Original Article

Indian Journal of Biology
Volume 8 Number 1, January – June 2021
DOI: http://dx.doi.org/ 10.21088/ijb.2394.1391.8121.1

Effect of Anthropogenic Disturbances on the Distribution of Spider Species in Gopalpur and its Adjacent Villages of Ganjam District Odisha

Gitanjali Mishra[1], Somanath Sahoo[2]

How to cite this article:
Gitanjali Mishra, Somanath Sahoo, Effect of Anthropogenic Disturbances on the Distribution of Spider Species in Gopalpur and its Adjacent Vill -ages of Ganjam District Odisha. Indian J Biol 2021; 8(1):9–15.

Author's Affiliations: [1]Professor, [2]Research scholar, PG Department of Zoology, Berhampur University, Odisha 760007, India.

Corresponding Author: Somanath Sahoo, Research scholar, PG Department of Zoology, Berhampur University, Odisha 760007, India.

E-mail: cool.somanath@gmail.com

Abstract

Anthropogenic disturbances cause many undesirable changes in our ecosystem that directly or indirectly affect the livelihood of people. In the present study, we investigated spider diversity and distribution in habitats with different degrees of anthropogenic disturbances in Gopalpur of Ganjam district, Odisha from November 2018 to January 2020. A total of 592 spider specimens belonging to 23 species were recorded. It was observed that the more the degree of anthropogenic disturbances, the lesser was the diversity of spider species. The spider population was negatively affected by the frequency of disturbances in their habitat. Ecological parameters such as temperature, humidity, wind speed and direction, and light intensity were changing at a higher rate in more disturbed areas, indicating differences, due to human impact. The study reveals that anthropogenic disturbances produce ecological changes that most of the spider species may not tolerate. Again, the distribution pattern of arboreal orb-web making spider species was greatly affected by the frequent disturbances whereas ground-dwelling species were least affected. To retain spider diversity in any locality, there needs a management plan for incorporating some undisturbed wild vegetation patches both in rural and urban areas. This could include rules on how to keep that vegetation patch undisturbed and not been influenced by any household waste materials or drained water from any industry, factory, or crop field.

Keywords: Spider; Vegetation; Diversity; Frequency.

Introduction

All living organisms including human depends on free services provided by natural ecosystems for their sustenance on earth. Although human can modify the natural ecosystems to grab most of the benefits for their own, anthropogenic disturbances cause many undesirable changes in the ecosystem that directly or indirectly affect the livelihood of people (Kremen*et al*., 2007; Winfree *et al*., 2009; Shrestha *et al*., 2013; Leal *et al*., 2014; Cambell*et al*., 2018).Spiders are the beneficial animal for agroecosystem as they control the pest population without degrading the quality of crop plants (Riechert, 1999; Maloney *et al*., 2003; Happe*et al*., 2019). The use of pesticides in crop fields can make the crops especially vegetables and fruits to be toxic for direct consumption (Fantke& Jolliet, 2016; Valcke, 2017; Carvalho, 2017). On the other hand, a low dose of pesticides in the field can induce resistant varieties of pests to be repopulated (Georghiou & Mellon, 1983; Guo *et al*., 1998). In this situation, integrated pest management can be helpful. Hereafter application of a low dose of pesticides in crop fields, spiders can be reintroduced to predating upon those resistant varieties. Therefore, in this context, it is very much important to know about the ecology of spider species to make them boons against pests in the modern system of integrated pest management. Anthropogenic disturbances influencing the diversity and distribution of most of the arthropod species.

In this present research work, it is hypothesized that the anthropogenic disturbances cause ecological changes that influence the distribution of spider species. This study aims to compare spider diversity and distribution at different grades of human-disturbed habitats in coastal areas of Gopalpur, Ganjam district, Odisha.

Materials and Methods

Study area: The study was conducted in a coastal belt of 5-kilometre width from the coastal line and20-kilometre length along the coastal line which includes Gopalpur and its adjacent area in Ganjam district of Odisha. The whole study area was divided into three categorical areas such as human settled areas (HSA), agricultural crop fields (ACF), and wild vegetational areas (WVA). That division was done according to the degree of human interference in the habitat. In the human settled areas, the sampling was conducted inside the vegetation grown at the side of the road, factories, and dump yards. In the agricultural crop fields, sampling was conducted inside the rice and vegetable crop field before harvesting. Wild vegetational areas were existed far from both human settled areas and crop fields and were mostly contained varieties of shrubs with randomly grown trees. We have selected 5 sampling sites randomly from each categorical area. Thus, a whole total of 15 sampling sites were chosen for all types of data collection.

