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Proceedings of the FORUM HERBULOT 2001 Neotropical Geometridae: Approaches to a Modern Concept of the Geometrid System on Genus and Tribe Level (8.3.-9.3.2001)

Axel Hausmann & Robert Trusch (ed.)

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The objectives, a list of participants and a short report on the results of the Forum Herbulot 2001 is presented emphasizing the great impact that this meeting had for coordinated, modern research in Geometridology and for creating a worldwide, IT-based network of scientists working on Geometridae. The abstracts of nine lectures from the seminary session of the Forum Herbulot are added.

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Objectives

Research on zoological systematics at the ZSM and its focus on Geometridae: towards a worldwide network of Geometrid researchers (from the 'introduction', shortened).

Axel Hausmann, ZSM

Claude Herbulot (Paris) has been known as the author of an amazing number of publications contributing valuably to the knowledge of taxonomy and systematics of the Geometridae of the world. His famous collection is now housed in the ZSM.

The fine collection as well as the productive enthusiasm of *Claude Herbulot* is a strong incentive for the pursuit of effective scientific work on Geometridae in the ZSM as regards the systematic order, taxonomical questions, biogeography and evolution, but also the use of IT in research and collection management. The FORUM HERBULOT shall focus on problems that can only, or better, or quicker, be solved by the personal co-operation of the leading specialists of our days. FORUM HERBULOT is therefore not meant to be just another congress but shall offer an opportunity for Geometridae-specialists to archieve tangible results that enhance top level progress in the field of Geometridology.

The ZSM houses one of the largest Lepidoptera collections in the world. Many years ago, such museums ceased to be part of 'Royal Natural Curiosity Cabinets', or collections for their own sake that can be mockingly considered as 'Zoological Registration Offices' (Autrum), but have become indispensable partners in research into biodiversity, biogeography, evolution and systematics. In systematics (with correlating taxonomy) research is almost exclusively left to the museums; in German universities at least there are now very few professorships in systematic zoology.

Our responsibility for systematic research is a great challenge. Most museums – as a result of having far too few personnel – are confronted with serious problems with the arrangement and curation of the collection (collection management) and with making the collection accessible by modern

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IT (cataloguing). On the other hand, computer techniques, methods of molecular biology, and recent, refined results from geology, climatology and palaeontology offer exciting new possibilities for systematic research. Coordination of the limited resources is strongly needed. Under the given conditions, continuous mutual exchange of opinions and information between specialists on the base of personal contacts may be the best way to achieve successful progress in systematic research. Neither regional nor professional frontiers should play a limiting role here.

The work in the Lepidoptera department of the ZSM is particularly and strongly focussed on Geometridae. For this reason the ZSM was proposed as the organisational framework for a forum for a worldwide network of Geometridae specialists. The name "Forum Herbulot" has been chosen in order to express the admiration and the deep respect for the magnificent lifework of a Grand-Master of our Geometridae guild, but mainly, because the name Herbulot symbolises today in a unique way, what must be regarded as the most important prerequisite for advanced systematic research, i.e. profund knowledge of Geometridae in all the continents. The outstanding and beautiful collection Herbulot with so many types and so many correlated publications forms an extraordinarily fruitful basis for our work.

I am very glad, that our friend Herbulot was able to accept the invitation. So, his honorary lecture on South American Eupithecia will be a highlight of the Forum, and we have the opportunity to give him our warmest congratulations for his 93rd birthday, which he celebrated just 3 weeks ago. I have to admit, that this factor played a certain role in choosing this date for our Forum.

Participants

Chairman **A. Hausmann**, ZSM, Munich

Opening address **G. Haszprunar**, director of the ZSM, Munich

Gunnar **Brehm**, University of Bayreuth, Germany; Charles V. **Covell**, University of Louisville, U.S.A.; Philippe **Darge**, Clenay, France; Sven-Ingo **Erlacher**, University of Jena, Germany; Claude **Herbulot**, Paris, France; Igor **Kostjuk**, University of Kiew, Ukraine; Martin **Krüger**, Transvaal Museum Pretoria, South Africa; Andreas **Kunkel**, ZSM (Generaldirektion); Michael **Miller**, ZSM; Vladimir **Mironov**, Acad. Sci. Russ., St. Petersburg, Russia; Linda **Pitkin**, The Natural History Museum, London, U.K.; Peder **Skou**, Apollo Books, Stenstrup, Denmark; Manfred **Sommerer**, München, Germany; Dieter **Stüning**, Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn, Germany; Robert **Trusch**, ZSM; Janusz **Wojtusiak**, Jagiellonian University, Kraków, Poland.

