Some Research Goals of fzi at El Bosque Nuevo

contributing to the knowledge of biodiversity of moths at EBN, identifying species suitable as indicators for habitat quality, investigating details of pheromone communication, mimicry, and other aspects of chemoecology as well as methods for inventories, and aiming to identify further species for commercial breeding and trading

fzi
boppre@fzi.uni-freiburg.de

Background

Based upon interest in Lepidoptera which are associated with plants containing pyrrolizidine alkaloids (**PAs**) and use these plant toxins for their own benefit – either as protection against enemies and/or as precursors for courtship scents (pheromones) – we identify natural sources of PAs at El Bosque Nuevo (plants of diverse families) and the respective chemistry; we also study the tiger moths (Lepidoptera) which as adults are pharmacophagously associated with PA-plants or of which the larvae use PA-plants as hostplants.

We have done similar studies in Africa and Asia, and it is exciting and successful to compare PA-insects and PA-plants in the different biota, in particular, since Central America is so diverse in species of tiger moths.

Specific Goals

Parallel to an inventory of PA-insects (mainly Arctiidae) and PA-plants, we study morphological characters of the species in question. In particular, androconial organs are in our focus.

Many species look alike and/or strikingly resemble other insects – wasps, beetles, cockroaches – and thus form so-called mimicry rings. To find out the basis for mimicry and describe the various mimicry assemblages is another goal.

Eggs, caterpillars and pupae of butterflies and moths are vulnerable not only to predation but also to parasitoidsm. Parasitoid flies and wasps, often quite specifically, contribute significantly to the regulation of the population density.
Adult Lepidoptera were thought not to be attacked by endoparasites. But at El Bosque Nuevo we have found moths carrying maggots of a species of fly which was previously unknown to science. We also study egg and larval-pupal parasitoids.

Pharmacophagy

Insects of different orders, families and genera independent of obtaining food (nutrients) actively search for and gather secondary metabolites (e.g., pyrrolizidine alkaloids (PAs)) from certain dry plants and utilize them for defence and/or as pheromone precursors. This syndrome of "pharmacophagy" relates to morphological, physiological and ethological questions as well as ecological, chemical and phylogenetic ones. We study these comparatively in order to be able to describe in detail relationships between insects and PAs and characterise direct as well as indirect functions of these secondary metabolites in an ecosystem. Knowledge and understanding of common and different features permits insight into phylogenetic development.

Moths' biodiversity at EBN

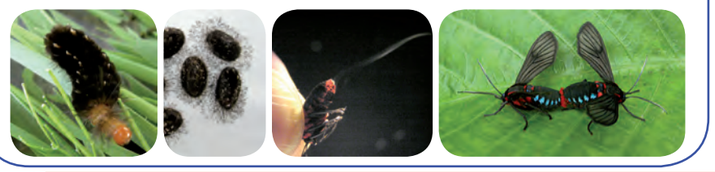
By trapping with light at night and by baiting with PA-plants and pure PA crystals we so far have found:
- 250 species of Arctiidae (tiger moths),
- 100 have androconial (scent disseminating) organs in the males,
- moths are involved in several mimicry rings with wasps (Hymenoptera), beetles (Coleoptera), flies (Diptera), and other Lepidoptera.
- Further: parasitoids of *Saurita* sp. and adult parasites of several Arctiinae.

sponsored by 3MBé gGmbH Forschungsförderung

Arctiidae (Tigers, Wooly Bears, Wasp Moths, ...)

Saurita spp. – a case study

Small moths of the genus *Saurita* gain special attention: on the one hand, their taxonomy is unclear and at El Bosque Nuevo there are several species plus others which can hardly be discriminated from *Saurita*. On the other hand, they exhibit interesting features: to attract a male, the females emit an aerosol – something new to Lepidopterology – and the males produce so-called flocculent of which the functions remain unknown. Further, the larvae built cocoons with their own hairs!



Mimicry

When a palatable (harmless) species looks like an unpalatable (defended) species, we call it Batesian mimicry. When two or more defended species resemble each other, we call it Müllerian mimicry.
The theory is that if a predator has made an unpleasant experience with a model, it will avoid all similar looking organisms – and thus the mimics gain protection.
Associated with mimicry is a warning colouration, the so-called aposematism. It concerns colours/patterns but may also involve sounds and (flight) behaviour.
The study of mimicry is complicated; Batesian and Mullerian mimicry usually occurs at the same time in the same place.