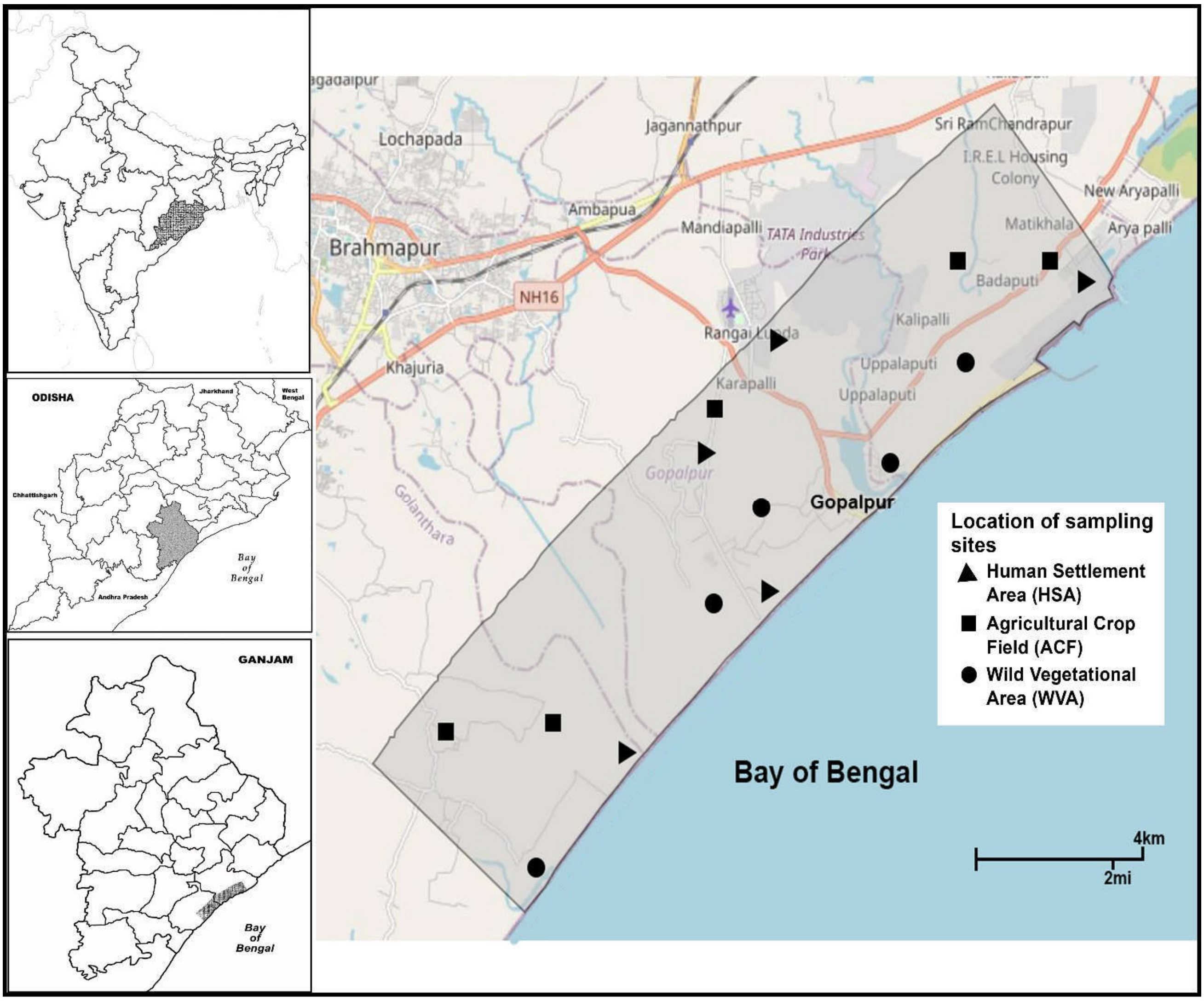


Fig. 1: Map showing study area and sampling sites. (Source: Google map)

Spider sampling: Spider sampling was done from the sampling sites of each category of the area twice a month for fifteen months from November 2018 to January 2020. Four methods were taken for spider samplings such as branch-beating and shaking technique for arboreal spiders, leaf litter sampling technique for ground-dwelling spiders, trapping technique (pit-fall trap for ground-dwelling spiders and hanging traps on shrubs and trees for arboreal spiders), and visual search technique. Some quadrates having the size of (1 X 1) m^2 were taken randomly from each categorical area for estimating spider density and distribution. During sampling, spiders were counted and identified in the field up to the family level by using standard field guides. Then collection and photography were done in the laboratory followed by preservation in 70% alcohol for later identification at least up to genus level.