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Short Report and Results

A. Hausmann, R. Trusch, C. Covell, M. Krüger, L. Pitkin

1. Aims of the FORUM HERBULOT as outlined by the chairman were agreed upon by the participants. The need for closer scientific cooperation among geometrid researchers was expressed.
2. The seminar session highlighted promising possibilities for systematic research. The importance of Gondwana studies was stressed by M. Krüger. Generic revisions of Ennominae (neotropical) by L. Pitkin prompted the question of tribal definitions which must be consistent in the other faunistic regions as well. A tentative tribal classification would seem worth working out and helpful. Research on Sterrhinae and Eupitheciini could be broadened to an interfaunistic scale (C. Covell; A. Hausmann; V. Mironov) and thus bridge existing gaps (e.g. *Eupithecia* in Africa as correlated to Asia and/or other regions).

   Molecular methods (e.g. working groups in Sweden and at the ZSM) need refining to form a more powerful tool for evolutionary and systematic studies and should supplement the morphological and ecological context.

   A linkage between the GEDIS transects in Ecuador (DFG) and the fascinating altitudinal borderlined sections of the *Erateina*-research (J. Wojtusiak) appears very desireable.
3. A proposal to continue the FORUM HERBULOT at the ZSM in 2003 was welcomed. An internet facility should be provided at the ZSM as a platform to continue cooperation between researchers and specialists; A. Hausmann, L. Pitkin, C. Covell, M. Krüger will supervise the goals and ways and means to achieve them.
4. Participants expressed their thanks to the organizers and sponsors of the FORUM HERBULOT 2001 and enjoyed the pleasure of attending the ceremony of the awarding of the Spix-Medal to Claude Herbulot.

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Abstracts

(Lectures of the Seminar Session)

On Neotropical *Eupithecia*

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Eupithecia is a genus with a very large number of species, in fact with the greatest number of species within the family Geometridae: 1,332 if we only consider the species and ignore the subspecies that have been listed by Malcolm J. Scoble in his inventory in 1999. However, to be honest I don't always agree with his classification of certain taxa as species or subspecies.

The genus *Eupithecia* is represented throughout the whole world as you can see on the globe on the transparency where red stripes show all the regions where the genus is known to exist. This picture is misleading in one respect, in that it fails to show correctly the important facts that the genus is well represented in Japan, Taiwan and Yunnan but only sparsely in Indochina, Malaysia and in the Sundas and that there are only two species in Australia and none in New Zealand.

Eupithecia species can be found from sea level to altitudes reaching about 4,000 metres. But, even though in moderate climates you can find them as well in the low lands as in the mountains, the rule is that in tropical regions you only find them in higher altitudes (starting at about 1000 metres).

Attempts have been made to divide such a large genus into smaller groups but, it is a very homogenous group, and the elements subject to differentiation are merely features of little importance such as a double areole instead of a single one in the neuration of the wings or differences in the structure of the antennae of the males. These variations are, as you know, not strong enough to define a genus. That is why none of the attempts to split the genus have succeeded.

Up to now, 352 species of *Eupithecia* are known in the Neotropics, i.e. more than a quarter of all known species, their distribution being very scattered: 44 species have been found in South Mexico, 39 in Central America, 9 in the Antilles, 9 in Venezuela (including Trinidad, Guyana, Surinam and French Guiana), 149 in Columbia, Ecuador, Peru and Bolivia (4 countries that I pool because a great many of the species found there are found in all of these countries), 26 in Brazil, 64 in Chile and 18 in Argentina and the Falkland Isles. However, this is far from being the true number of species in the region, as the investigation in most of the countries is only just starting. This is particularly true for the four central Andean countries. I estimate that the number of known species in these countries is barely half of all the species actually present. Strong support for this opinion can be found in my own collection in which the species from Ecuador and Peru are well represented and where the number of species I was able to label with a scientific name is more or less the same as the number of species I was unable to determine.

