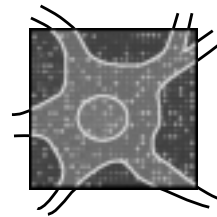
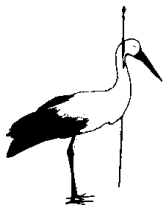


# Abstractband



## 97. Jahresversammlung der Deutschen Zoologischen Gesellschaft vom 31. Mai bis 4. Juni 2004



**Universität Rostock**



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# Allgemeine Hinweise

Die Titel der Plenarvorträge, Hauptvorträge, Kurzvorträge und Poster sind wie im Programmheft nach Hauptthemen (HT) und Studiengruppen (SG) geordnet. Diese Bezeichnungen finden sich jeweils in den Kopfzeilen der nachfolgenden Aufstellung. Innerhalb der Themenbereiche (HT oder SG) sind die Beiträge in der Reihenfolge Plenarvorträge, Hauptvorträge, Kurzvorträge und Poster geordnet. Ausserdem ist jeder Vortrag und jedes Poster innerhalb eines Themenbereichs mit einer fortlaufenden Nummer versehen.

Die Verteilung der Vorträge über Raum und Zeit entnehmen Sie bitte den folgenden Seiten.



**Montag 31.05.2004**

	14:30	14:45	15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	
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Schwaansche Straße 4 Kursraum																								

Anmeldung

**Abendvortrag**

Sitzungsleiterin: *B. König*  
 Schnecken ganz anders – die Schokoladenseite einer  
 „schleimigen“ Tiergruppe. Zur Evolution der Opistho-  
 branchia  
 Heike Wägele (Bochum)  
 S. 63

Vorstandssitzung

Beiratssitzung

Posterhängung





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		13:00	13:15	13:30	13:45	14:00	14:15	14:30	14:45	15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	
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Universitätsplatz 1 Aula	SG Entwicklungsbiologie	Kurzvorträge HT II – Signals and Cell Differentiation in Tissue and Organ Development Sitzungsleiterin: <i>N. Rebscher</i>	Kaffeepause																		
Universitätsplatz 1 Hörsaal 218			SG Systematik	Kurzvorträge HT I – Species Concepts Sitzungsleiter: <i>M. Ohl</i>	Kurzvorträge SG 8 – Zoologische Systematik Sitzungsleiter: <i>M. Ohl</i>	Kaffeepause															
Universitätsplatz 2 Hörsaal Zoologie	SG Physiologie	Kurzvorträge SG 6 – Physiologie Sitzungsleiter: <i>W.M. Weber</i>	Kaffeepause																		
Universitätsplatz 3 Hörsaal Physik	Hauptvorträge HT III – Sensory Systems: Biological Mechanisms and Technical Applications Sitzungsleiter: <i>W. Rössler</i>																				
Universitätsplatz 1 Hörsaal 315	SG Verhalten	Kurzvorträge SG 3 – Morphologie Sitzungsleiterin: <i>N. Schilling</i>	Kaffeepause																		
Universitätsplatz 1 Säle 229–232, Poster	Postersession bis 18:30																				
Schwaansche Straße 4 Kursraum	Gründung des Arbeitskreises Chancengleichheit (AKCB) <i>D. Brückner</i>																				

**Mittwoch 02.06.2004 – Vormittags**

	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00		
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Universitätsplatz 1 Aula			<b>Plenarvortrag HT IV</b> Sitzungsleiter: <i>G. Graf</i> Marine invertebrate dynamics: Combining pelagic and benthic studies Matthias Strasser (List S.37)				<b>Kurzvorträge HT IV – Coastal Seas and Estuaries</b> Sitzungsleiter: <i>T. Bartolomaeus</i>	Kaffeepause			<b>Kurzvorträge HT IV – Coastal Seas and Estuaries</b> Sitzungsleiter: <i>T. Berendank</i>	Kaffeepause			<b>Kurzvorträge HT IV – Coastal Seas and Estuaries</b> Sitzungsleiter: <i>T. Berendank</i>					Mittagspause	
Universitätsplatz 1 Hörsaal 218							<b>Kurzvorträge SG 2 – Evolutionbiologie</b> Sitzungsleiter: <i>H. Schulenburg</i>	Kaffeepause			<b>Kurzvorträge SG 2 – Evolutionbiologie</b> Sitzungsleiter: <i>E. Strohm</i>	Kaffeepause			<b>Kurzvorträge SG 2 – Evolutionbiologie</b> Sitzungsleiter: <i>E. Strohm</i>					Mittagspause	
Universitätsplatz 2 Hörsaal Zoologie							<b>Kurzvorträge HT III – Sensory Systems</b> Sitzungsleiter: <i>H. Luksch</i>	Kaffeepause			<b>Kurzvorträge HT III – Sensory Systems</b> Sitzungsleiter: <i>H. Bleckmann</i>	Kaffeepause			<b>Kurzvorträge SG 4 – Neurobiologie</b> Sitzungsleiter: <i>K. Wiese</i>					Mittagspause	
Universitätsplatz 3 Hörsaal Physik							<b>HT V – Temperature-Dependent Biogeography of Aquatic Ectotherms</b> Sitzungsleiter: <i>MW</i>	Kaffeepause			<b>HT V – Temperature-Dependent Biogeography of Aquatic Ectotherms</b> Sitzungsleiter: <i>MW</i>	Kaffeepause								Mittagspause	
Universitätsplatz 1 Hörsaal 315							<b>Kurzvorträge SG 7 – Verhaltensbiologie</b> Sitzungsleiter: <i>N. Sächser</i>	Kaffeepause			<b>Kurzvorträge SG 7 – Verhaltensbiologie</b> Sitzungsleiter: <i>V. Sferanski</i>	Kaffeepause			<b>Kurzvorträge SG 7 – Verhaltensbiologie</b> Sitzungsleiter: <i>V. Sferanski</i>					Mittagspause	
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															<b>SG Morphologie</b> Offenes Gespräch: Lage der Zoo- Morphologie in Deutschland						Mittagspause

Mittwoch 02.06.2004 – Nachmittags

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Universitätsplatz 2 Hörsaal Zoologie			SG Neurobiologie																								
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Schwaansche Straße 4 Kursraum			SG Morphologie																								