Determination of ecological disturbances: Temperature, humidity, wind speed, wind direction, and light intensity was recorded near the vegetation at an interval of five minutes for one hour during mid-day time to find out the average change in the value of an ecological parameter per minute that represent the degree of anthropogenic disturbances in a particular habitat. Temperature, humidity, wind speed, and light intensity were measured by using portable standard digital instruments whereas wind direction was determined by the smoke direction from a burning incense stick using a compass.

Data analysis: Spider abundance in each categorical area was calculated as the average density (number per meter square) of five sampling sites in that habitat. For measuring spider diversity, species richness (total number of species) and the Shannon-Weiner species diversity index were used. Mean species richness and mean diversity index per sampling site were considered for comparative analysis. Statistical calculations were done by using Microsoft Excel 2013.

Results

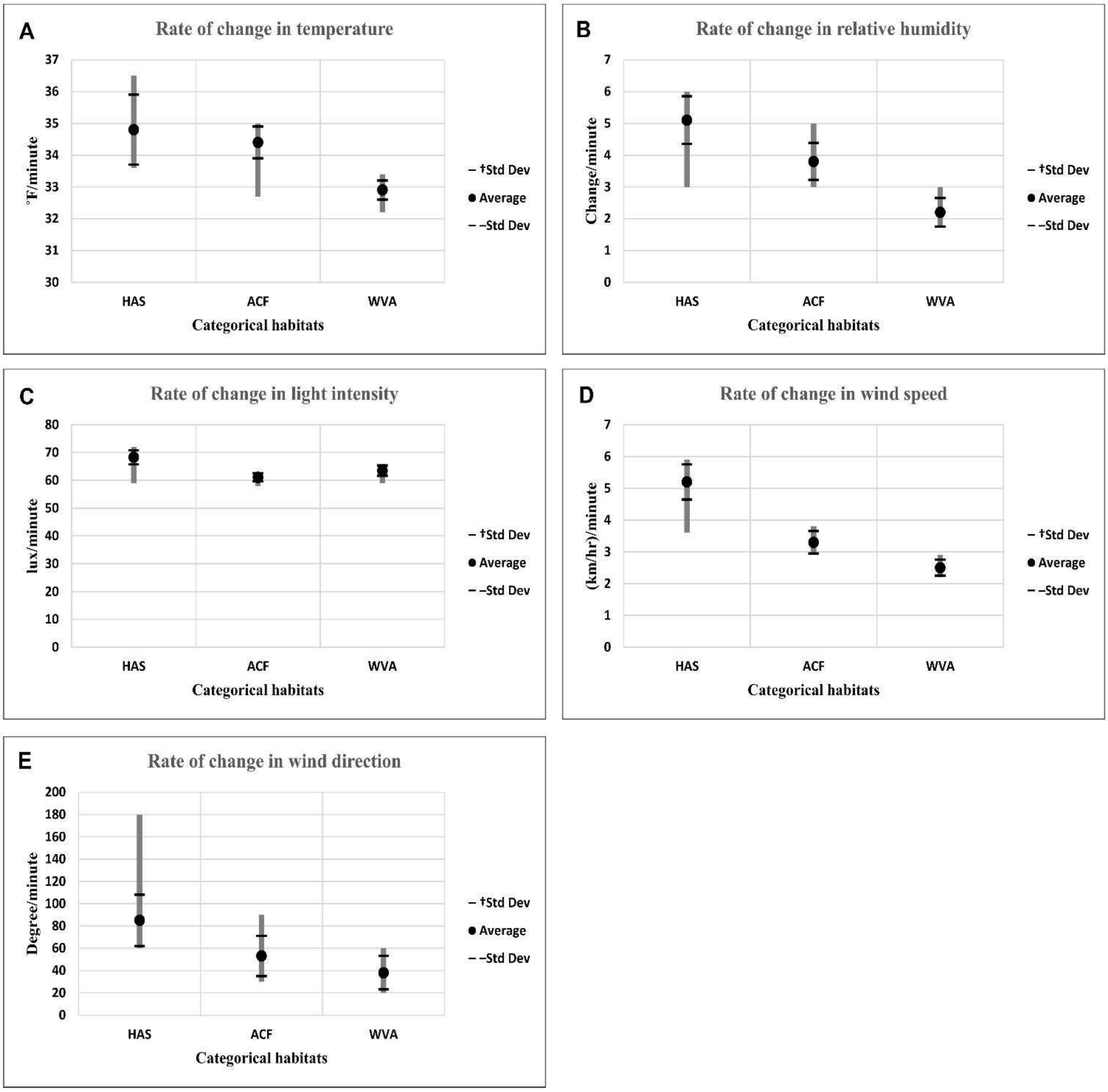


Fig. 2: Rate of change of ecological parameters at different categorical habitats.

Ecological parameters of each categorical habitat or areas: The average values of change in Fahrenheit temperature per minute in the five sampling sites of each categorical areas have been compared to found that, In the human settlement areas (HSA), there exhibits a large range of fluctuation in comparison to agricultural crop fields (ACF) and wild vegetational areas (WVA). There is a little significant difference between ACF and WVA. A similar result is found for change in the percentage of relative humidity per minute. Change in light intensity in lux per minute is slightly higher in HSA, but there was no significant difference between ACF and WVA. Therefore change in light intensity due to anthropogenic disturbances is insignificant to produce an effect on the ecological condition. Change in wind speed in (km/hour) per minute and change in wind direction in degree per minute has much significant difference among the three categorical habitats in the order of HSA>ACF>WVA.

