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Arthropod diversity indices in floricultural ecosystem: Which fares better?

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ABSTRACT

Biodiversity being a multidimensional property is always considered as tough to measure or quantify mostly because of the assortment of indices recommended for this purpose. However, there is no agreement about which indices are more appropriate and informative. Arthropods are one of the groups that have evaded the knowledge of human beings of their role in ecosystem function. We used data collected from floricultural ecosystems of rose, jasmine and cock's comb fields during 2016 in Coimbatore, Tamil Nadu and calculated common arthropod diversity indices of species richness and species dominance in ordinal, familial and species level. The aim was to find out whether surrogacy is possible as far as arthropod diversity analyses are concerned and to determine whether some were better suited than others. In the present study, it was found that in most of the cases, irrespective of the index used, estimating species richness based on family level presented a closer picture to that of species level analysis, but could not totally replicate the sensitivity reflected by species level classification. Of the three dominance indices, only the Simpson's index discriminated the variation at all the three levels, viz. ordinal, familial and species with the discrimination being more pronounced at the species level. Hence, it could be inferred that the Simpson index could successfully be used in the floricultural ecosystems for estimating arthropod diversity based on dominance measures.

Keywords: Arthropod, Cock's Comb, Diversity indices, Jasmine, Rose

Biodiversity represents the variety and heterogeneity of organisms or traits at all levels of the hierarchy of life, from molecules to ecosystems. In the last decade, biodiversity concerns have been in the forefront of conservation efforts worldwide. The term biodiversity has generally been used in a very comprehensive manner, meaning the variability of life (composition, structure and function). Noss (1992) stated that biodiversity can be represented as an interlocked hierarchy of elements on several levels of biological organization, but typically, the focus is on species diversity. Even after deciding which form of diversity to measure, quantifying biodiversity remains problematic because of the assortment of indices recommended and due to the fact that there is no single index that adequately summarizes the concept (Hurlbert 1971, Purvis and Hector 2000). Indices are extremely important in efforts intended to monitor and conserve the environment (Morris *et al*. 2014). However, there is no agreement about which indices are more appropriate and informative.

Though the importance of biodiversity and its usefulness to mankind is widely known, the rich potentialities of smaller groups are often under estimated. Arthropods are one such group that has evaded the knowledge of human beings of their role in ecosystem function and popularly known as little things that run the world. They are frequently used as ecological indicators because they represent more than 80 per cent of the global species richness (Ehrlich & Wilson 1991, Samways 1993, Ramya *et al*. 2017). Biodiversity can be conserved only if its components are known and its study is essential for biodiversity conservation. The overall objective of this study was to throw light on the little-known area of arthropod diversity in floricultural ecosystem including the crops like rose, cock's comb and jasmine. We used data collected from floricultural ecosystems of rose, jasmine and cock's comb fields and calculated common arthropod diversity indices of species richness and species dominance in ordinal, familial and species level. The aim was to find out whether surrogacy is possible as far as arthropod diversity analyses are concerned and to determine whether some were better suited than others.

MATERIALS AND METHODS

The experiment was conducted at the farmers' fields during 2016 in Coimbatore, Tamil Nadu for rose, cock's

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comb and jasmine. For carrying out arthropod collection, the plot was divided into 100 quadrats (10 m × 10 m). Five such quadrats were chosen each at random and the entire plot was covered during the sampling period. Collections were made at weekly intervals using four different methods, viz. active searching, net sweeping, pitfall trap and rubbish trap (Ramya *et al*. 2017; Ranjith *et al*. 2018). The collected arthropods were sorted out based on taxon. Soft bodied insects and spider species were preserved in 70% ethyl alcohol in glass vials. Other arthropods were card mounted or pinned. The preserved specimens were photographed and identified based on the taxonomic characters. All arthropod species were identified to the lowest possible taxon. Insects were identified following Lefroy (1984), Comstock (1984), Richards and Davis (1983), Ayyar (1984), Poorani (2002) and also by comparing with the specimens in the Department of Agricultural Entomology, Tamil Nadu Agricultural University.

The alpha diversity indices like species richness and species dominance indices were used to assess and compare the diversity of arthropods in rose, cock's comb and jasmine. SPECIES RICHNESS AND DIVERSITY II (Pisces Conservation Ltd., www.irchouse.demon.co.uk) (Henderson 2003) programmes were used for calculating the diversity indices.