**D o n n e r s t a g 0 3 . 0 6 . 2 0 0 4 – V o r m i t t a g s**

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<b>Universitätsplatz 4 Tagungsbüro 8:00–18:00</b>																					
<b>Universitätsplatz 1 Aula</b>			<b>Plenarvortrag HT VII</b> Sitzungsleiter: <i>S. Scheu</i> The structure of biodiversity – insights from molecular phylogeography Godfrey M. Hewitt (Norwich, UK) S. 51				<b>Hauptvortrag HT VII</b> Sitzungsleiterin: <i>K. Böhmig-Gaëse</i> The importance of immune gene variability (MHC) in evolutionary ecology and conservation Simone Sommer (Hamburg) S. 52	Kaffeepause			<b>Kurzvorträge HT VII – Molecular Evolution Meets Conservation Biology</b> Sitzungsleiter: <i>K. Witte</i>		Kaffeepause		<b>Kurzvorträge HT VII – Molecular Evolution Meets Conservation Biology</b> Sitzungsleiter: <i>K. Witte</i>					Mittagspause	
<b>Universitätsplatz 1 Hörsaal 218</b>							<b>Hauptvortrag HT VI</b> Sitzungsleiterin: <i>S. Kaiser</i> Prudent Mothers, Hormones, and Development Hubert Schwabl (Washington, USA), S. 49				<b>Kurzvorträge SG 7 – Verhaltensbiologie</b> Sitzungsleiter: <i>M. Naguib</i>		Kaffeepause		<b>Kurzvorträge SG 7 – Verhaltensbiologie</b> Sitzungsleiter: <i>M. Naguib</i>					<b>Kurzvorträge SG 2 – Evolutionsbiologie</b> Sitzungsleiterin: <i>A. Dornhaus</i>	
<b>Universitätsplatz 2 Hörsaal Zoologie</b>											<b>Kurzvorträge SG 6 – Physiologie</b> Sitzungsleiter: <i>C. Müller</i>		Kaffeepause		<b>Kurzvorträge SG 6 – Physiologie</b> Sitzungsleiter: <i>C. Müller</i>					Mittagspause	
<b>Universitätsplatz 3 Hörsaal Physik</b>											<b>Kurzvorträge SG 5 – Ökologie</b> Sitzungsleiterin: <i>E.M. Griebeler</i>		Kaffeepause		<b>Kurzvorträge SG 5 – Ökologie</b> Sitzungsleiterin: <i>E.M. Griebeler</i>					Mittagspause	
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<b>Universitätsplatz 1 Säle 229–232, Poster</b>																					
<b>Schwaansche Straße 4 Kursraum</b>																					

**Donnerstag 03.06.2004 – Nachmittags**

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Universitätsplatz 1 Aula					<b>Kurzvorträge SG 4 – Neurobiologie</b> Sitzungsleiter: <i>K. Wiese</i>					Kaffeepause			<b>Poste- prä- mierung</b>							
Universitätsplatz 1 Hörsaal 218					<b>Kurzvorträge SG 2 – Evolutionbiologie</b> Sitzungsleiterin: <i>A. Dornhaus</i>					Kaffeepause										
Universitätsplatz 2 Hörsaal Zoologie					<b>Kurzvorträge SG 6 – Physiologie</b> Sitzungsleiter: <i>M.M. Weber</i>					Kaffeepause										
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Universitätsplatz 4  
8:00–12:00

**Exkursion**  
Prerow Darsser Ort (Nationalpark)  
Ende ca. 18:00

**Exkursion**  
Stralsund & Meeresmuseum  
Ende ca. 16:00

**Exkursion**  
Vogelpark Marlow  
Ende ca. 13:00

**Exkursion**  
Wissenschaftspark Nieklitz  
Ende ca. 18:00

**Führungen, Treffpunkte und Zeiten im Tagungsbüro**  
Zoo Rostock  
Stadtführung Rostock  
Zoologische Sammlung Universitätsplatz 2  
Biowissenschaften in der Albert-Einstein-Straße 3  
Institut für Ostseeforschung (IOW)

# HT I Species Concepts

**Michael Doebeli**

PhD at the University of Basel (1992) is followed by a research and teaching position at the University of British Columbia. Main field is adaptive speciation: theory and experiments.

**PV Adaptive speciation: theory and evolutionary experiments**  
Michael Doebeli

Department of Zoology, 6270 University Boulevard, Vancouver BC V6T 1Z4, Canada  
[doebeli@zoology.ubc.ca]

Understanding the evolutionary origin and maintenance of diversity is a fundamental biological problem. Generation of diversity occurs when an ancestral lineage splits into two descending lineages, a process called speciation. The past years have seen a veritable paradigm shift in our understanding of this process, which has shaken the foundations of one of the most cherished beliefs in evolutionary biology: that speciation is no more than a by-product of geographical isolation. I first review some of the theoretical work showing that adaptive speciation – speciation directly favored by natural selection rather than incidental speciation following geographical isolation – is an entirely plausible evolutionary process. This work is based on the mathematical framework of adaptive dynamics, and in particular on the phenomenon of evolutionary branching due to frequency-dependent ecological interactions. I then describe ongoing efforts to test evolutionary branching in experimental population of *Escherichia coli*, which provides an ideal model system to study the adaptive evolution of diversity.

## **Ulrich Schliewen**

Diploma 1992, PhD 1999 Max-Planck-Institut für Verhaltensphysiologie Seewiesen and Universität München; scientist Zoologisches Institut Universität München (1996–2001); DFG fellowship Zoologische Staatssammlung München (2001). Species and speciation in small lacustrine fish-species-flocks, including sympatric speciation.

### **HV Species and speciation in small lacustrine fish-species flocks** Ulrich Schliewen

Curator of Ichthyology, Zoological State Collection, Muenchhausenstr. 21, D-81247 Munich, Germany [schliewen@zsm.mwn.de]

Lacustrine fish-species flocks of large lakes, e.g. the cichlid species flocks of the east african lakes Victoria, Malawi and Tanganyika, have been used extensively to test hypothesis about speciation processes. However, the large size of these lakes as well as their flocks renders critical testing of alternative hypotheses problematic, since geographic effects on speciation and species-flock formation are difficult to separate from intrinsic effects. This problem has been exacerbated by the difficulty of reconstructing species-flock phylogenies, since a growing number of studies show that mitochondrial gene phylogenies often conflict with phylogenies based on numerous nuclear genes.