The males of some *Eupithecia* species in the Neotropics show special features which are found nowhere else, as you will be able to see on the drawings on the next slides. The hindwings can be shortened, cut shorter, or more or less peaked. The forewings, as well as the hindwings, may have fossules and swellings on their upper surfaces as well as on their undersides. The underside of the forewings sometimes has long patches with hairs. As a rule the species showing such features seem to be mainly species from lower and intermediate altitudes, even though I also caught one at 3,200 metres. Numerous genera have been created for all these species but, as I already told you, they cannot be considered as valid: the females of these species do not show any special features and the male genitalia are of the same type as those of all the other species of the genus.

It follows a characterisation of the seven groups of countries to which the author attributed all the neotropical *Eupithecia* species (South Mexico; Central America; Antilles; Venezuela, Trinidad, Guyana, Surinam, French Guiana; Columbia, Ecuador, Peru, Bolivia; Brazil; Chile; and Argentina, Falkland Islands).

The genus *Eupithecia* is well represented in South America, perhaps even better than in the rest of the world, if one considers the quota of species still to be discovered. Furthermore some neotropical species show special morphological features which are without parallels in any other region. Can we use these findings when searching for the place on earth where the genus originated? I do ask this question but I do not dare to answer to it.

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Suprageneric Classification of the Ennominae: The Neotropical Component

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The subfamily Ennominae is the largest in the Geometridae, comprising approximately 10,000 species (about half of the total number in the family) in 1100 genera. Many of the genera are

poorly defined, and the classification above that level is still inadequately resolved. Studies in recent decades, particularly by Holloway ([1994], focussing on the Bornean fauna), Rindge, Scoble, and other authors) have helped to improve the definition of various tribes and the taxa included in them, but much more study is needed.

The Neotropical component of the Ennominae is species-rich, with about 3300 species in about 300 genera. These genera have been the subject of a nearly completed review (Pitkin, in prep.), and their placement within tribes, reviewed in the same work, is considered here, together with some of the defining characters of those tribes. Study of the Neotropical fauna generally supports the usage of family-group names within the Ennominae as reviewed by Holloway ([1994]), but a few further synonyms have been found amongst these names.

Prior to recent decades, many Neotropical genera were dubiously assigned to tribes, or not at all. Certain tribes have benefited enormously from more recent revision, notably the Nacophorini and Lithinini (Rindge, 1983 and 1986 respectively), the Palyadini (Scoble, 1995), and the Macariini (Scoble & Krüger, in prep.). The current review of the Neotropical Ennominae broadens the scope of a number of tribes by newly assigning many genera to them. This is most marked in the tribes Ourapterygini (which gains 20 Neotropical genera) and Cassymini (which gains 10 Neotropical genera). The supra-generic classification of the Ennominae requires further resolution and some of the tribes may not be monophyletic.

Ennomine tribes represented in the Neotropical Region

	Total number of Neotropical genera	Newly assigned
Azelinini	2	0
Caberini and Baptini	15	6
Boarmiini	16	7
Melanolophiini [subgroup of Boarmiini]	10	0
Cassymini	14	10
Lithinini	12	3
Macariini	3	0
Nacophorini	43	11
Nephodiini	12	7
Ourapterygini	40	20
Palyadini	6	0
'Cratoptera group'	9	9

More than 60 Neotropical genera remain unplaced. Ennomine tribes with Neotropical representation probably excluded now are Angeronini, Crocallini, and Campaeini.

On the tribal classification of southern African Ennominae (Lepidoptera, Geometridae)

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Since the 1930's, the geometrid fauna of southern Africa has been considered as relatively well known. This notwithstanding, revisions published during the past decade have shown that the subregion is inhabited by an unexpectedly high number of Ennominae, with 545 species in 104 genera thus far described. The three largest tribes, Macariini, Ennomini, and Boarmiini comprise more than 40 % of genera and 67 % of species. Examples of less well represented groups include Cassymini, Caberini, Diptychini, Abraxini, Eutoeini, Lithini, and Gnophini.

