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Tropical Biodiversity: Science, Data, Conservation

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IBISCA: a large-scale study of arthropod mega-diversity in a neotropical rainforest

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The IBISCA (Investigating the BIodiversity of Soil and Canopy Arthropods[1]) project aims to study the relationships between beta-diversity and the vertical stratification of arthropods in a neotropical rainforest. To this end, the arthropod fauna of nine sites (400m^2), all less than 2km apart, has been studied from the ground to the upper canopy in the San Lorenzo Protected Area, Panama (near Colon, Caribbean coast, 9º17'N, 79º58'W; alt. 130m). This tropical wet evergreen forest averages 3152mm of rainfall each year and has a mean annual air temperature of 25.8ºC.

IBISCA participants used an unprecedented range of techniques for canopy access. As well as insecticide knockdown techniques ("fogging") and single rope access, a range of major access devices was available. The canopy crane at the Fort Sherman site was one of these (see www.stri.org/tesp/fts.htm). The canopy platform known as the "Solvin Bretzel" was also used. This is a structure of pneumatic plastic beams and netting, and is the latest version of the canopy raft ("Radeau des Cimes"). A transect based on use of a manned helium balloon ("Bulle des Cimes") was also established. The "IKOS" treehouse was available at an additional site. Information about the Solvin Bretzel and related procedures can be found on www.radeau-des-cimes.org.

These techniques and devices complement each other well and IBISCA represents the first attempt to combine them in a large-scale investigation. They provided spatial replication during a six-week field study that involved 45 participants from 15 countries (23 professional entomologists, 5 professional botanists, 7 students and 10 technical staff members) and which took place in September-October 2003 (rainy season). Three sites were delineated within the perimeter (0.8ha) of the San Lorenzo canopy crane. Two sites were installed along the 800m transect of the Bubble. One site consisted of the Solvin Bretzel and another was centred on the IKOS. In addition, two canopy sites were accessible via a network of ropes set up by professional tree climbers (the ninth site was seldom used).

Seasonal replications were conducted three times at the three crane sites: one complete replication (all the sampling protocols described hereunder were used) in May 2004 (beginning of the rainy season) and two partial replications (only a few sampling protocols involved) in February 2004 (dry season) and October-November 2004 (rainy season).

1 In French: Inventaire de la Biodiversité des Insectes du Sol et de la CAnopée
In Spanish: Investigaciones sobre la Biodiversidad de los Insectos de la Selva Centro Americana

To collect arthropods, 14 different protocols were used (see Table 1) involving sampling techniques such as fogging (insecticide knockdown; 3 surrogate sites were fogged instead of the crane sites), branch beating, various kinds of traps including pitfalls, small and large flight intercepting traps, sticky traps, light traps, bait traps, Berlese-Tullgren Extractors (for microarthropods in suspended soils and on the ground), Winkler sifters (litter) and hand-collecting (ants and termites).

Table 1. IBISCA sampling effort.

Sampling protocol (target arthropods)	**September/October 2003** Sites (n)	Samples (n)	02/04	**05/04** Sites (n)	10/04
Soil/Litter:					
1. Pitfall traps (active arthropods)	8	120 (3 days each)	2	2	2
2. Winkler (active and passive arthropods)	8	408 samples of 1 m^2		3	
Canopy and/or understorey:					
3. Canopy fogging (wide range of arthropods)	8	48 (6 subsamples at each)		6	6
4. Composite flight-interception traps* (large flying insects)	5	120 (3 weeks each)	5	5	5
5. Beating (passive foliage arthropods)	7	320	2	2	2
(dead branches)	16 trees			16 trees	
6. Light traps (insects attracted to light)	8	48 (1 night each)	2	3	2
7. Sticky traps (small flying insects)	9	594 (5 days each)	2	2	2
8. Ground flight interception traps (large flying insects)	8	60 (2 days each)		8	
9. Malaise traps (large and small insects flying in the understorey)			6	6	6
10. Bait traps (bees)	8			6	
11. Hand collecting (galling insects)	6	18 vertical transects		5	
Both soil/litter and canopy:					
12. Berlese-Tullgren (microarthropods)	8	384		4	
13. Wood rearing (xylophagous insects)	One experiment carried at one site with ca. 15 plant species.				
14. Hand collecting (social insects)	8			3	
160 sections of 10 m^2 on ground 45 samples in the canopy (termites); two 170x40 m transects and approximately 300 samples in the canopy and understorey each (ants).					
12 sites of 400 m^2 were surveyed for vascular plants with a DBH ≥ 10 cm (9 sites and 3 surrogate sites for fogging at crane sites).					

* Composite flight-interception traps have run continuously until the end of October 2004.

The sampling protocols used during IBISCA at the different canopy/ground sites permitted, for the first time, a large-scale study of the interactions between horizontal and vertical faunal turnover. The analysis of a careful selection of focal taxa of arthropods from different clades and ecological niches will provide valuable information on faunal distributions. Actually more than 50 focal taxa in all, mostly families or sub-families, were studied. The spatial replication achieved with programmes such as the sticky, light and flight interception traps and the Berlese-Tullgren extractors is high and has few equivalents in the published literature, particularly when the vertical dimension is also being considered.

Roslin (2003) and Ozanne *et al.* (2003) provide useful summaries of the significance of canopy research in tropical rainforests. Detailed information on the IBISCA field work, accessible to a broad audience, is reported in Didham and Fagan (2003), Corbara (2004a, 2004b), Schmidl and Corbara (2005) and Ribeiro and Corbara (2005), for example. Updated information on the whole program is also available in several reports (Springate & Basset 2004, Basset & Leponce 2005), as well as on the IBISCA website at www.naturalsciences.be/cb/ants/projects/ibisca_main.htm

Arthropod data collected during IBISCA are entered into a shared database, conceived and maintained by Maurice Leponce and Yves Basset (Royal Belgian Institute of Natural Sciences, Brussels). It is accessible through the Internet to all IBISCA field participants as well as to the many taxonomists involved in the identification of the collected material (being sorted, at least, to the morphospecies level). As of recently (May 2006), +400,000 specimens and +3,000 species of arthropods have been data-based, among which many species will eventually prove to be new to science and described. For example, 26 new species have already been described from tenebrionid and buprestid material alone (Ferrer & Ødegaard 2005, Curletti 2005), including one species named in honour of the project, *Lenkous ibisca* Ferrer & Ødegaard 2005 (Col. Tenebrionidae).

The interpretation of the results (in terms of both vertical stratification and beta-diversity of the different focal taxa) is still at an early stage, but will benefit from information provided by several parallel studies which characterize the sites surveyed (e.g., type of vegetation, canopy thickness, incidence of light, apparent leaf damage, etc.). A joint ESF (European Science Foundation) – UNEP (United Nations Environment Program) – GCP (Global Canopy Program) Exploratory Workshop ("The Last Biotic Frontier: Towards A Census of Canopy Life" – www.naturalsciences.be/cb/ants/meetings/esf_exploratory_workshop.htm) has been held in July 2005 in Brussels, with all the European and most of the non-European IBISCA participants, as well as invited high-ranking ecologists and statisticians. This aims to produce the best synthesis from the 14 sampling programs.

IBISCA may be considered as a model for ongoing large-scale programmes of biodiversity investigation. Comparable projects which involve multiple canopy access are in preparation. These will also include devices such as the "Canopy-Glider", an innovative flying inflatable craft which is actually in its test phase.

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