Table 1: Diversity and distribution of spiders inside the whole studied area.

Family	Species	Habitat			Description
		HSA	ACF	WVA	
Araneidae	1. *Anepsion maritatum* (O.Pickard-Cambridge, 1877)	0	1	3	Arboreal, Orb-web builders
	2. *Cyclosa* sp.	0	1	3	Arboreal, Orb-web builders
	3. *Neoscona* sp.	0	0	1	Arboreal, Orb-web builders
	4. *Argiope pulchella* Thorell, 1881	1	2	3	Arboreal, Orb-web builders
	5. *Gasteracantha geminata* (Fabricius, 1798)	1	2	3	Arboreal, Orb-web builders
	6. *Araneus* sp.	0	0	1	Arboreal, Orb-web builders; Nocturnal
Ctenidae	7. *Ctenus* sp.	1	1	2	Ground dwelling; Found in leaf litter, crevices of the rock, sandy surface or on the muddy semi-dried soil; Nocturnal
Lycosidae	8. *Lycosa* sp.	2	3	2	Ground dwelling; Found in leaf litter, crevices of the rock, sandy surface or on the muddy semi-dried soil; Nocturnal
	9. *Hippasa* sp.	2	3	2	Ground dwelling; Tunnel sheet/funnel-web builder
	10 *Paradosa* sp.	1	3	2	Ground dwelling; Tunnel sheet/funnel-web builder
Oxyopidae	11. *Oxyopes birmanicus* Thorell, 1887	2	3	2	Arboreal, ambush hunter
	12. *Oxyopes sp.*	2	2	3	Ground dwelling on leaf litter or herbs, Diurnal
	13. *Peucetia viridana* (Stoliczka, 1869)	1	3	3	Arboreal, ambush hunter
Salticidae	14. *Telamonia dimidiata* (Simon, 1899)	1	2	2	Arboreal, ambush hunter
	15. *Hyllus semicupreus* (Simon, 1885)	1	2	2	Arboreal, ambush hunter
	16. *Phintella vittata* (C.L. Koch, 1846)	1	2	2	Arboreal, ambush hunter
	17. *Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)	0	2	2	Ant mimicking spider, Close proximity to ant
	18. *Myrmaplata* sp.	2	2	1	Ant mimicking spider, Close proximity to ant
	19. *Portia* sp.	0	0	2	Arboreal, hunt small spiders and termites.
Sparassidae	20. *Olios milleti* (Pocock, 1901)	0	1	3	Arboreal, ambush hunter
Tetragnathidae	21. *Tetragnatha javana* (Thorell, 1890)	1	1	2	Arboreal, horizontal orb-web builder
Theridiidae	22. *Argyrodes* sp.	0	1	2	Arboreal, Orb-web builder
Thomisidae	23. *Thomisus* sp.	1	3	3	Arboreal, Ambush hunters

0=Poor abundance, 1=Little abundance, 2=Moderate abundance, 3=High abundance.


