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An Overview on Ants as Bioindicator

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Abstract: The indicator qualities of terrestrial invertebrates are widely recognized in the context of detecting ecological change associated with human land-use. However, the use of terrestrial invertebrates as bio indicators remains more a topic of scientific discourse. The biotic and abiotic components of the ecosystem under restoration can be used to assess the response of the ecosystem to the restoration. The bio indicator should be able respond positively to the diminishing elements causes the degradation and interact positively to some of the biotic and abiotic components expected to prevail when the ecosystem is fully restored. One of such variable is ants. Ants are a useful tool not only because they are sensitive to environmental changes; but also because they are keystone species in several ecological processes and, therefore, provide reliable inferences about the ecological and functional implications of disturbances. Information about the eligibility of using ants as indicators of terrestrial ecosystems undergoing restoration and sampling and basic analytical methods to apply when implanting ants at assessing ecosystem undergoing restoration\is discussed.

Keyword: Ants, Bioindicator, Sensitive, Environmental changes

INTRODUCTION

Insects constitute 85% of the world's animal biodiversity [1]. Inclusion of ground-dwelling arthropods in environmental assessment surveys and biodiversity inventories has increased in the recent past [2]. Ants (Hymenoptera: Formicidae) have numerous advantages over other arthropods in studies of species diversity. Ant is one of the most diverse and ubiquitous groups of the social insect [3]. Ants are known to be an important part of ecosystems not only as they constitute a great role of the animal biomass but also because they act as ecosystem engineers. All the known species of ants are eusocial [4]. Ant species can be used in monitoring environmental impacts, ecosystem funding, and tools in ecological studies [5]. Ant species are used as excellent indicators of land management practices and restoration efforts [6]. All varieties of ant species exert an immense impact on the environment. It directly or indirectly influences the development and destruction of flora and fauna of its surrounding environment[7].

Intensive exploitation of natural resources and the resulting impacts on pristine habitats have led to calls from the scientific community and the general public to measure or monitor the level of these environmental impacts [8-10]. Bioindicators are a useful way to evaluate such impacts, since changes in their population dynamics or community parameters can indicate an environmental state more easily, quickly, and safely and with lower financial and labour inputs than direct measurements [11-13]. Ants have been used as a powerful tool in several ecological studies [14,15]. This group has useful characteristics for successful indication and monitoring of environmental impacts, including widespread distribution, high abundance, importance in ecosystem functioning, ease of sampling, and relatively well-known taxonomy and ecology [16]. With this scenario, present narrative review of literature study was conducted to describe and delineate the bioindicator role of Ants.

Bioindicator Role of Ants Functional Groups

The use of bioindicators to assess ecological change in relation to land use is most effective when supported by a predictive understanding of the organization of bioindicator communities. This allows the impact of anthropogenic disturbance to be distinguished from inherent site variability. More generally, it ensures correct interpretation of the "signal" provided by the bioindicator, especially given the limited replication available for many impact studies [17,18]. The strong tradition of plot-scale research on ant communities has not provided such a predictive understanding.

Little or nothing is known of the species composition of most ant communities, let alone their dynamics. In most cases, predictive power is not possible at the species level, and will not be in the foreseeable future. Predictive power is possible, however, at the functional group level. Ant functional groups have been identified which vary predictably in relation to climate, soil, vegetation, and disturbance; these functional groups have formed the basis of continental and global analyses of community composition [19,20]. In addition to biogeographic comparisons, this broad scale predictive power, in relation to environmental stress and disturbance, has been usefully applied to plot-scale studies,

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such as the identification of taxa most likely to be limited by competitive interactions [21,22], and the responses of local communities to disturbance [23,24].

In a bioindicator context, the use of functional groups to provide broad scale predictive power is particularly valuable when the requirement of species-level precision is relatively low. The best examples concern mine site restoration [25], where environmental disturbance has been extreme, and the goal of management is to produce self-sustaining ecosystems broadly similar to, but (given the relatively small area of land affected) not necessarily identical to, those occurring prior to disturbance. Ant functional groups show clear successional patterns in relation to time since rehabilitation [26], and the restoration of functional group composition might satisfy the "broadly similar" goal of restoration, even if species-level differences persist. Other examples include the monitoring of ecological responses to contrasting fire regimes, which produce markedly different profiles of ant functional groups [20,27].