RESULTS AND DISCUSSION

The collection yielded two classes of arthropods, viz. Arachnida and Insecta, the maximum number of individuals were from class Insecta (8,854) followed by Arachnida (3,817). Totally, 12,671 arthropods were collected from rose, cock's comb and jasmine fields (Table 1). As complete

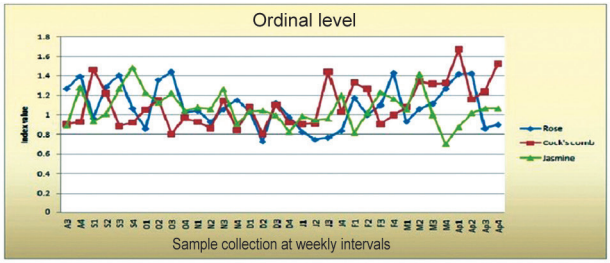
Table 1 Diversity of arthropods at ordinal level in floricultural ecosystems

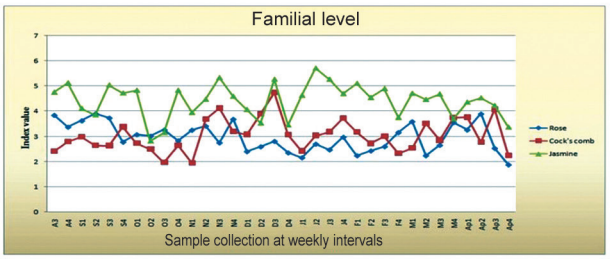
Class	Order	Total	Grand total
Arachnida	Araneae	2811	3817
	Acarina	1006	
Insecta			
Exopterygota	Odonata	84	2915
	Orthoptera	761	
	Dermaptera	77	
	Dictyoptera	274	
	Isoptera	63	
	Hemiptera	1558	
	Thysanoptera	98	
Endopterygota	Neuroptera	64	5939
	Lepidoptera	822	
	Diptera	958	
	Hymenoptera	1555	
	Coleoptera	2540	
			8854
Grand Total			12671

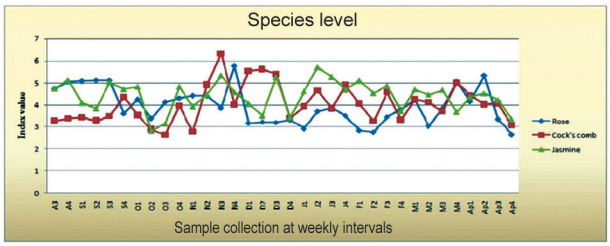
counts of organisms are impractical, indirect solutions that are practical, rapid and inexpensive are necessary and hence diversity indices have gained importance. Morris *et al*. (2014) opined that while common diversity indices may appear interchangeable in simple analyses, when considering complex interactions, the choice of index can profoundly alter the interpretation of results. They also inferred that simultaneously considering analyses using multiple indices can provide greater insight into the interactions in a system. So, in the present study, the data on the arthropods collected were subjected to alpha or within habitat diversity. In the current study, species richness was estimated based on Species number, Fishers alpha index, Margelef's D index, Brillouin index and Shannon-Weiner index.

Analysis of data based on familial level revealed that the species number peaked at 18 in rose and jasmine fields, while in cock's comb, the peak was observed as 20. On the species level, in rose, the maximum species number varied between 23 in rose, 28 in cock's comb, and 26 in jasmine. Based on familial level analysis, the maximum Fisher's index value fluctuated between 3.9008 in rose, 4.7407 in cock's comb and 3.8723 in jasmine. At species level, the maximum Fisher's index ranged between 2.6410 in rose, 6.3279 in cock's comb and 5.7175 in jasmine (Fig 1A). Analysis of data based on family revealed maximum Margelef's D index of 2.8433 in rose, 3.2438 in cock's comb and 2.8350 in jasmine. Based on species level, the highest index recorded was 3.7272 in rose, while in cock's comb and jasmine, it was 4.3121 and 3.9783 respectively (Fig 1B). The maximum Brillouin's index value recorded based on familial level was 2.6853 in rose, 2.6436 in cock's comb, and 2.7159 in jasmine. On species level, the maximum value for the index was 1.9282 in rose, whereas in cock's comb and jasmine, it was 3.0074 and 2.9798 respectively. The maximum Shannon-Weiner index value on familial level was 2.7850 in rose, while it was 2.7420 in cock's comb and 2.8000 in jasmine. In species level, the maximum value for the index was 3.0430, 3.1210 and 3.0870 in rose, cock's comb and jasmine respectively.