1. *Anepsion maritatum* (O.Pickard-Cambridge, 1877)


2. *Cyclosa* sp.


3. *Neoscona* sp.


4. *Argiope pulchella* Thorell, 1881


5. *Gasteracantha geminata* (Fabricius, 1798)


6. *Araneus* sp.


7. *Ctenus* sp.


8. *Lycosa* sp.


9. *Hippasa* sp.


10 *Paradosa* sp.


11. *Oxyopes birmanicus* Thorell, 1887


12. *Oxyopes sp.*

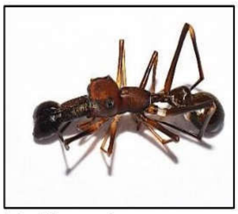

13. *Peucetia viridana* (Stoliczka, 1869)


14. *Telamonia dimidiata* (Simon, 1899)

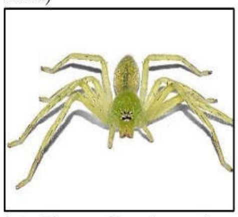

15. *Hyllus semicupreus* (Simon, 1885)

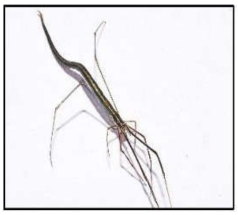

16. *Phintella vittata* (C.L. Koch, 1846)


17. *Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)


18. *Myrmaplata* sp.


19. *Portia* sp.


20. *Olios milleti* (Pocock, 1901)


21. *Tetragnatha javana* (Thorell, 1890)


22. *Argyrodes* sp.


23. *Thomisus* sp.

Fig. 3: Photographs of spiders from sampling.

Spider diversity and distribution: Overall 592 spider specimens were collected by all collecting methods from 15 sampling sites, representing 9 families and 23 species. From HSA and ACF, only 14 and 19 species were found respectively. All species were found to available in WVA. Spider abundance in number per square meter area is least in HSA and on the other hand, there is a little higher abundance in ACF in comparison to WVA. Mean species richness per sampling site and diversity indices per sampling site have values in the order of HSA<<ACF<WVA.