The distribution of these taxa on both the species- and genus levels is highly skewed and of zoogeographic interest. The distribution of Macariini is concentrated in the savannas of the northern

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and eastern parts of the area. This pattern is in accordance with the utilization of Fabaceae, especially the species-rich genus Acacia, by most of its representatives. Conversely, boarmiine diversity is centered around afromontane forests, although the tribe also enjoys a substantial representation in the savanna biome. Perhaps most interesting from a phylogenetic point of view are Ennomini, which inhabit mainly the macchia-like Fynbos areas of the Western Cape Province and the semi-arid Karoo. In the northern parts of southern Africa Ennomini are largely montane, which, supported by geological and phytogeographical data, points towards an ancient origin of this group.

Studies on the Neotropical Sterrhinae (Geometridae) and Correlation of Species with those in the North American Fauna

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Status of North American studies on Sterrhinae:

A. Moths of America North of Mexico series, Fascicle 18.1: progress report
B. Synonymies of species-group names of species in United States and also in Mexico and other Central and South American countries
C. Un-named or unreported N. American/neotropical species additional to Covell (1983)
D. Currently known Sterrhinae genera and species fauna of North America – Sterrhini (species numbers in brackets; total species: 100): *Eumacrodes* Warren (1), *Euacidalia* Packard (5), *Protoproutia* McDunnough (2), *Lobocleta* Warren (7), *Idaea* Treitschke (30), *Paota* Hulst (1), *Pigia* Guenée (2), *Odontoptila* Warren (1), *Ptychamalia* Prout (1) – Cosymbiini: *Pleuroprucha* Möschler (2), *Cyclophora* Hübner (7), *Semaeopus* Herrich-Schäffer (5) – Timandrini: *Haematopis* Fabricius (1), *Calothysanis* Hübner (1) – Scopulini: *Acratodes* Guenée (1), *Scopula* Schrank (24), *Leptostales* Möschler (8), *Lophosis* Hulst (1).

Status of work on the neotropical Sterrhinae:

A. Most species are known only from original descriptions, and most were published between 1850 and 1950.
B. Faunal studies have not yet included many records of this subfamily.
C. Checklist of Sterrhinae of Costa Rica begun 1997 by Covell, but much of it remains incompleted.
D. Geometridae of Ecuador and Galapagos: Projects of Fr. Francisco Piñas R., PUCE, Quito; Lazaro Roque (Charles Darwin Res. Station), Bernard Landry, and Covell on the "Lepidoptera of the Galapagos Islands"; and the work of colleagues speaking at this Forum (cf. Gunnar Brehm et al.)
E. Resources at University of Louisville for further systematic studies: 1. Type information & pictures; 2. Literature; 3. Collections
F. Major areas of consideration: 1. Microtaxonomy: Species recognition, descriptions, synonymies, etc.; 2. Consideration of generic and tribal classification (Holloway's recent synonymising of *Anisodes* Guenée to *Cyclophora* Hübner; question of Cyllopodini as Sterrhinae, etc.); 3. Faunal investigations
G. Dedication: New species of *Cyclophora* from Galapagos to be named *herbuloti* in honor of our distinguished colleague, Claude Herbulot (C. Covell & L. Raque-Albelo).

Neotropical moths of the genus *Erateina* (Geometridae, Larentiinae). Evaluation of morphological and genital characters for the purpose of systematic revision of the genus

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Studies on moths of the neotropical genus *Erateina* Doubleday, 1848, encompassing 89 species and 20 subspecies, were aimed to examine external morphology and genital structures of adults to select characters of primary importance for establishing possible evolutionary relationships within the group. These included also SEM method of examination of microstructures on males' scent organs, which are developed on hind wings of most of the species. As a result, nine distinctive groups of species can be

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distinguished within the genus. Some species do not fit well into any of these groups and show intermediate characters.

Morphological differences between species are unusually high in *Erateina*. This concerns especially the variability of hind wing shape, its size and colour pattern. Male genitalia are characterised by wide, triangular valvae with broadly rounded posterior margin and by a set of tiny rows on internal surface. Species of all groups bear short, straight or hooked thorn in outer part of the ventral edge of valva, cristae are well developed, stalked but their size varies from group to group.