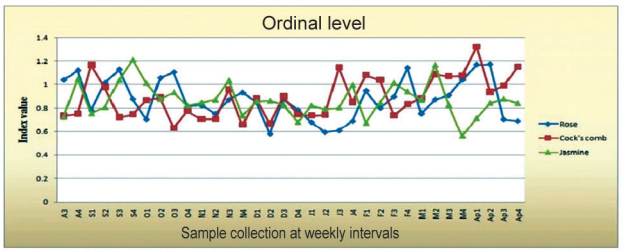
Dominance measures are weighted towards the abundance of the commonest species rather than providing the measure of species richness. In the current study, three indices were used for the estimation, ie. Simpson's index, McIntosh index and Berger Parker index. The Simpson's index calculated based on familial level revealed a maximum of 15.4000 in rose, 14.4910 in cock's comb and 15.1290 in jasmine. However, Simpson's index (species level) varied with the values of 20.3010 in rose, 20.3070 in cock's comb and 20.2630 in jasmine (Fig 1C). The maximum value of the index in the level of family was observed as 0.7798 in rose, 0.7737 in cock's comb and 0.7740 in jasmine. Maximum McIntosh diversity indices of species varied with the values of 0.8174, 0.8136 and 0.8178 in rose, jasmine and cock's comb respectively (Fig 1D). The maximum value for Berger Parker index in familial level was recorded to be 0.3693 in rose, while it was 0.3549 in cock's comb and 0.3184 in jasmine. The species level calculation of Berger Parker

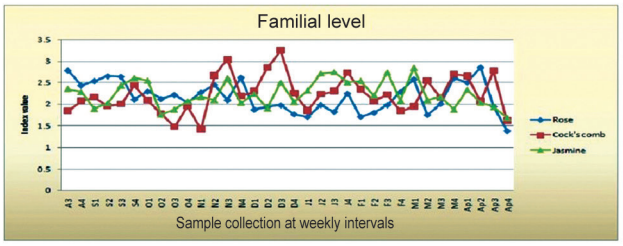


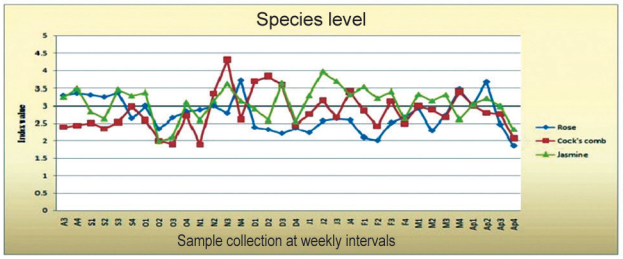




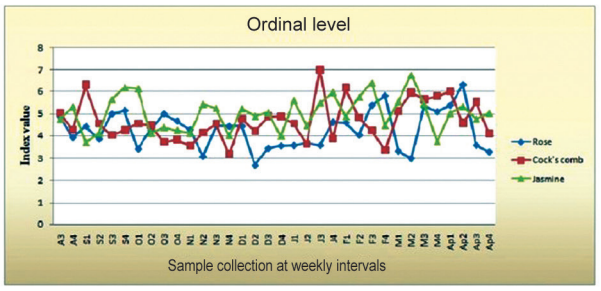
A. Arthropod diversity based on Fisher's alpha index