In this talk I present data on species-assemblages inhabiting three small lakes, one comprising 11 tilapiine cichlid fishes of the tiny crater lake Barombi Mbo (Cameroon), another comprising two separate tilapiine mini-flocks from Lake Ejagham (Cameroon) and one comprising 10 telmatherinid silversides species from Lake Matano, Malili Lake System (Sulawesi, Indonesia). Due to the simple geographic scenario under which species flock formation has taken place in these lakes, evidence for a prominent role of natural selection and hybridisation is presented which is based on mitochondrial and nuclear species-flock phylogenies as well as quantitative ecological observations.

The findings as well as comparative data from other small lacustrine species flocks are discussed mainly in the context of the recently forwarded “syngameon-hypothesis” for the formation of species flocks by Seehausen (2004). According to this hypothesis, the initial formation of hybrid swarms of originally allopatric populations coming together in a newly colonized habitat as well as secondary hybridisation of *in situ* diverged lineages theoretically explain the rapid formation of megadiverse species flocks.



### V-S1.1 **Speciation via differential host plant utilisation in *Tephritis conura* (Diptera: Tephritidae)**

T. Diegisser, J. Johannesen & A. Seitz

<sup>1</sup>Inst. f. Zoologie, Abt. Ökologie, Uni. Mainz, Germany [thorsten.diegisser@uni-mainz.de]

A key question in evolutionary biology is whether speciation is driven primarily by genetic drift, by natural selection or by both. Here we present a model system that may contribute to our understanding of speciation processes. The fruit fly *Tephritis conura* infests thistles of the genus *Cirsium*. Previous work has shown that *T. conura* forms biotypes on *Cirsium oleraceum* and *C. heterophyllum*, respectively. The host plants occur sympatrically, parapatrically and in allopatry. By comparing biotypes from each geographic setting we wish to examine mechanisms driving host plant mediated speciation.

MtDNA revealed that biotypes have split very recently. However, allozyme data exclusively cluster populations according to their host plant affiliation, giving evidence for geographically stable biotypes. The host-related topology is caused by five loci out of 13 loci. This type of divergence might be expected under sympatric speciation where disruptive selection is acting on only few loci. If disruptive selection is effective in *T. conura* one would expect that, due to reinforcement, biotypes differ more in sympatry/parapatry than in allopatry. Indeed, host plant affiliation accounts for more inter-host variance in parapatry (98.46%) than in allopatry (92.42%), but the results are equivocal because sympatric variance was not higher (92.43%). We are exploring causes for the ambiguity, including the consequences of multiple host shifts and lineage sorting. Future research will include quantifying pre- and postzygotic isolation in *T. conura* and phylogeographic analyses of the host plants to investigate possible allopatric origin of biotypes.

### V-S1.2 **Heterochronic shift of the first juvenile stage into the egg period may be the basis for diversity in diplogastrids (Nematoda)**

Alexander Fürst von Lieven

AG Evolutionsbiologie, Institut für Biologie/Zoologie, Königin-Luise-Str. 1–3, 14195 Berlin, Germany [lieven@zedat.fu-berlin.de]

Diplogastrids possess only three free living juvenile stages compared to the usual four (J1-J4) found in the majority of other nematodes. Careful examination of diplogastrid eggs revealed that the J1 to J2 moult occurs before hatching. Since the same is true for all hitherto examined diplogastrids including *Pseudodiplogasteroides* that is sister group of all other diplogastrids, the anticipated moult can be regarded as an apomorphy of the diplogastrid stem species. Within the egg, the J1 does not feed and the corresponding J1 pharynx cuticle is not secreted. Pharynx cuticle secretion begins with formation of the J2 body cuticle. In diplogastrids with complicated mouthparts, the period between reaching worm shape (that is maintained by J1 cuticle) and the first secretion of pharynx cuticle is used for complex morphogenetic processes of those pharynx cells that contribute to formation of the stoma (the stegostom). The fact that the J1 stage does not feed as it is traversed within the egg facilitated the loss of J1 pharynx cuticle expression. The loss of the first round of pharynx cuticle secretion provides the period of time that is needed for complex stegostom morphogenesis. The heterochronic shift of the J1 stage into the egg period can therefore be regarded as a prerequisite for the origin of diplogastrid diversity that basically reflects a diversity of stegostom shape in correspondence with diverse feeding habits. (As opposed to rhabditids that feed on bacteria, Diplogastrids are also herbi-, fungi-, carni-, or omnivores.) This example shows how heterochronic changes in development provided new opportunities for morphological alterations in correspondence with the acquisition of new food resources.

### V-S1.3 **Fatal attraction – sexual interactions between grasshopper species**

Axel Hochkirch

Universität Osnabrück, FB 5, Fachgebiet Ökologie, Barbarastr. 11, 49076 Osnabrück  
[hochkirch@biologie.uni-osnabrueck.de]

Die Koexistenz von Arten wird durch verschiedenste Beziehungen bestimmt, so etwa durch Räuber-Beute-Systeme, Kommensalismen oder Konkurrenz. Sexuelle Beziehungen zwischen unterschiedlichen Arten werden meist durch präzygotische Isolationsmechanismen vermieden. Bei Heuschrecken dienen akustische und optische Signale zur Kommunikation und damit als Barrieren für Hybridisierung. In mehreren Ersetzungsexperimenten konnten wir feststellen, dass diese Kommunikationsformen keineswegs so spezifisch sind, wie bislang angenommen. Bei einigen Arten kommt es zur Kreuzung und zur damit verbundenen negativen Heterosis. Bei anderen Arten kommt es trotz fehlender Kreuzung zu negativen Effekten, die durch eine verstärkte Attraktivität heterospezifischer Weibchen und damit vergeudeter Ressourcen der Männchen zustande kommt. Die Folgen sexueller Interferenz können sehr vielschichtig sein. So ist etwa ein starker Selektionsdruck auf Arterkennungssysteme als wichtige Folge anzunehmen, der die Evolution von Arten stark beschleunigen könnte (Sexual Character Displacement). Andererseits wird in vielen Populationen Ausschluss der unterlegenen Art eine wichtige Folge sein. Ab 2004 wird in einem Freilandexperiment die mittelfristige Folge der sexuellen Interferenz analysiert.

