comparison of species diversity indices among different studied sites revealed that Arampora is an ideal micro-habitat for flea beetles. There are a number of studies that indicate the effect of microclimate variation on species distribution in practice. The present finding is also explained by the fact that species composition of phytophagous insect communities is affected by a combination of geographical and environmental factors including vegetation, habitat, climate, topography, altitude and human influence [17, 32]. Since North Kashmir is influenced by the temperate regional climate, which is the same for all the microsites selected for the study, but the microsites show microclimate variation, therefore the difference in species richness is related to microclimate e.g. solar radiation, temperature and humidity [8]. The findings are further supported by Aslan [4] and Joshi *et al.* [15] who observed distinct variation in the diversity of flea beetles occurring between the sites with different degrees of altitudes, vegetation and climate. The differences in the diversity of their communities may be due to the differences in the floristic composition and herbaceous plant densities at the sites [2].

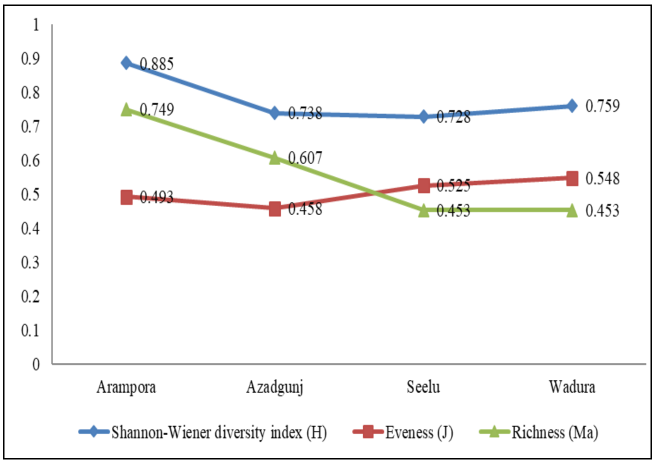

Fig 1: Biodiversity indices; Species diversity index (H), Richness index (Ma) and Evenness index (J) during study period for Turnip

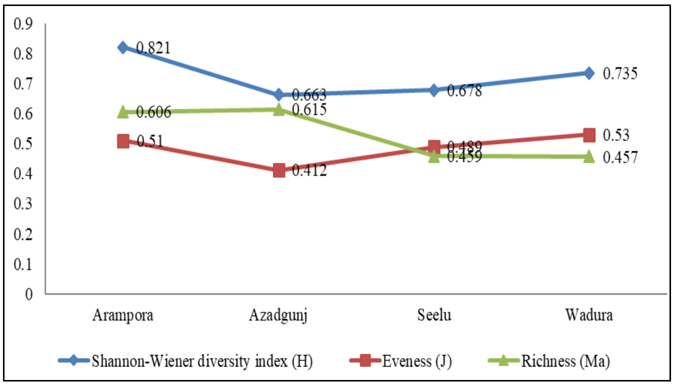

Fig 2: Biodiversity indices; Species diversity index (H), Richness index (Ma) and Evenness index (J) during study period for Radish

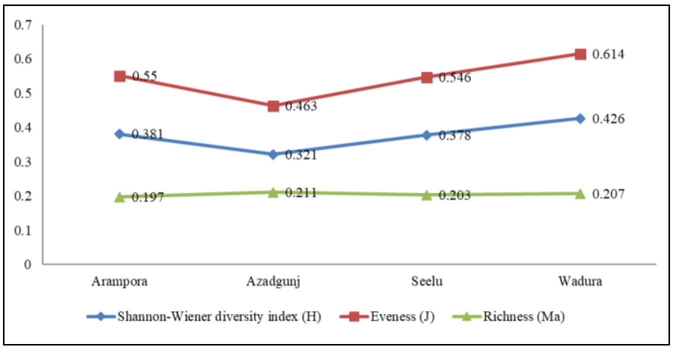

Fig 3: Biodiversity indices; Species diversity index (H), Richness index (Ma) and Evenness index (J) during study period for Cabbage