Female's genital structures are characterized by a very large bursa copulatrix which is bulbous in anterior part and narrow and conical in the posterior. Asymetric sclerotisation inside the bursa is especially thick at the posterior part and occupies about half of the lenght of the organ.

Scent organs, that seem to play a role in a chemical communication between sexes, also show a variety of types, from the simplest, bearing only one type of scent scale, as in *E. coeruleopicta* or *E. meduthina*, to the most elaborate ones, as in *E. drucei* and *E. subundulata*. The research is being continued to estimate also the relationship of *Erateina* with genus *Heterusia* and *Trocherateina* with which it seems to be the most closely related.

Problems in the study of the tribe Eupitheciini (Lepidoptera: Geometridae, Larentiinae)

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The tribe Eupitheciini is a most species-rich group of the family Geometridae. According to the Catalogue of the Geometrid Moths of the World this tribe includes nearly 1,700 species. The majority of Pug species are small, unattractive grey or brown coloured and can hardly been distinguished from each other by means of external features. They sometimes show no clear morphological differences. Therefore, the identification of many species from the tribe Eupitheciini including European species is extremely difficult. There are some urgent problems connected with the study of the Geometrid Moths of the tribe Eupitheciini, such as:

1. The composition of the tribe Eupitheciini. – Until now, we have no full information about morphological signs differing the representatives of this tribe from others. There is no clear knowledge about how many and which genera form the tribe Eupitheciini. In my opinion, at least 15 genera belong to this tribe, such as: *Axinoptera* Hampson, 1893 (13 species); *Bosara* Walker, 1866 (11 sp.); *Chloroclystis* Hübner, [1825] (17+"128" sp.); *Glaucoclystis* Holloway, 1997 (10 sp.); *Gymnoscelis* Mabille, 1868 (88 sp.); *Eupithecia* Curtis, 1825 (1,330 sp.); *Eupithystis* Holloway, 1997 (1 sp.); *Eva* Vojnits, 1981 (2 sp.); *Micrulia* Warren, 1896 (7 sp.); *Mnesiloba* Warren, 1901 (4 sp.); *Nasusina* Pearsall, 1908 (4 sp.); *Pasiphila* Meyrick, 1883 (36 sp.); *Pasiphilodes* Warren, 1895 (19 sp.); *Prorella* Barnes & McDunnough, 1918 (15 sp.) and *Ziridava* Walker, [1863] (11 sp.).
2. Revision of the genus *Eupithecia* Curtis, 1825. – The genus includes more than 1,300 species. A great number of species, subspecies and taxa of infrasubspecific rank have been described on the basis of single specimens or small series of adults. The descriptions of many species and subspecies do not correspond to modern requirements. Informations on type-specimens of many *Eupithecia* species are still lacking.
3. Revision of the genus *Chloroclystis* Hübner, [1825]. – The genus *Chloroclystis* had been expanded to include a large number of species over many years. According to Holloway (1997), the tropical representatives of this genus demonstrate a strong morphological diversity. I hope that detailed study will undoubtedly show that many species previously associated with *Chloroclystis* should be excluded from *Chloroclystis* and included mainly to the genera *Gymnoscelis* and *Pasiphila* in revision.
4. Distribution of species. – Modern guides, catalogues and atlases on Eupitheciini are absent for many countries and broad geographical regions. We have poor knowledge about geographical variation of many species especially widespread ones. It is necessary to compile the distribution maps for many species of Eupitheciini of the World.
5. Data on phenology, biology, foodplants of larvae and habitats. – Most of these data are known for European and north American species of Eupitheciini. Other regions, especially tropical territories are very poorly studied in these respects.
6. A system of the genus *Eupithecia* Curtis, 1825. – In the history of Lepidopterology many systems

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of *Eupithecia* have been published. The traditional order of species of European *Eupithecia* in particular has become imperfect long ago. Closely related species are often placed far away from each other in this system of European *Eupithecia*. In some European faunistic publications, the *Eupithecia* species are arranged totally in disorder. It is necessary to create a new modern system of the genus *Eupithecia* on the basis of more or less clear morphological features, mainly on the basis of structure of the male and female genitalia.