### V-S1.4 **Karyotype evolution in *Chromaphyosemion* killifishes (Teleostei: Cyprinodontiformes)**

Harald Kullmann & Martin Völker

Institut für Evolutionsbiologie und Ökologie, An der Immenburg 1–2, 53121 Bonn, Deutschland  
[hkullmann@evolution.uni-bonn.de, mvoelker@evolution.uni-bonn.de]

The monophyletic taxon *Chromaphyosemion* comprises 9 described and several undescribed species, each consisting of a variety of phenotypically distinguishable populations. For more than 30 years, it has been known that there is a huge variability in chromosome number and morphology among species or even populations. Until now, the evolution of different karyotypes and its implication for differentiation and speciation in this group of fishes is unclear. We examine the karyotypes of several populations of all major *Chromaphyosemion* groups with advanced cytogenetic techniques and compare the results with a molecular phylogeny to trace back the evolutionary changes. Comparison of data from cytogenetics, molecular genetics and biogeography and the examination of pre- or postzygotic reproductive isolation between different forms shall help to determine the role of chromosomal evolution for the observed radiation. First results suggest that chromosomal rearrangements might play a role in some, but not in all differentiation processes.

**V-S2.1 What about parthenogenetic radiations?**

Mark Maraun<sup>1</sup>, Michael Heethoff<sup>1</sup>, Katja Schneider<sup>1</sup>, Stefan Scheu<sup>1</sup>, Gerd Weigmann<sup>2</sup>, Jennifer Cianciolo<sup>3</sup>, Richard H. Thomas<sup>4</sup>, Roy A. Norton<sup>5</sup>

<sup>1</sup>Technische Universität Darmstadt, Institut für Zoologie, Schnittspahnstrasse 3, 64287 Darmstadt, Germany [maraun@bio.tu-darmstadt.de]; <sup>2</sup>Freie Universität Berlin, Institut für Bodenzöologie und Ökologie, Grunewaldstrasse 34, 12165 Berlin, Germany; <sup>3</sup>Indiana University, Department of Evolution, Ecology and Behaviour, Bloomington, Indiana 47405, USA; <sup>4</sup>The Natural History Museum London, Department of Zoology, Cromwell Road, SW7 5BD, London, UK; <sup>5</sup>State University of New York, College of Environmental Science and Forestry, Faculty of Environmental and Forest Biology, 1 Forestry Drive, Syracuse NY 13210, USA

Nucleotide sequences of the D3 expansion segment and its flanking regions of the 28S rDNA gene were used to evaluate phylogenetic relationships among representative sexual and asexual oribatid mites (Oribatida, Acariformes). The aim of this study was to investigate the hypothesis that oribatid mites consist of species rich clusters of asexual species that may have radiated while being parthenogenetic. Furthermore, the systematic position of the astigmatid mites (Astigmata, Acariformes) which have been hypothesised to represent a paedomorphic lineage within the oribatid mites, is investigated. This is the first phylogenetic tree for oribatid mites s.l. (incl. Astigmata) based on nucleotide sequences. Intraspecific genetic variation in the D3 region was very low, confirming the hypothesis that this region is a good species marker. Results from neighbour joining (NJ) and maximum parsimony (MP) algorithms indicate that several species rich parthenogenetic groups like Camisiidae, Nanhermanniidae and *Nothrus* are monophyletic, consistent with the hypothesis that some oribatid mite groups diversified despite being parthenogenetic. The MP and maximum likelihood (ML) method indicated that the D3 region is a good tool for elucidating the relationship of oribatid mite species on a small scale (genera, families) but is not reliable for large scale taxonomy because branches from the NJ algorithm collapsed in the MP and ML tree. In all trees calculated by different algorithms the Astigmata clustered within the oribatid mites, as proposed earlier.

**V-S2.2 Radiation of endemic freshwater crabs of the family Parathelphusidae (Brachyura, Crustacea) in the ancient lakes of the Malili region, Sulawesi**  
Tobias Santl & Christoph D. Schubart

Biologie I, University of Regensburg, Regensburg, Germany [tobias.santl@biologie.uni-regensburg.de, christoph.schubart@biologie.uni-regensburg.de]

The Indonesian island of Sulawesi has four large ancient lakes. Three of them, Lake Matano, Lake Mahalona and Lake Towuti, are located in the Malili region and are interconnected by rivers. Until recently, three endemic freshwater crabs of these ancient lakes were known *Parathelphusa matannensis* Schenkel 1902, *P. pantherina* Schenkel, 1902 and *Nautilothelphusa zimmeri* Balss 1933. Our recent collections in the Malili region prompted Chia & Ng (in press) to reappraise the taxonomy of the lacustrine freshwater crabs. Based on morphological data, they described one new genus and two new species, one of the two new species occurring in three different colour-morphs. The aim of this study was to reconstruct phylogenetic relationships of the Malili freshwater crabs with the use of molecular methods. Preliminary work showed that the mitochondrial subunit 16S was not variable enough for distinguishing closely related species and genera, thereby suggesting a recent radiation of the crab fauna. We therefore used the more variable mitochondrial COI gene to sequence up to 956 basepairs of mtDNA. With this dataset we constructed maximum parsimony and neighbour joining trees as well as minimum spanning networks. The obtained trees provide a clear picture of the radiation of the Malili freshwater crabs and support the taxonomy of Chia and Ng. They also indicate the existence of an additional undescribed species in the Malili lake system.

**P-1 Genes and individuals, populations and species. The reasons why species concepts are necessarily contradictory: Is taxonomy incommensurable with evolution?**

Werner Kunz

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The crux of taxonomy (and particularly the species problem) is that we are compelled to construct and use categories of organisms, and we are compelled to understand biological diversity, and these two motives are frequently incommensurable. While bearing the knowledge that real species are not distinct and not countable, taxonomists are steadily reporting new species that they suppose are really out there. It is this conflict that supports misguided behaviors with respect of understanding the species problem.

It is not possible to find any general rule how to identify actual species in nature. Gene trees are not species trees. An apomorphic character usually results from the polygenic expression of both apomorphic and plesiomorphic genes. Placing of particular isolates in one or other species often depends on which gene one uses in classification.

Are dogs one species or many species? Dog diversity fulfills several (if not every) species criteria. They can be described in terms of diagnostically reproducible kinds of organisms, which have their own distinct genealogy and can not join in sexual reproduction. The dog species question is not an easy one to answer.

The persistent lack of agreement on species boundaries results from the fact that species have a history that includes the formation of varieties as arising by the same process that gives rise to species. The irony is that taxonomists firmly reject the essentialist view of Linnaeus that each species represents a nonevolving essential type, distinct from other types, but at the same time they handle species as largely distinct. There is a lack of progress on this problem. Our behavior over taxons is irrational. The debates continue, but they have a disheartening repetitive aspect.