6. Conclusion

Differences in microclimate, habitat heterogeneity, difference in floristic composition and herbaceous plant densities may be the factors responsible for differential diversity and abundance of flea beetles among various locations as well as crops studied. More descriptive studies are needed to widen our knowledge on ecology of flea beetles. Among various species of flea beetles, *P. striolata* and *A. himensis* of genera *Phyllotreta* and *Altica* are more abundant and specific on turnip and radish crops than other species of flea beetles. Therefore, a study on the biology, extent of damage, and management of such specific and dominant flea beetles at early stages of the important cruciferous crops is the need of hour.

7. Acknowledgement

The authors are highly thankful to Department of Entomology, FOA, Wadura, SKUAST-Kashmir for providing necessary help.

6. References

1. Ahad I, Baba ZA, Lone GM. Changing scenario in host range of flea beetle, *Phyllotreta cruciferae* (Goeze) (Coleoptera: Chrysomelidae). In: Souvenir, 1st Jammu and Kashmir Agriculture Science Congress (Theme: Mountain Agriculture in Transition-Challenges and way forward), 2011, 213.
2. Aslan EG, Ayvaz Y. Diversity of Alticinae (Coleoptera: Chrysomelidae) Kasnak Oak Forest Nature Reserve, Isparta, Turkey. Turkish Journal of Zoology. 2009; 33:251-262.
3. Aslan EG, Gok A. Host-plant relationship of 65 flea beetle species from Turkey, with new associations (Coleoptera: Chrysomelidae: Alticinae). Entomology Newsletter**.** 2006; 117:297-308.
4. Aslan EG. Comparative diversity of Alticinae (Coleoptera: Chrysomelidae) between Cigalkara and Dibek Nature Reserves Antalaya, Turkey. Biologia. 2010; 65(2):316-324.
5. Axmacher JC, Brehm G, Hemp A. Determinants of diversity in afrotropical herbivorous insects (Lepidoptera: Geometridae): plant diversity, vegetation structure or abiotic factors. Journal of Biogeography. 2009; 36(2):337-349.
6. Axmacher JC, Tünte H, Schrumpf M. Diverging diversity patterns of vascular plants and geometrid moths during forest regeneration on Mt Kilimanjaro, Tanzania. Journal of Biogeography. 2004; 31(6):895-904.
7. Burkness S, Hahn J. Flea beetles in home gardens, University of Minnesota. 2010, 1-4.
8. Chikatunov V, Pavlicek T, Lopatin I, Nevo E. Biodiversity and microclimatic divergence of chrysomelid beetles at 'Evolution Canyon', Lower Nahal Oren, Mt Carmel, Israel. Biological Journal of the Linnean Society. 2000; 69:139-152.
9. Furth DG, Longino JT, Paniagua M. Survey and quantitative assessment of flea beetle diversity in a Costa Rican rainforest (Coleoptera: Chrysomelidae: Alticinae) 2003; 1-23. In: Special Topics in Leaf Beetle Biology (Ed. D. G. Furth). Proceedings of the Fifth International Symposium on the Chrysomelidae, Pensoft Publishers, Moscow.
10. Furth DG. Zoogeography and host plants of *Longitarsus* in Israel, with descriptions of six new species (Coleoptera: Chrysomelidae). Israel Journal of Entomology. 1980; 13:79-124.
11. Gavloski JE, EKvere V, Keddie A, Dosdall L, Kott L, Good AG. Identification and evaluation of flea beetle (*Phyllotreta cruciferae*) resistance within Brassicaceae. Canadian Journal of Plant Science. 2013; 80:881-887.
12. Grubinger V. Flea Beetles Management. University of Vermont extension, https: //www. uvm. edu/vtvegandberry/factsheets/fleabeetle. html 2003, 1-2.
13. Hannah L, Flint L, Syphard AD, Moritz MA, Buckley L B, McCullough IM. Fine-grain modeling of species' response to climate change: holdouts, stepping-stones, and micro-refugia. Trends in Ecology and Evolution. 2014; 29:390-397.
14. Haysom KA, Coulson JC. The Lepidoptera fauna associated with *Calluna vulgaris*: effects of plant architecture on abundance and diversity. Ecological Entomology. 1998; 23(4):377-385.
15. Joshi PC, Kumar K, Manoj A. Assessment of insect diversity along an altitudinal gradient in Pinderi forests of Western Himalayas, India. Journal of Asia-Pacific Entomology. 2008; 11:5-11.
16. Kearney M, Shine R, Porter WP. The potential for behavioural thermo- regulation to buffer "cold-blooded" animals against climate warming. Proceedings of the Natural Academy of Science, USA. 2009; 106:3835-3840.
17. Lassau SA, Hochuli DF, Cassis G, Reid CAM. Effects of habitat complexity on forest beetle diversity: do functional groups respond consistently. Diversity Distribution. 2005; 11:73-82.
18. Lawton JH. Plant architecture and the diversity of phytophagous insects. Annual Review of Entomology. 1983; 28(1):23-39.