This is a day-flying moth – and not a wasp; an excellent example of mimetic resemblance.

General Inventories

Of course, during our studies we are finding all kinds of interesting animals and plants which we record to contribute to the general fauna and flora of EBN; there is collaboration with the Instituto Nacional de Biodiversidad (INBio) in San José.

Further tasks

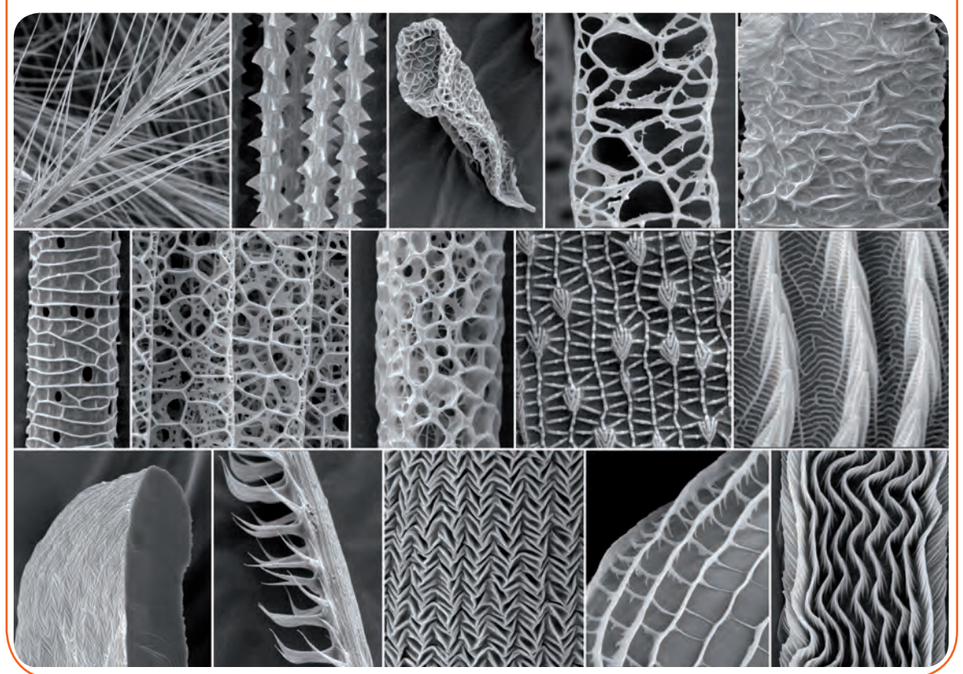
- Which EBN plants provide insects pyrrolizidine alkaloids?
- Larval characters and hostplant relationships of larvae
- Structural and chemical basis for intra- and interspecific communication
- Pheromone-transfer-particles and 'flocculent materials' in Lepidoptera
- Pheromones in *Morpho* butterflies
- Specificity of attraction of EBN arctiids to pyrrolizidine alkaloids

Androconial organs

Males of many species of butterflies and moths possess so-called androconial organs which are usually hidden but expanded during courtship behaviour. They release pheromones which serve female mate-choice. The diversity of structures is enormous: they occur on the abdomen, fore- and hindwings, legs; some are small, some have spectacular size. General news discovered at EBN is the presence of sugar-filled scales which are associated with inflatable 'coremata' in many taxa.

Scanning Electron Microscopy

With a scanning electron microscope one can study surfaces in large magnifications. We employ a SEM to investigate the structures of hairs and scales comprising androconial organs. Some examples of particularly aesthetic structures found at EBN moths (note the magnification!):



Chemoecology

• Chemoecology is the science investigating all those relationships between organisms which are mediated by natural products and which concern interactions at all levels of organisation – from individuals and populations to ecosystems.
• Chemoecology integrates ecology and chemistry and aims to elucidate the significance of natural products in an evolutionary biological frame; it tries to describe by comparative approaches the use of natural products in organismic relationships in the context of ecological conditions and thus to understand adaptive values and selective advantages.

[cf. Boppré & Malcolm, Chemoecology 1: 1-2 (1990)]

but also includes

Functional Morphology, Taxonomy, Systematics, Behaviour, and Evolutionary Ecology.

We do organismic biology in an integrated approach.

References

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Pheromone-transfer-particles and 'flocculent materials' in Ledpidoptera
Mimicry in Arctiinae

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