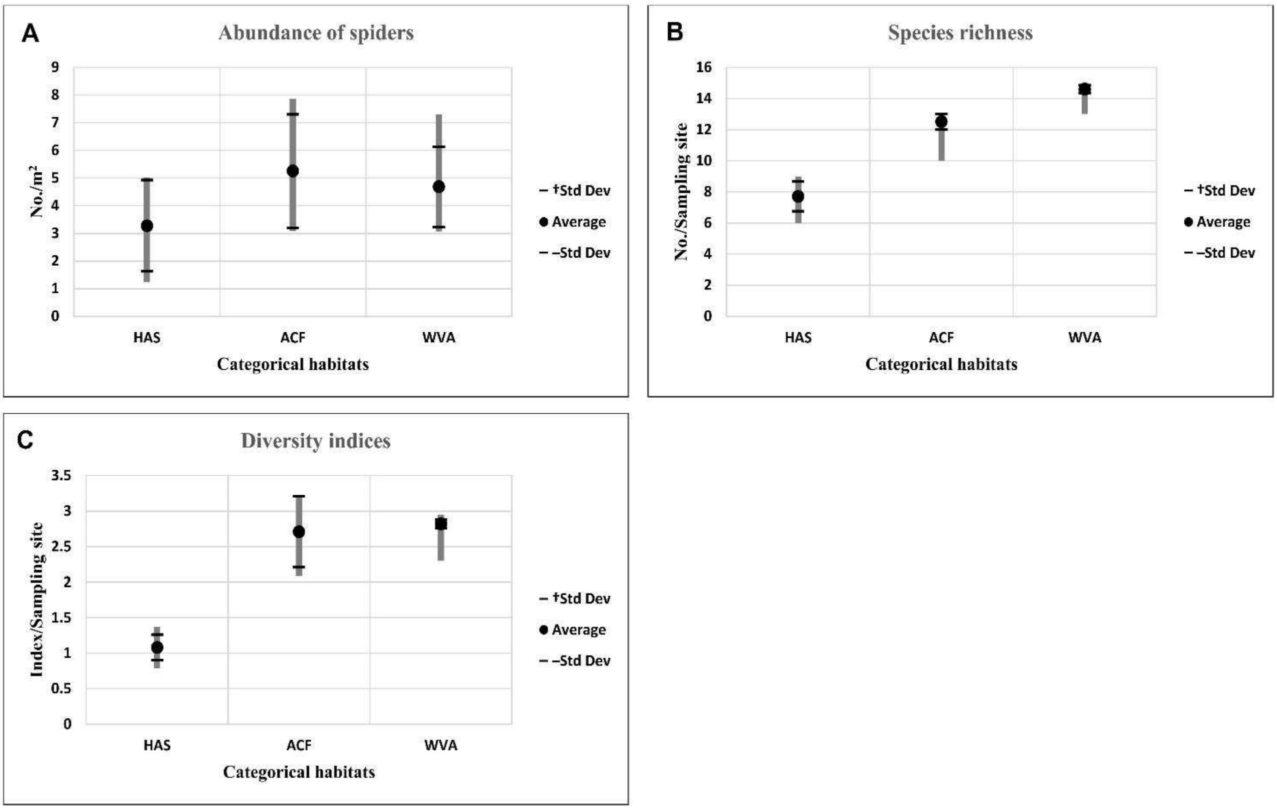


Fig.4: Spider abundance, species richness, and diversity indices at different categorical habitats.

Discussion

From the study, it is found that temperature and humidity in HSA are highly fluctuating, mostly due to burning action, the presence of concrete roads and buildings, smoke, and dust particles in the air. Wind speed and wind direction are not fluctuating to a greater extent at WVA due to the presence of trees and dense vegetation. In ACF, small height plants do not resist the change in wind speed and wind direction. Heavy vehicular movements is an important reason for the high rate of fluctuation of wind speed and wind direction at HAS. Anthropogenic disturbances make a high rate of change in the ecological factors that directly affect the population growth rate of different spider species in a different manner (Schweiger et. al., 2005; Lowe et. al., 2014; Picchi et. al., 2016). Changing and fluctuating ecological state reduces the predatory and mating behaviour, their fecundity rate, and developmental success by most of the wild spider species (Johonson et. al., 2019). Changing environmental conditions whether at a higher or lower degree, but in a constant rhythmic pattern (diurnal or seasonal changes), allows the growth of certain varieties of adaptable species to be populated and establish a good ecological community. On the other hand, habitats having frequently changing ecological factors which are mostly due to anthropogenic activities, resist the growth of most of the orb-web builder and other arboreal spider species. Only a few spider species such as ground-dwelling spiders and sheet web builder species can exploit the area to establish a poor diversified community structure (Shochat et. al., 2008). Ground dwelling spiders in the community can only participate in the ecological food chain at the ground part of the whole habitat, but not at the upper arboreal habitat. For establishing complete ecological balance, there needs the presence of spiders exhibiting all types of functional habitats or niches.

Conclusion

As spider diversity and distribution is considered as the indicator of sustainable ecological habitat (Maelfait & Hendrick, 1998; Langor & Spence, 2006), their conservation strategies can bring ecological balance which will be beneficial for the vegetational growth, both at human settlement areas and crop fields. Therefore, to retain spider diversity in any locality, there needs a management plan for incorporating some undisturbed wild vegetational patches both in rural and urban areas. This could include rules on how to keep that vegetational patch undisturbed and not been influenced by any household waste materials or drained water from any industry, factory, or crop field.

References

1. Campbell AJ, Carvalheiro LG, Maues MM, Jaffe R, et al. Anthropogenic disturbance of tropical forests threatens pollination services to açaí palm in the Amazon river delta. J Appl Ecol. 2018; 55:1725-1736.
2. Carvalho FP. Pesticides, environment, and food safety. Food and Energy Security 2017; 6(2): 48–60.