Estimations about the systematic position of *Pseudobiston pinratanai* Inoue, 1994

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Inoue described this peculiar, large, rather bombycoid moth in the Geometridae, subfamily Geometrinae, though he emphasized, on the other hand, the absence of the only known synapomorphy of the Geometridae, the characteristic abdominal tympanal organs. He outlined this placement as being tentative. However, some of the characters figured in his publication seem to support the proposed position: the presence of a tubular vein M2 in the hindwings, arising close to M1; vein M1 in the forewing arising from the commom stalk of R2-R5; large, sclerotized socii in the male genitalia. Other characters are contradictory to this placement or at least rarely found in the Geometrinae: absence of tympanal organs; cross-bar between Sc+R1 and cell in the hindwings, R2 arising from the common stalk of R3+R4 in the forewing (drawn incorrectly in Inoue's publication); tibia of hindlegs with one pair of spurs only; shape of socii and furca-arms in male genitalia.

The aim of this study was to check the given characters and/or to find additional ones supporting or not the systematic placement proposed by Inoue. The results are still rather preliminary:

1. Tympanal organs: not reduced or degenerated, but totally absent. Instead there are normal apodemes as found in many other families;
2. Tergal phragmata: agreeing with the condition found typical for Ennominae and Geometrinae;
3. Chaetosemata: present;
4. Thoracic tympana: absent (some characters, e.g. venation, shape of antennae, specialized shape of scales, small middle- and hind-legs with only one pair of spurs) agree with the conditions found in some Notodontidae, but the absence of thoracic tympanal organs contradict a possible relationship).

The (mostly plesiomorphic) characters studied so far neither support nor contradict reliably the systematic position proposed by Inoue.

Diversity of Geometrid moths along an altitudinal gradient in a Mountain Rainforest in South Ecuador

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(& Dirk Süßenbach, Christoph Häuser, Konrad Fiedler)

Herbivorous insects play an important role in terrestrial ecosystems. Therefore, understanding the extend and determinants of herbivore diversity will be a crucial element of ecosystem analysis. This is presently aimed by a research group of the German Research Foundation DFG. Its subject is to investigate functional aspects in a tropical rainforest in South Ecuador, its diversity, dynamic processes and potentials of use from an ecosystem viewpoint. We chose two model groups, Geometrid and Pyralid moths, in a first step of analysis. Our study area is a mountain rainforest in South Ecuador (1.800-3.100 m asl). We want to answer the following questions.

How large is the diversity of Geometrid moths (alpha diversity)?

So far, we found approximately 700 species or morphospecies in the study area. Fisher's alpha is a diversity measure which is independent of sample size. The area belongs to the hot spots of Geometrid diversity in the world because values between 110 and 130 are achieved. A comparable diversity is thus far only known from SE Asia.

How do communities change along an altitudinal gradient?

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So far we investigated an altitudinal gradient between 1,800 m and 2,400 m asl. The distance between the plots is some 100 m elevation. At lower altitudes, communities are dominated by the subfamily Ennominae whereas Larentiinae become more important at higher altitudes.

We use the NESS index as a measure of similarity because abundances of the species and the role of rare species are considered. The ordination method of Multidimensional Scaling (MDS) is used to visualize results and provide appropriate data for further statistical tests.

Which habitat parameters determine the diversity of Geometrid moths?

MDS allows to test correlations between the diversity of the moths and habitat parameters. We cooperate with participants of the DFG research group who work in the same study area. They will provide us with data of vegetation structure, diversity of plant and animal groups and others. These analyses will be carried out in the next months.

Life Histories of Geometrid moths

So far, little is known about the biology of Neotropical Geometrid moths. Larvae were collected in the field and reared to adults. Data for more than 20 species of habitus and food plants of the species can be provided now.

The phylogenetic relationships in Geometrid moths. An approach using mitochondrial DNA (mtDNA) sequences.