Global-scale functional groups can also be useful when greater sensitivity is required, but ants are more effective as bioindicators in these situations when functional groups are refined from more detailed analyses of ant community dynamics at regional or local scales. For example, the global functional group scheme has been modified to achieve more precision in a regional study of land use impacts in Argentinian chaco [28]. The modifications include subdividing some groups and, in the case of Solenopsis previously outlined, assigning taxa according to their regional, rather than global, role. Similarly, some predictable functional group patterns emerged from a study of local emission impacts from mining in South Australia, but a greater understanding of the ecology of key species was required for the most effective use of ants as bioindicators [29].

The requirement of species-level precision may also be low, and therefore the use of functional groups particularly valuable, when information on the ecological structure of bioindicator communities is more important than their specific composition. In ant communities, high levels of species turnover across sites often involve ecologically similar species, such that ecological structure is conserved. Such ecological structure might be a more reliable indicator than species composition. For example, changes in functional group composition of ants at disturbed sites in the Kakadu region of northern Australia sometimes provide a more reliable indication of the responses of other invertebrate groups than does ant species composition [25].

Bioindicator Role Ants Diversity

Numerous scaling challenges confront the use of ant species richness as a general "biodiversity indicator" [30]. At a continental scale, it seems to me absurd even to suggest that diversity patterns in any particular taxon might be representative of all others. Ants, for example, favor hot and open habitats; although ant species richness might reflect the richness of other arid-adapted taxa over very large spatial scales, it obviously would not for taxa preferring cool and moist habitats! Any general biodiversity indicator is therefore only likely to be reliable at regional or smaller scales, and this will be confounded by complex, nonlinear diversity patterns. For example, comparative "site" diversity for ants is highly scale dependent, with one "site" capable of being particulary rich at one scale, but not at another. Given such scale dependency of site rankings, what is the appropriate scale for comparison? A corollary is that any relationship between ant species richness and the richness of other groups is also likely to be scale dependent, as scaling functions are unlikely to be uniform across taxa. A similar argument applies to the use of surrogates (such as genus richness, or the species richness of target genera) to estimate ant species richness, where, again, diversity patterns are highly scale dependent. Whatever the case, the spatial scale at which biodiversity surrogacy is being examined must be clearly specified, and it cannot be assumed that the results will apply to other scales.

The conclusion of this analysis is that perceptions of fundamental patterns and processes in ant communities, and measurements of ant species richness, composition, and relative abundance, are all scale dependent, and that surrogates of total ant diversity are scale specific. The traditional small-plot paradigm of ecological research is unable to deal with these issues. As with conservation biology in general, the use of ants as bioindicators is best served by studies providing predictive power over a range of spatial scales, and this requires the integration of results from plot-scale research with the broader scale paradigms of biogeography, systematics, and evolutionary biology [31-33].

Summary

Perceptions of fundamental patterns and processes in ant communities, and measurements of ant species richness, composition, and relative abundance, are all scale dependent, and that surrogates of total ant diversity are scale specific. As with conservation biology in general, the use of ants as bioindicators is best served by studies providing predictive power over a range of spatial scales, and this requires the integration of results from plot-scale research with the broader scale paradigms of biogeography, systematics, and evolutionary biology [31-33].

