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When less means more: Reduction of both effort and survey methods boosts efficiency and diversity of harvestmen in a tropical forest

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ABSTRACT

Several ecological studies and monitoring programs of biodiversity have shown that using fewer collecting methods in biological surveys is more efficient than several redundant ones. However, in an attempt to increase species detection, researchers are still using as many field methods as possible in the surveys of arthropods and other megadiverse groups of invertebrates. The challenge is to reduce the overall time and effort for surveys while still retaining as much information about species richness and assemblage composition as possible. Researchers usually face a trade-off of loosing some information in order to have more efficient surveys. Here we show that more species were obtained in harvestmen surveys using a reduced version of the traditional method of active nocturnal search. We evaluated both the congruence and efficiency of the beating tray, and three versions of active nocturnal search across a tropical forest area in the Amazon basin. As nocturnal search has long been proved to be the most efficient method to capture arachnids, we tested three variations of this method in an attempt to improve harvestmen survey. A total of 2338 individuals of 23 species, in 20 genera and 10 families, were recorded using all methods together. Just one method, the active cryptic nocturnal search, encountered all taxa sampled with the maximum effort (sum of all methods) and data from this method recovered the ecological patterns found by the more intensive methods. Financial costs and time spent sampling and identifying specimens were reduced by 87% when compared to the maximum effort. We suggest that only one method, active cryptic nocturnal search, is the most efficient method to both sample and monitor harvestmen in Amazon tropical forests.

1. Introduction

Biological surveys generally use a variety of collecting methods to estimate the species richness and describe assemblage composition of a particular locality (Coddington et al., 1991; Longino and Colwell, 1997; Pinto-da-Rocha and Bonaldo, 2006). Several field methods should provide a larger species data set, however detailed and exhaustive biodiversity surveys are time consuming and very expensive. The costs of biodiversity research in tropical forests are especially high due to complex logistics and difficult in accessing some areas. Therefore a major limitation is inadequate funding (Balmford and Whitten, 2003; Magnusson et al., 2013). When sufficient resources exist for sampling, their more effective use may allow for the more extensive spatial and temporal sampling that is crucial to understand both biogeographic, ecological patterns, processes, and also for biodiversity monitoring (Costa and Magnusson, 2010; Kallimanis et al., 2012).

Efficient field methods are extremely important to obtain data on poorly known faunal groups (such as arthropods, and other invertebrates), so as to detect threats to biodiversity, prioritize areas for conservation and monitoring compositional changes to regional faunas (Longino and Colwell, 1997; Silveira et al., 2010). However, for studies focused on both species richness and composition the use of a combination of several field methods is not always necessary. In fact, several studies have shown that the use of fewer methods may be more efficient and less expensive than several redundant ones (Souza et al., 2012; Azevedo et al., 2013; Tourinho et al., 2014). Nevertheless, usually not as much data is collected if sampling effort is reduced, and then the impacts of reducing the

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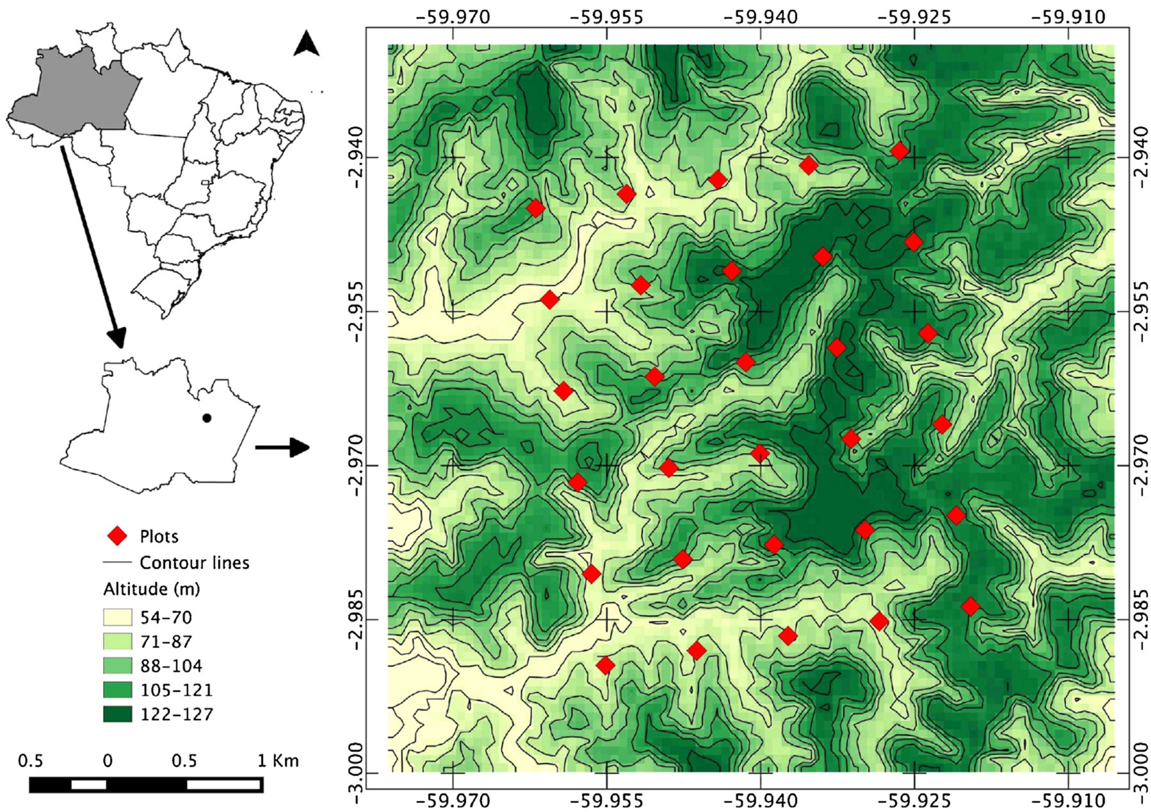