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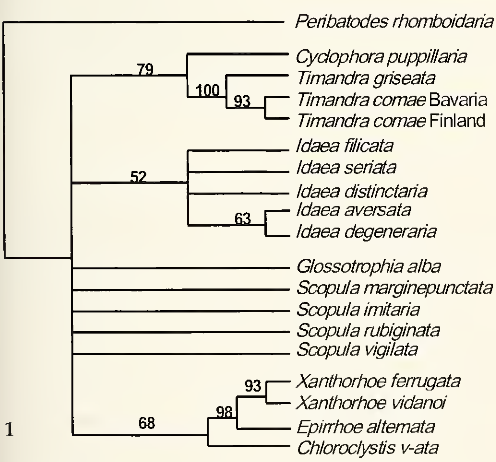
DNA sequence analysis has become a widespread tool for taxonomic identification and reconstruction of phylogeny. However, molecular genetic approaches to phylogenetic reconstruction face the problem that the sequence divergence caused by evolutional processes of the genes targeted for sequence analysis must match the evolutionary pace of the taxon group under consideration. For phylogenetic interpretation it is necessary to find such loci that can provide appropriate 'signal sequences' for phylogenetic interpretation. In a first approach on Geometrid moths we explored the phylogenetic signal from DNA-sequences of the mitochondrial ND1 protein-coding gene and the 16S ribosomal RNA.

Genomic DNA was extracted from 19 specimens of 18 representative taxa of the subfamilies Ennominae, Larentiinae, and Sterrhinae, focussed on subfamily Sterrhinae with 14 taxa. The subse-



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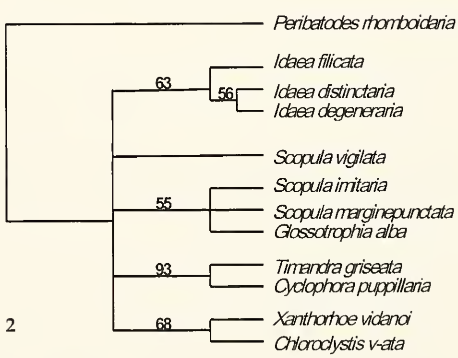

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Fig. 1. Bootstrap 50 % majority-rule consensus tree for 19 Geometrid taxa using 135 informative sites of the mitochondrial ND1 gene (rooted with *Peribatodes rhomboidaria*). Settings for tree computation: Heuristic search, bootstrap with 100 replicates.

Fig. 2. Bootstrap 50 % majority-rule consensus tree of a reduced set of taxa using combined sequences of the mitochondrial ND1 gene and the 16S rRNA locus (102 parsimony informative characters, rooted with *Peribatodes rhomboidaria*). Settings for the analysis see fig. 1.

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quent PCR amplified a fragment enclosing both genes (primer: ND-2, 5-ACATGATCTGAGT-TCAAACCGG, Vogler & De Salle 1993; ND-S, 5-TAGAATTAGAAGATCAACCAGC, Weller pers. comm.). Sequencing was done by an ABI 377 automated sequencer. Sequences were aligned to a respective sequence of *Bombyx mori* (GenBank ass. No. NC 002355), gaps and alignment ambiguities in the stretch of both sequences were excluded for analysis. The data-matrix contained 464 nucleotides (only ND1) or 779 bp in total (ND1 and 16S combined). Phylogenetic tree reconstruction was done by parsimony analysis using PAUP 3.1.1 with computation settings indicated in Figs. 1 and 2.

Tree reconstructions show close relations between tribes Timandrini *(Timandra griseata, T. comae)* and Cosymbini *(Cyclophora puppillaria)*, supported by relatively high bootstrap values (fig. 1, 2). The monophyly of the tribe Scopulini, strongly supported by morphological characters, is still unsupported by the used set of data. The examined Xanthorhoini species *(Xanthorhoe* spp., *Epirrhoe alternata)* show close relations to each other (bootstrap value 98; fig. 1). Certain affinities result as well between Xanthorhoini *(Xanthorhoe vidanoi)* and Eupitheciini *(Chloroclystis v-ata*; bootstrap value 68; figs. 1, 2). The relationships between the other tribes are not resolved by the present set of data.

We conclude that the preliminary results from our using the two mitochondrial genes ND1 and 16S are not yet satisfactory to tackle all details of subfamily and tribal relationships in the Geometridae by DNA sequencing. The implementation of more loci should contribute to a better resolution of the tree. Recently, Abraham et al. (2001) directed this way by running a molecular analysis with three gene fragments (ND1, D1- and D2- expansion elements of the nuclear 28S RNA) to reconstruct the phylogeny of Geometrid familiy with still more encouraging results.

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