3. Fantke P, Jolliet O. Life cycle human health impacts of 875 pesticides. Int J Life Cycle 2016; 21: 722–733. https://doi.org/10.1007/s11367-015-0910-y
4. Georghiou G.P., Mellon R.B. (1983) Pesticide Resistance in Time and Space. In: Georghiou G.P., Saito T. (eds) Pest Resistance to Pesticides. Springer, Boston, MA. https://doi.org/10.1007/978-1-4684-4466-7_1
5. Guo F, Zhang Z & Zhao Z. Pesticide resistance of Tetranychuscinnabarinus (Acari: Tetranychidae) in China: a review. Systematic and Applied Acarology 1998; 3(1):3-7. https://doi.org/10.11158/saa.3.1.1
6. Happe AK, Alins G, Bluthgen N, Boreux V, et al. Predatory arthropods in apple orchards across Europe: Responses to agricultural management, adjacent habitat, landscape composition and country. Agriculture, Ecosystems & Environment 2019; 273: 141-150.
7. Johnson JC, Urcuyo J, Moen C, Stevens DR. Urban heat island conditions experienced by the Western black widow spider (Latrodectushesperus): Extreme heat slows development but results in behavioral accommodations. PLOS ONE 2019; 14(9): e0220153. https://doi.org/10.1371/journal.pone.0220153
8. Kremen C, Williams NM, Aizen MA, Herren BG, et al. Pollination and other ecosystem services produced by mobile organisms: a conceptual framework for the effects of land-use change. Ecology Letters 2007; 10: 299-314.
9. Langor DW and Spence JR. Arthropods as ecological indicators of sustainability in Canadian forests. The Forestry Chronicle 2006; 82(3): 344-350. https://doi.org/10.5558/tfc82344-3
10. Leal, L.C., Andersen, A.N. & Leal, I.R. Anthropogenic disturbance reduces seed-dispersal services for myrmecochorous plants in the Brazilian Caatinga. Oecologia 2014; 174: 173-181.
11. Lowe EC, Wilder SM, Hochuli DF. Urbanisation at Multiple Scales Is Associated with Larger Size and Higher Fecundity of an Orb-Weaving Spider. Plos one 2014; 9(8): e105480. https://doi.org/10.1371/journal.pone.0105480
12. Maelfait J, Hendrickx F. Spiders as bio-indicators of anthropogenic stress in natural and semi-natural habitats in Flanders (Belgium): some recent developments. Proceedings of the 17th European Colloquium of Arachnology, Edinburgh 1997; Selden PA, editor; 293-300.
13. Maloney D, Drummond FA & Alford R. Spider Predation in Agroecosystems: Can Spiders Effectively Control Pest Populations? Technical Bulletin, The University of Maine 2003; 190: 1-27.
14. Picchi MS, Bocci G, Petacchi R, Entling MH. Effects of local and landscape factors on spiders and olive fruit flies. Agriculture, Ecosystems & Environment 2016; 222: 138-147. https://doi.org/10.1016/j.agee.2016.01.045.
15. Riechert SE. The Hows and Whys of Successful Pest Suppression by Spiders: Insights from Case Studies. The Journal of Arachnology 1999; 27(1): 387–396. JSTOR, www.jstor.org/stable/3706011. Accessed 30 Nov. 2020.
16. Schweiger O, MaelfaitJp, Wingerden Wv, Hendrickx F, Billeter R, Speelmans M, Augenstein I, Aukema B, Aviron S, Bailey D, Bukacek R, Burel F, Diekötter T, Dirksen J, Frenzel M, Herzog F, Liira J, Roubalova M, Bugter R. Quantifying the impact of environmental factors on arthropod communities in agricultural landscapes across organizational levels and spatial scales. Journal of Applied Ecology 2005; 42: 1129-1139. https://doi.org/10.1111/j.1365-2664.2005.01085.x
17. Shochat E, Stefanov W, Whitehouse M, Faeth S. Urbanization and Spider Diversity: Influences of Human Modification of Habitat Structure and Productivity. In: Marzluff J.M. et al. (eds) Urban Ecology. Springer 2008. https://doi.org/10.1007/978-0-387-73412-5_30
18. Shrestha KB, Måren IE, Arneberg E, Sah JP, et al. Effect of anthropogenic disturbance on plant species diversity in oak forests in Nepal, Central Himalaya. International Journal of Biodiversity Science, Ecosystem Services & Management 2013; 9(1): 21-29,
19. Valcke M, Bourgault MH, Rochette Louis, Normandin L., et al. Human health risk assessment on the consumption of fruits and vegetables containing residual pesticides: A cancer and non-cancer risk/benefit perspective. Environment International 2017; 108: 63-74.
20. Winfree R, Aguilar R, Vázquez DP, LeBuhn G, et al. Marcelo A. Aizen. A meta-analysis of bees' responses to anthropogenic disturbance. Ecological Society of America 2009; 90 (8): 2068-2076.