REFERENCES

1. Groombridge B. Global biodiversity status of the Earth's living resources. World Conservation Monitoring Centre, Cambridge (RU); 1992.
2. Oliver I, Beattie AJ. Designing a cost-effective invertebrate survey: a test of methods for rapid assessment of biodiversity. Ecological applications. 1996;6(2):594-607.
3. Bolton B. Bolton's Catalogue and Synopsis, in http://gap.entclub.org/ Version: 1, 2011. Last accessed on January 26, 2022.
4. Gadagkar R, Nair P, Chandrashekara K, Bhat DM. Ant species richness and diversity in some selected localities of Western Ghats. Hexapoda. 1993;5(2):79-94.
5. Ramesh T, Hussain J, Satpathy KK, Selvanayagam M, Prasad MV. Diversity, distribution and species composition of ants' fauna at Department of Atomic Energy (DAE) campus Kalpakkam, south India. World Journal of Zoology. 2010;5(1):56-65.
6. Andersen AN. The use of and communities to evaluate change in Australian terrestrial ecosystems: a review and a recipe. InProc. Ecol. Soc. Aust. 1990; 16:347-357.
7. Clark DB, Guayasamin C, Pazmino O, Donoso C, de Villacis YP. The tramp ant Wasmannia auropunctata: autecology and effects on ant diversity and distribution on Santa Cruz Island, Galapagos. Biotropica. 1982:196-207.
8. Wilson EO. On the future of conservation biology. Conservation Biology. 2000:1-3.
9. Bawa KS, Kress WJ, Nadkarni NM, Lele SR, Janzen DH, Lugo AE, Ashton PS, Lovejoy TE. Tropical ecosystems into the 21st century. Science. 2004;306 (8): 227-228.
10. Benhin JK. Agriculture and deforestation in the tropics: a critical theoretical and empirical review. AMBIO: A Journal of the Human Environment. 2006;35(1):9-16.
11. Niemi GJ, McDonald ME. Application of ecological indicators. Annu. Rev. Ecol. Evol. Syst. 2004; 35:89-111.
12. Goodsell PJ, Underwood AJ, Chapman MG. Evidence necessary for taxa to be reliable indicators of environmental conditions or impacts. Marine Pollution Bulletin. 2009;58(3):323-31.
13. Gardner TA. Monitoring Forest Biodiversity: Improving Conservation through Ecologically-Responsible Management, Earthscan, London, UK, 2010.
14. Folgarait PJ. Ant biodiversity and its relationship to ecosystem functioning: a review. Biodiversity & Conservation. 1998;7(9):1221-44.
15. Lach L, Parr CL, Abbott KL. Synthesis and perspectives. Oxford University Press; 2010.
16. Agosti D, Majer JD, Alonso LE, Schultz TR. Standard methods for measuring and monitoring biodiversity. Smithsonian Institution, Washington DC. 2000(9):280.
17. Reynoldson TB, Bailey RC, Day KE, Norris RH. Biological guidelines for freshwater sediment based on BEnthic Assessment of SedimenT (the BEAST) using a multivariate approach for predicting biological state. Australian journal of ecology. 1995;20(1):198-219.
18. Wright JF. Development and use of a system for predicting the macroinvertebrate fauna in flowing waters. Australian Journal of Ecology. 1995;20(1):181-97.
19. Andersen AN. A classification of Australian ant communities, based on functional groups which parallel plant life-forms in relation to stress and disturbance. Journal of biogeography. 1995:15-29.
20. Andersen A. Functional groups and patterns of organization in North American ant communities: a comparison with Australia. Journal of biogeography. 1991;24(4):433-60.
21. Andersen AN. Regulation of" momentary" diversity by dominant species in exceptionally rich ant communities of the Australian seasonal tropics. The American Naturalist. 1992;140(3):401-20.
22. Andersen AN, Patel AD. Meat ants as dominant members of Australian ant communities: an experimental test of their influence on the foraging success and forager abundance of other species. Oecologia. 1994;98(1):15-24.
23. Andersen AN, McKaige ME. Ant communities at Rotamah Island, Victoria, with particular reference to disturbance and Rhytidoponera tasmaniensis. Proceedings of the Royal Society of Victoria. 1987; 99: 141-146.
24. Andersen AN. Responses of ground-foraging ant communities to three experimental fire regimes in a savanna forest of tropical Australia. Biotropica. 1991a:575-85.
25. Andersen AN. Ants as indicators of ecosystem restoration following mining: a functional group approach.1997. Last accessed on January 26, 2022.
26. Andersen AN. Ants as indicators of restoration success at a uranium mine in tropical Australia. Restoration Ecology. 1993;1(3):156-67.
27. Vanderwoude C, Andersen AN, House AP. Ant communities as bio-indicators in relation to fire management of spotted gum (Eucalyptus maculata Hook.) forests in south-east Queensland. Memoirs of the Museum of Victoria. 1997;56(2):671-5.

DOI: 10.17148/IARJSET.2022.9278

28. Bestelmeyer BT, Wiens JA. The effects of land use on the structure of ground-foraging ant communities in the Argentine Chaco. Ecological Applications. 1996 Nov;6(4):1225-40.
29. Read JL. Use of ants to monitor environmental impacts of salt spray from a mine in arid Australia. Biodiversity & Conservation. 1996;5(12):1533-43.
30. Abensperg-Traun M, Arnold GW, Steven DE, Smith GT, Atkins L, Viveen JJ, Gutter M. Biodiversity indicators in semi-arid, agricultural Western Australia. Pacific Conservation Biology. 1995;2(4):375-89.
31. Levin SA. The problem of pattern and scale in ecology: the Robert H. MacArthur award lecture. Ecology. 1992;73(6):1943-67.
32. Brown JH. Macroecology. University of Chicago Press; 1995.
33. Wiens JA. The emerging role of patchiness in conservation biology. In The ecological basis of conservation Springer, Boston, MA. 1997:93-107.