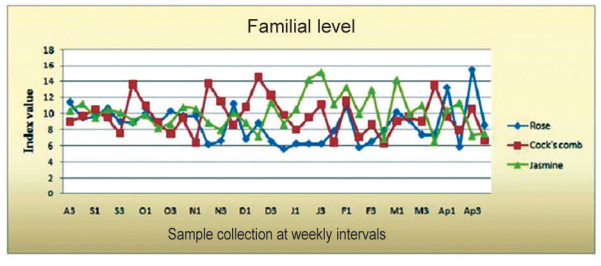


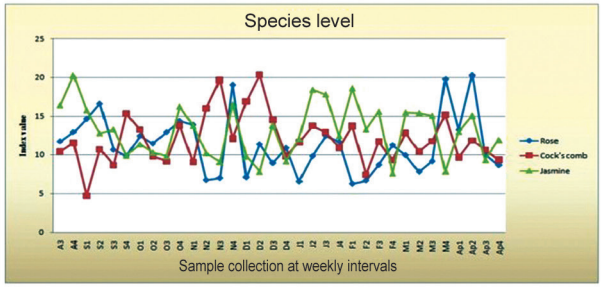




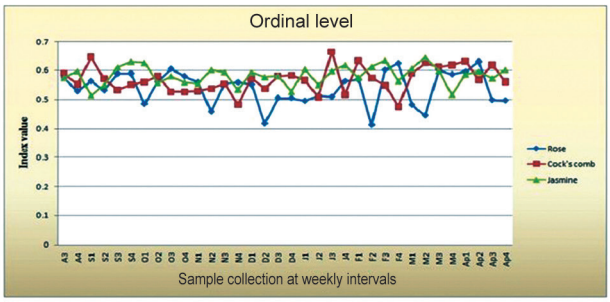
B. Arthropod diversity based on Margalef's D index

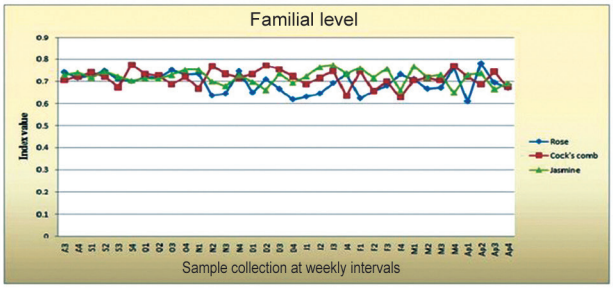


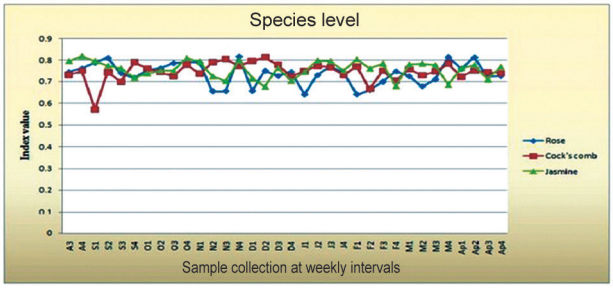




C. Arthropod diversity based on Simpson's index







D. Arthropod diversity based on McIntosh index

Fig 1 Representative figures of selected species richness and dominance indices in rose, cock's comb and jasmine ecosystems.

indices in the three crops revealed the values of 0.3529, 0.9256 and 0.3047 respectively.

With reference to most of the species richness indices, analysis at familial and species level followed an identical pattern in rose. The same phenomenon was observed in cock's comb and jasmine also. So, in the present study, it was noted that irrespective of the index used to assess species richness, estimates based on family level presented a closer picture to that of species level analysis, but could not totally replicate the sensitivity reflected by species level classification. Hoback *et al.* (1999) reported that ideally an estimate of diversity should examine organisms at species level, as any estimate of diversity at taxonomically higher level will be unable to explain the relationship between the species or population size or rate. By not identifying the species, trophic relationship of a community cannot be defined nor can diversity estimate based on family be compared to those of other taxa. However, in the absence of taxonomic expertise, the examination of the community for the purpose of estimating the diversity could be accomplished by use of family level identification.

The observation that species vary in abundance has promoted the development of statistical models such as species abundance models (Magurran 2004). Sometimes called dominance diversity curves, these models provide a graphical way of describing species richness and the relative abundance of species in communities (Morin 2011). This tool is important as it allows a quick and easy comparison of biological communities. Of the three dominance indices analysed in this study, only the Simpson's index discriminated the variation at all the three levels, viz. ordinal, familial and species with the discrimination being more pronounced at the species level. Other species dominance indices, viz. McIntosh D and Berger Parker were analysed at familial and species level and were almost similar in all the three fields. According to Magurran (1987), of the three indices, Simpson's index is commonly used for estimating diversity based on dominance with moderate discriminant ability.