# HT II Signals and Cell Differentiation in Tissue and Organ Development

**Detlev Arendt**

Academic CV starts with PhD 1998 at the University of Freiburg, Germany, followed by postdoctoral training funded by a EMBO Long Term Fellowship. Since 2002 Team Leader at the EMBL, Heidelberg. Research covers evolution and development of the nervous system. Special field is the polychaete photoneuroendocrine complex in relation to the evolution of eyes in Bilateria by use of a broad “Evo-Devo” approach. Ontogenetic development and patterns of gene expression are used as marker for evolutionary processes.

**PV Evolution of photoneurosecretory cell types in bilaterian brains – a comparative study of eye and brain development in *Platynereis dumerilii* (Polychaeta)**

Detlev Arendt

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We investigate brain and eye development at trochophora larval stages in the ragworm *Platynereis dumerilii* (Polychaeta, Annelida, Lophotrochozoa) to detect similarities and differences with insects and vertebrates, and to learn from this about the evolution of photosensitive-neuroendocrine systems in the Bilateria. Morphological and molecular approaches are combined in a novel Evo-devo approach, the molecular comparison of cell types (“comparative molecular cell biology”). For example, we find that ciliary photoreceptor cells detected in the *Platynereis* brain, and the ciliary photoreceptor cells of the vertebrate retina, the rods and cones, share a conserved molecular fingerprint – expressing orthologous transcription factors for their specification as well as a conserved, orthologous subtype of the opsin photopigment. Also, the rhabdomeric photoreceptor cells of the *Platynereis* eyes molecularly more closely resemble the ganglion cells of the vertebrate retina. We thus unravel homologies of cell types across Bilateria that help reconstructing the evolution of eyes and brains in Bilateria.

**Jochen Wittbrodt**

PhD 1991 University of Munich, Postdoc Biocenter, University of Basel, Switzerland; Junior Group Leader at the Max Planck Institute for Biophysical Chemistry, Göttingen; EMBL (Developmental Biology Program, European Molecular Biology Laboratory Heidelberg) since 1998. Early development of the brain and the eyes in vertebrates, by using the fish genus *Medaka*, which provides a wealth of suitable mutants, as a model.

**HV Mutants, molecules, mechanisms – control of proliferation and differentiation in the vertebrate retina**

Jochen Wittbrodt

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**V-S1.1 The molecular decision of sexual fate by complementary alleles in the honey bee**

Tanja Gempe & Martin Beye

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Molecular decision making is a general problem in developmental biology. The initial signal of sex-determining in the honey bee is provided by the complementary sex determiner (*csd*) gene at the beginning of the sex-determining cascade. Males are derived from unfertilized eggs that are hemizygous at *csd*, while females develop from fertilized eggs that are heterozygous at *csd*. Diploid males occur from fertilized eggs when *csd* is homozygous, however, they are non-reproductive. Up to 19 alleles are found to segregate in populations leading to a low proportion of diploid males in natural populations. In previous studies we have identified *csd* by positional cloning approach. Different alleles have been isolated that show major differences in the nucleotide sequence. Totally unknown, however, is how the highly polymorphic signal is transferred into the binary switch of male and female development. To test whether the proposed protein binding function of different alleles is required to promote female development we have done in vitro interaction assays. Different allelic CSD proteins that have S or HSV tags in either combination were obtained from insect cell culture and baculovirus systems. Proteins were combined in different allelic combinations. The allelic protein interactions were then monitored by a cell lysate based pull-down assay. These results have major implications to understand how the molecular decision is made based on multiple sex-determining alleles. Molecular models will be presented that should help to further elucidate the underlying molecular mechanism.

**V-S1.2 Myoblast determination in the visceral mesoderm of *Drosophila* depends on *milliways/Alk* as receptor for *Jeb* signalling**

Christiana Stute<sup>1</sup>, Kristina Schimmelpfeng<sup>2/3</sup>, Renate Renkawitz-Pohl<sup>1</sup>, Ruth H. Palmer<sup>4</sup> & Anne Holz<sup>5</sup>

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The visceral muscles of the *Drosophila* midgut consist of syncytia and arise by fusion of founder and fusion competent myoblasts. A prerequisite for muscle fusion is the establishment of myoblast diversity in the mesoderm prior to the fusion process itself. We identified two independent mutations causing loss of visceral midgut muscles. In both of these mutants visceral muscle founder cells are missing and the visceral mesoderm consists of fusion competent myoblasts only. Thus, no fusion occurs resulting in a complete disruption of visceral myogenesis. Subsequent characterisation of the mutations revealed that they are novel alleles of *jelly belly* (*jeb*) and the *Drosophila* Alk homologue named *milliways* (*mili/Alk*). We show that the process of founder cell determination in the visceral mesoderm depends on *Jeb* signalling via the *Milliways/Alk* receptor. Moreover, we demonstrate that in the somatic mesoderm determination of the opposite cell type, the fusion competent myoblasts, also depends on *Jeb* and *Alk*, revealing different roles for *Jeb* signalling in specifying myoblast diversity. This mechanism uncovers a crosstalk between somatic and visceral mesoderm leading not only to the determination of different cell types but also maintains the separation of mesodermal tissues, the somatic and splanchnic mesoderm.

### V-S1.3 Evidence for acetylcholinesterase as moonlighting protein during grasshopper development

Mario Naujock & Gerd Bicker

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We examined the cellular expression of acetylcholinesterase (AChE) in the nervous system and in epidermal body structures during the complete embryonic development of the locust. The histochemical labelling was blocked by the enzyme inhibitors eserine and BW284c51, but not by iso-OMPA, showing that the staining reflects true AChE activity. The majority of the staining was localized on the cell surface, but in many cell bodies granular intracellular staining was also visible. Initially, mainly epidermal tissue structures are stained on the various body appendages. Then, the labelling appeared in outgrowing neurons of the central nervous system and in the nerves innervating the limbs and dorsal body wall. The latter staining was transient and originated in motoneurons of the ventral nerve cord. In a third phase, the somata of certain identified mechanosensory neurons start to express AChE activity, reflecting presumably cholinergic differentiation. Primary cultures of the ventral nerve cord at different stages revealed an increase of up to 83% AChE-positive somata at the end of embryogenesis. The histochemical study shows a developmental appearance of AChE in the CNS that largely precedes synaptogenesis suggesting other developmental functions.