Fig. 1. Ducke Reserve map showing the position of the 30 curvilinear sampling plots of the PPBio grid (red diamonds). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

taxonomic and numerical resolution must be evaluated together with assemblage congruence among different taxonomic groups, especially if there are multiple questions to be answered (Landeiro et al., 2012).

There is a debate about whether we should or should not put a huge effort on very detailed inventories and on species-level identification. Some researchers advocate that the species is the unity carrying most information on organisms and their relationships with environmental variation. Systematists and museum personnel are usually included in this group, as they are most interested in documenting and listing the species diversity (Lenat and Resh, 2001; Marshall et al., 2006; Verdonschot, 2006). Others say that detailed inventories and species-level identification provide little extra information over higher taxonomic levels about community responses to environmental conditions (Warwick, 1993; Bowman and Bailey, 1997; Bailey et al., 2001). Given the global biodiversity and economic crises the ideal is to find a protocol that is cheap, allows rapid surveys, collecting as many species as possible and that is also optimized to meet requirements for both ecological studies and monitoring species occurrence.

Traditional inventories were mainly developed for taxonomic purposes, where the effort is devoted to gain the largest number of species in a single visit to a site (Coddington et al., 1991; Cardoso et al., 2006; Pinto-da-Rocha and Bonaldo, 2006). We have been using harvestmen as models for different biodiversity studies, because this group of arachnids has a moderate local diversity, ranging from 12 to 52 species per locality, that makes species sorting and identification faster than in other megadiverse arthropod groups (Kury, 2011). They also have limited dispersal capability, and a strong relationship with environment conditions, and are thus very sensitive to alterations in temperature, humidity and microhabitat (Bragagnolo et al., 2007; Tourinho et al., 2014).

Six methods normally used to sample arachnids were tested in one of the traditional papers dealing with sampling design and protocols for arthropods surveys in Tropical Ecosystems (Coddington et al., 1991). Those authors chose four protocols that were designed to include basic microhabitat assessment. Two of them, “the looking up” and “the looking down”, were variations of the active hand searching method, known as active night searching, which is typically performed during the night when most of the arachnids are active in the forest. These two methods were later fused into one single nocturnal search method that is frequently applied in tropical-forest surveys. In this, the collectors look up and down searching for arachnids in several types of microhabitat in the forest (Bragagnolo et al., 2007; Azevedo et al., 2013; Tourinho et al., 2014).

Even though a combination of three or more methods are constantly used to capture spiders and harvestmen (Bragagnolo and Pinto-da-Rocha, 2003; Bragagnolo and Pinto-da-Rocha, 2006; Bragagnolo et al., 2007; Tourinho et al., 2014), a higher number of spiders is often collected using active nocturnal search (Azevedo et al., 2013). In one recent study evaluating both the method and effort necessary for an effective harvestmen survey in the Amazon region, the authors demonstrated that four methods (beating tray, active nocturnal search, leaf-litter manual sorting and Winkler apparatus) that are regularly used to collect harvestmen documented different assemblages, but the active nocturnal search method have statistically less variance, and was more efficient when compared to other single method, to represent both harvestmen richness and composition (Tourinho et al., 2014).

Here we: tested the redundancy of four field methods (traditional active nocturnal search, modified active nocturnal search, active cryptic nocturnal search and beating tray), two of them newly designed for this study, to investigate how reduction in