19. Metspalu L, Kruus E, Ploomi A, Williams IH, Hiiesaar K, Jõgar K. Flea beetle (Chrysomelidae: Alticinae) species composition and abundance in different cruciferous oilseed crops and the potential for a trap crop system. Acta Agriculturae Scandinavica, Section B, Soil and Plant Science. 2014; 64(7):572-582.
20. Oke TR. Boundary Layer Climates. Routledge, London. 2002.
21. Parmesan C, Yohe G. A globally coherent fingerprint of climate change impacts across natural systems. Nature. 2003; 421:37-42.
22. Pielou EC. An Introduction of Mathematical Ecology. Wiley, New York, 1969.
23. Pielou EC. Ecological Biodiversity. Wiley, New York, 1975.
24. Potter KA, Woods HA, Pincebourde S. 2013.Microclimatic challenges in global change biology. Global Change Biology. 2013; 19:2932-2939.
25. Poyry J, Luoto M, Paukkunen J. Different responses of plants and herbivore insects to a gradient of vegetation height: an indicator of the vertebrate grazing intensity and successional age. Oikos. 2006; 115(3):401-412.
26. Root TL, Macmynowski DP, Mastrandrea MD, Schneider SH. Human modified temperatures induce species changes: joint attribution. Proceedings of the Natural Academy of Science, USA. 2005; 102:7465-7469.
27. Root TL, Price JT, Hall KR, Schneider SH, Rosenzweig C, Pounds JA. Fingerprints of global warming on wild animals and plants. Nature. 2003; 421:57-60.
28. Samoon JI. Studies on flea beetles infesting the *Brassica* group of oilseed crops. M. Sc. Thesis. Division of Entomology, SKUAST-Kashmir, 2004, 51.
29. Shannon CE. A mathematical theory of communication. Bulletin of Systematic Technology. 1948; 27:379-423.
30. Soroka JJ, Bartelt RJ, Zilkowski BW, Cosse AA. Responses of flea beetle *Phyllotreta cruciferae* synthetic aggregation pheromone components and host plant volatiles in field trials. Journal of Chemical Ecology. 2005; 31(8):1829-1843.
31. Wagner T. Influence of forest type and tree species on canopy-dwelling beetles in Budongo Forest, Uganda. Biotropica. 2000; 32 (30):502-514.
32. Wasowska M. Impact of humidity and mowing on chrysomelid communities (Coleoptera: Chrysomelidae) in meadows of the Wierzbanowka valley (Pogorze Wielickie hills, Southern Poland), Biologia. 2004; 59:601-611.
33. Yadav D, Swaminathan R, Ameta OP. Species diversity and population dynamics of flea beetles on mustard and Radish. Indian Journal of Applied Entomology. 2010; 24(2):109-115.
34. Yi Z, Jinchao F, Dayuan X, Weiguo S, Axmacher J. Insect Diversity: Addressing an Important but Strongly Neglected Research Topic in China. Journal of Research in Ecology. 2011; 2(4):380-384.