Research on morphogenetic properties of vertebrate AChE has taken advantage of peptides, that have been isolated from snake venom and that bind to the peripheral anionic site of AChE. We are currently using the ligand fasciculin I to investigate effects on neurite outgrowth in cultured grasshopper neurons. A reduction in neurite growth and branching indicates that AChE is also involved in morphogenetic interactions during the development of an insect nervous system.

### V-S1.4 Origin and growth of germ cells in nereids (Annelida: Polychaeta)

Nicole Rebscher, Javier Garcia & Fabiola Zelada

Universität Heidelberg, Institut für Zoologie

In nereid polychaetes the oocytes develop freely floating in the coelomic cavity. Little is known about their origin due to a lack of suitable molecular markers. We have cloned a *Platynereis dumerilii* orthologue of the RNA helicase *vasa*, a marker of germ cells found throughout the animal kingdom. *In situ* hybridizations showed that *vasa* mRNA is ubiquitously expressed in oocytes and cleavage stages. During larval development, a progressive localisation to the posterior growth zone occurs. In juvenile worms, *vasa* is expressed in groups of large, round cells in most body segments. We propose that these cells represent the migrating primordial germ cells. We also found clusters of putative oogonia in histological sections of young females. These clusters will later enter the coelomic cavity where they break apart once the oocytes enter prophase of meiosis I. Oocytes grow freely floating by uptake of nutrients such as the yolk protein precursor vitellogenin. We study the endocrine regulation of this process in the large polychaete *Nereis virens*. We cloned a fragment of the estradiol receptor from eleocytes, specialised somatic cells known to secrete vitellogenin. Induction of vitellogenin synthesis is under the control of 17 $\beta$ -estradiol in many vertebrate and invertebrate species. We suggest that steroids might also be involved in the regulation of *vitellogenin* expression in nereid polychaetes.

Acknowledgments: F. Zelada is supported by a grant of the DFG, J. Garcia by a DAAD Fellowship

**V-S2.1 Ontogeny of the caudal skeleton in the ostariophysian fishes *Kneria* sp. (Teleostei: Gonorynchiformes) and *Candidia barbatus* (Teleostei: Cypriniformes) with comments on the homology of the pleurostyle within the Otocephala**

Peter Bernstein & Christine Ruf

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Fishes in the major teleostean lineage Ostariophysii are well known for possessing a unique specialisation of the ear in form of the Weberian apparatus. However, this character complex is only well developed in the subgroup Otophysi, comprising the cyprinids, characins, South American knifefishes and catfishes. The other subgroup, the Anotophysii, lack otical specialisations, whereas in the sistergroup of the Ostariophysii, the Clupeomorpha, a specialised ear has evolved in a different way. Here we use another character complex to investigate the interrelationships within the Otocephala (Clupeomorpha + Ostariophysii) and present data on the ontogeny of the caudal skeleton in the genus *Kneria* (Anotophysii: Gonorynchiformes) and in the genus *Candidia* (Otophysi: Cypriniformes).

In both genera a direct ossification of the pleurostyle without any cartilaginous precursor takes place though very early the pleurostyle gets into contact with the cartilaginous precursor of one of the posterior neural arches.

In comparison to the conditions within the Clupeomorpha the location and the way of ossification indicate an evolutionary tendency towards an advanced reduction of the cartilaginous precursors of the uroneurals and the pleurostyle. These results together with other observations of the composition of the compound centrum confirm the more derived condition of the caudal skeleton in the Ostariophysii than in the Clupeomorpha.

**V-S2.2 Thymosin beta4 in the development of heart and blood vessels**

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Beta Thymosins are the major G-actin sequestering proteins of the cell. This highly conserved small molecules play an important role in angiogenesis, cell motility and tumorigenesis. In the genome of many vertebrate species at least two thymosin beta genes are described, which are differentially expressed within different cell types and tissues. Thymosin beta4 is known as anti-inflammatory agent and can reduce inflammation in wound healing assays.

We cloned the chick homologue of *Homo sapiens* thymosin beta in order to analyse its role during embryonic development of the chick model organism. Thymosin beta4 is known as anti-inflammatory agent and can reduce inflammation in wound healing assays. The observed expression pattern of thymosin beta4 in chick embryos indicates a function mainly in development of the blood circulatory system which closely parallels findings in vitro. Important new aspects are the early onset of expression, the expression in the mesoderm preceding heart formation.



**V-S2.3 Analysis of the innate immune system in the nematode*****Caenorhabditis elegans***

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Simple model organisms that are amenable to comprehensive experimental analysis can be used to elucidate the molecular genetic architecture of complex traits. They can thereby enhance our understanding of these traits in other organisms, including humans. Here, we describe the use of the nematode *Caenorhabditis elegans* as a tractable model system to study innate immunity. For this, we focus on two main approaches: i) functional analysis of putative immunity genes using available mutants and gene silencing through RNA interference in the main *C. elegans* strain N2, and ii) analysis of natural variation in immunity among different *C. elegans* strains including an examination of gene expression patterns. Our current data reveal an unexpected diversity of functions for the insulin-like receptor pathway, which has gained high popularity for its role in worm longevity. We also find significant variation in the response of the natural *C. elegans* strains towards different pathogen species, the Gram-negative bacterium *Serratia marcescens* and the Gram-positive bacterium *Bacillus thuringiensis*. Taken together, our results highlight that the *C. elegans* immune system is surprisingly complex.

**V-S2.4 900 MHz electromagnetic fields do not affect the spontaneous development of lymphoma in female AKR/J mice**

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Several reports indicate that non-thermal electromagnetic radiation, such as that from mobile phones and base stations, may be carcinogenic. To investigate this possibility experimentally, the influence of life-long electromagnetic field exposure on lymphoma induction was determined in a mouse strain that is genetically predisposed to this disease. The AKR/J mice genome carries the AK-virus, which leads to spontaneous development of thymic lymphoblastic lymphoma within one year.

Unrestrained female mice were sham-exposed or exposed (total = 160 animals per group) by use of a radial waveguide setup to a typical mobile phone 900 MHz electromagnetic field according to the GSM standard for 24 hours per day, 7 days per week. Animals were visually checked daily for signs of a developing disease and were weighed and palpated weekly to detect swollen lymph nodes. Starting at the age of 6 months, blood samples were taken monthly from the tail to perform differential leucocyte counts. Animals with signs of disease or with an age of about 42 weeks were sacrificed and a gross necropsy was performed. There was no effect of electromagnetic field exposure at average whole body SAR values of 0.4 W/Kg on body weight gain or survival rate, and lymphoma incidence did not differ between exposed and sham-exposed animals. Therefore, these data do not support the hypothesis that exposure to 900 MHz electromagnetic fields is a significant risk factor for developing lymphoma.