McIntosh and Berger-Parker indices had highly contradictory results as far as ordinal, familial and species level in all the three ecosystems. Ravera (2001) emphasized on the discriminant ability to detect small differences between sites (or over time) as one of the most important quality of diversity indices. Further, the discriminant ability of these two indices was far from satisfactory in deducing significant conclusion from the analysis of data. This highlights the conclusion of Magurran (1987), regarding the poor discriminant ability of both McIntosh and Berger - Parker indices. So, in the present study, it could be found that for identifying arthropods the Simpson index could successfully be used in the floricultural ecosystems for estimating arthropod diversity based on dominance measures. It was also understood that with arthropods, for want of taxonomic expertise, family level identification might be a reasonable option for diversity estimates that seek to incorporate all data from a given sampling area.

REFERENCES

Ayyar T V R.1984. *Hand Book of Economic Entomology for South India*, pp 180–92. Narendra Publishing House, Delhi.

Comstock J H.1984. *An Introduction to Entomology*, 80 pp. Satish Book Enterprises, Agra, India.

Ehrlich P R and Wilson E O.1991. Biodiversity studies and policy. *Science* **253**: 758–62.

Henderson P A.2003. *Practical Methods in Ecology*, 151 pp. Blackwell Publishers, United Kingdom.

Hoback W, Tina M, Swados M, Stephenson M, Spomer P and Leon G.1999. Trap colour and placement affects estimates of insect family level abundance and diversity in a Nebraska salt marsh. *Entomologica Expermentalis et Applicata* **91**: 393–402.

Hurlbert S H.1971. The nonconcept of species diversity: a critique and alternative parameters. *Ecology* **52**: 577–86.

Lefroy H.1984. *Indian Insect Life*, 786 p. Jagmander Book Agency, New Delhi.

Magurran A E.1987. *Ecological diversity and its Measurement*, 179 pp. Chapman and Hall, New York.

Magurran A E.2004. *Measuring Biological Diversity*, 264 pp. Blackwell, Malden, MA.

Morin P J.2011. *Community Ecology*, 407 p. 2nd Edition. Willey-Blackwell, New Brunswick, NJ.

Morris E K, Caruso T, Buscot F, Fischer M, Hancock C, Maier T S, Meiners T, Muller C, Obermaier E, Prati D, Socher S A, Sonnemann I, Waschke N, Wubet T, Wurst S and Rillig M C.2014. Choosing and using diversity indices: insights for ecological applications from the German Biodiversity Exploratories. *Ecology and Evolution* **4**(18): 3514–24.

Noss R F.1992. Issues of scale in conservation biology. *Conservation Biology: The Theory and Practice of Nature Conservation, Preservation and Management*, pp 240–41. Fieldler P L and Jain S K. (Eds). Chapman & Hall, New York.

Poorani J.2002. An annotated checklist of the Coccinellidae (Coleoptera) of the Indian subregion. *Oriental Insects* **36**: 307–83.

Purvis A and Hector A.2000. Getting the measure of biodiversity. *Nature* **405**: 212–19.

Ramya R S, Ganesh Kumar M and Ranjith M.2017. Influence of weather parameters on seasonal abundance of arthropods in a floricultural ecosystem. *Journal of Entomology and Zoology Studies* **5**(3): 1672–76.

Ranjith M, Bajya D R, Manoharan T and Ramya R S.2018. Biodiversity of insect pests and natural enemies affliated with wheat (*Triticum aestivum*) ecosystem in Haryana. *Indian Journal of Agricultural Sciences* **88**(1): 157–58.

Ravera O.2001. A comparison between diversity, similarity and biotic indices applied to the macroinvertebrate community of a small stream: the Ravella river (Como Province, Northern Italy). *Aquatic Ecology* **35**: 97–107.

Richards O W and Davis R J.1983. *Imms General Text Book of Entomology*, 784 p. BI Publications Private Ltd, New Delhi.

Samways M J. 1993. Insects in biodiversity conservation: some perspectives and directives. *Biodiversity and Conservation* **2**: 258–82.