# HT III Sensory Systems: Biological Mechanisms and Technical Applications

**Helmut Schmitz**

PhD 1991, Habilitation 2001 zoology. Privatdozent Institut für Zoologie, Universität Bonn.

## **HV1.1 Infrared sensory systems in pyrophilous beetles: evolutionary and bionic aspects**

**Helmut Schmitz**

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Some few buprestid beetles are attracted by forest fires. In the palaeartic region, about a dozen species of the genus *Melanophila* approach ongoing fires. In Australia *Merimna atrata* shows the same pyrophilous behaviour. The reason for this behaviour is that the larvae of the pyrophilous buprestid beetles can only develop in freshly burnt wood. Therefore, beetles of both sexes invade a burnt area after the running fire has raged over the vegetation. After mating, the females deposit the eggs under the bark of the burnt trees. Because the reproduction obligatorily depends on forest fires, a strong evolutionary pressure has acted upon the sensory systems enabling a beetle to find a fire and to cope with the extreme thermal environment on a burnt area. This pressure has caused the development of infrared (IR) receptors in *Melanophila* species and in *M. atrata*. In *M. atrata* one to three pairs of IR receptors can be found on the abdominal sternites. The outer IR absorbing area of each receptor is innervated by a large multipolar thermoreceptor. Therefore, the receptors can be classified as microbolometers. In *Melanophila*, one pair of thoracic IR organs can be found. In each organ, 70 IR sensilla are situated. A sensillum consists of an internal cuticular sphere which is innervated by a ciliary mechanoreceptor. Absorption of IR radiation causes the expansion of the sphere which stimulates the mechanoreceptor (photomechanic mechanism). The photomechanic principle of IR detection was used to build an uncooled IR sensor. The fundamental differences between the IR organs of *Melanophila* beetles and *M. atrata* strongly suggest an independent evolution.

## **Eric Warrant**

Born and raised in Australia, I studied the odd but fascinating combination of physics and entomology at the University of New South Wales in Sydney, receiving an Honours degree in Physics in 1985. I completed my PhD on the optics of arthropod superposition eyes in 1990 at the Australian National University in Canberra. Following an invitation from Dan-Eric Nilsson, I moved to Lund in 1990 to continue my studies on the ecology of vision. I was appointed Docent in Functional Morphology in 1995, and was elected Schering Fellow for 1997–98 at the Institute for Advanced Studies in Berlin. Together with Dan-Eric Nilsson, Almut Kelber, Ronald Kröger, and a wonderful collection of enthusiastic students I have the privilege of exploring my major research topics – strategies for vision in dim light, and the design and evolution of eyes – in an atmosphere of happiness and excellence.

If I were to summarise my feelings for our research, and the animals that we study, I couldn't do better than Hugh Cott, who so splendidly expressed it in the preface of his 1940 classic *Adaptive Colouration in Animals*: “All men, provided they are not too ignorant, too proud, or too sophisticated, are bound to take a delight in animal life; and fortunate are those who have learned to see, in the wild things of nature, something to be loved, something to be wondered at, something to be revered, for they will have found the key to a never-failing source of recreation and refreshment.”

### **HV1.2 The remarkable visual abilities of nocturnal insects**

Eric Warrant

Department of Cell & Organism Biology, University of Lund, Sweden

It is well known that insects active in bright daylight use several visual cues for navigation and orientation, including landmarks and celestial cues. Our recent work on nocturnal dung beetles and bees has shown that these visual cues are even used in very dim light. These animals have remarkable navigational abilities, despite the fact that their small eyes and visual systems are operating at the physical limits of sensitivity. In my talk I described this impressive visual performance in the light of our recent behavioural, physiological, histological and theoretical investigations.

**Anne-Kathrin Warzecha**

Diploma 1991, PhD 1994, postdoc 1995–2002, habilitation 2000, VW-Nachwuchsgruppenfellowship, PD 2003, all: chair for neurobiology university Bielefeld. Research: On the reliability of encoding visual motion information.

**HV1.3 On the reliability of encoding visual motion information**

Anne-Kathrin Warzecha

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Changes in the activity of sensory neurons carry information about the stimulus an animal is confronted with. However, neuronal activity changes may also arise from noise sources within or outside the nervous system. The variability and precision of encoding visual motion information will be presented using the fly as a model system. The findings will be compared to those obtained in other animal species. The contribution of cellular computations as well as potential noise sources such as photon noise and synaptic variability to the variability of neuronal responses will be presented. It will be shown that several constraints determine and limit the reliability of encoding of visual motion information: (i) biophysical mechanisms underlying the generation of action potentials, (ii) the computations performed in the motion vision pathway, and (iii) the dynamical properties of the stimuli an animal encounters when moving around in its natural environment. It will be discussed on what timescale behaviourally relevant information may be encoded.

## **Harald Luksch**

Diploma 1990 University of Bonn, PhD 1994 University of Cologne, Postdoc 1994–96 Institut für Hirnforschung Universität Bremen and University of California San Diego. Since 1996

Institut für Biologie II, RWTH Aachen, Chair Zoologie/Tierphysiologie. Habilitation 2002, zoology. Research: Cellular mechanisms for motion detection in the avian midbrain.

### **HV2.1 Cellular Mechanisms for Motion Detection in the Avian Midbrain**

Harald Luksch

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To survive, animals need to monitor their environment closely to detect potentially harmful objects as early as possible. For the visual system, this poses a computational problem. A high resolution of the retina generates a high information load; a lower resolution however might not be capable of detecting important stimuli, i.e., an approaching predator. Many organisms solve that problem by regional specializations of their retina. The detailed analysis of a visual signal is often accomplished by a fovea, while the retinal periphery performs a ‘quick and dirty’ survey to extract crucial information, for example object motion.

I have investigated cellular mechanisms in the avian midbrain to delineate the computations involved in motion detection. A specific cell type in the stratum griseum centrale has large dendritic fields that cover approx. 30 degrees of visual angle and receive monosynaptic input from small retinal ganglion cells onto characteristic distal dendritic specializations. In vivo, these neurons are sensitive to a variety of moving but not to static stationary stimuli. Experiments performed in a brain slice preparation with electrical stimulation revealed phasic signal transfer at the retino-tectal synapse and binary dendritic responses to synaptic inputs that interact in a mutually exclusive manner. A model of the tectal circuitry predicts that the two observed cellular properties mediate sensitivity to a wide range of dynamic spatiotemporal stimuli, including moving stimuli, but not to static stationary stimuli in a tectal neuron. Interestingly, the cells also respond to second-order motion, indicating that form-cue invariant computation of dynamic spatiotemporal stimuli is initiated by tectal neurons.

## **Henrik Mouritsen**

Ph.D. 1998; Research assistant at Centre for Sound Communication at Odense University 1998; visiting scientist at Department of Psychology, Queen's University, Canada 1999–2001; Leader of the Nachwuchsgruppe “Animal Navigation” financed by the Volkswagen Stiftung since 2002. My Nachwuchsgruppe intends to use mathematical modelling, physics, quantum chemistry, molecular biology, neurobiology, computer simulations and newly developed laboratory equipment in combination with behavioral experiments and analyses of field data to achieve a better understanding of the behavioral and physiological mechanisms of long distance navigation in insects and birds.

### **HV2.2 Visual perception of the Earth's magnetic field – The secret behind the magnetic compass of birds?**

Henrik Mouritsen

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The physiological mechanisms enabling migratory birds to sense the earth's magnetic field have long remained a mystery. Recently, behavioural data and theoretical considerations have suggested that migratory birds can sense the compass direction of the earth's magnetic field through radical-pair processes in differently oriented, light sensitive molecules of the retina and thus perceive the magnetic field as visual patterns. Here I will present physiological and molecular evidence recently obtained from Garden Warbler retinae supporting the idea that birds “see” the geomagnetic field.

## **Christine Köppl**

Diploma 1985, PhD 1989. Habilitation 1997, Heisenberg fellowship 1998–2003, scientist at the Institute of Zoology at TU München since 2003. Research covers auditory processing mechanisms in birds, currently dealing with fine structure and function (sum-potentials and single cell responses) of the inner ear of the barn owl (*Tyto alba*).

### **HV2.3 Auditory processing mechanisms in birds** Christine Köppl

Zoologie, TU München, Lichtenbergstr. 4, 85747 Garching, Deutschland  
[Christine.Koeppel@bio.tum.de]

This talk will discuss two aspects of auditory processing that can provide valuable insights for technical applications: cochlear amplification and neural mechanisms of sound localization.

1) The sensory cells of the vertebrate inner ear, the hair cells, are not only mechanoreceptors, but can themselves feed mechanical energy into a positive feedback loop that enhances both sensitivity and frequency selectivity. One of the most admirable features of this “cochlear amplifier” is that it works stably. Technical acoustic amplifiers operating at high gain commonly battle feedback problems, also known as “whistling”. How does the cochlear amplifier avoid these problems?

The most sophisticated cochlear amplification systems are seen in the inner ears of birds and mammals. Interestingly, they have convergently evolved a division of labour between hair cells specializing in mechanical feedback and hair cells transmitting the resulting stimulus to the brain. Current knowledge about how the amplification process works in both cases will be reviewed.

2) Sound localization is a computational problem that has to be solved by the central auditory system because the receptor organ contains no map-like representation of stimulus location. Humans and other animals rely on subtle differences between the sound arriving at the two ears to reconstruct its spatial origin. Interaural differences occur both in the time of arrival and the intensity of the sound, abbreviated as ITD and IID. The barn owl is an animal model that has contributed much to our understanding of the neural mechanisms of ITD processing. Technical implementations of the principles learned from its neural circuits are currently being realised.



## Stefan Schütz

Diplomas in biology and chemistry, PhD 1991 chemistry, Habilitation: 2000. Professor 2001, Institut für Forstzoologie und Waldschutz, Universität Göttingen. Elektroantennography (EAG) is developed as a suitable method to measure olfactory reactions of an insect by registration of electric signals from its antennas, which are provided with different types of sensory organs with selective responses on different substances. This is used to analyse complex scents, as exemplified by the antenna of the Colorado Potato Beetle (*Leptinotarsa decemlineata*).

### HV2.4 Insect antennae: Peripheral olfactory processing mechanisms and technical applications as a biosensor

Stefan Schütz

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Insect antennae are morphologically and physiologically highly specialised organs for odour perception. Their sensitivity, selectivity, and response time cannot be matched by any technical method of trace analysis. Utilisation of these unique abilities of insects for trace analytical purposes demands a thorough adaptation of technical devices to the special needs of insect antennae. Yet approaches using electroantennogram (EAG) techniques are highly sophisticated, however, insect antennae have to be damaged limiting lifetime of the preparations. Using a field effect transistor directly coupled to an undamaged insect antenna proved to solve some of the problems. Moreover, detailed examination of sensitivity and cross-reactivity of antennal responses to binary mixtures of odours yields an improved knowledge about peripheral signal processing. Therefore practical applications of biosensors on the basis of intact insect antennae as a sensitive odour detecting and recognizing device become more feasible. Besides sex pheromones, insect antennae are able to detect a broad range of odours specific to their habitat. The Colorado beetle (*Leptinotarsa decemlineata*) shows a high sensitivity to infestation and infection induced volatiles released by potato plants, the Steelblue jewel beetle (*Phaenops cyanea*) detects volatiles released by water-stressed pine trees, and the Black jewel beetle (*Melanophila acuminata*) as well as the Australian pyrophilic beetle *Merimna atrata* shows a very high sensitivity to wood-fire specific volatiles. First practical applications of the biosensor in plant protection and stored food protection will be presented and further possible applications in forest protection and fire early warning will be discussed.

## **Guenter W. Gross**

PhD Florida State University, Postdoc MPI Psychiatrie München 1974–1976, Guest professor, University of Rostock, Germany. Editorial Board of Neural Networks.

Professor for neurobiology at the Univ. North Texas, Denton. Investigations have focused on exploration of basic mechanisms and strategies underlying the phenomena of pattern generation, recognition, storage, and fault tolerance in neuronal ensembles. Most investigations use long-term multichannel monitoring of action potential (spike) traffic in spontaneously active networks. Our basic experimental strategy is to seed dissociated cells from specific embryonic neural tissues onto beds of substrate integrated, photoetched microelectrodes. Application of spontaneously active networks to the fields of neurotoxicology, drug development, and biosensors are in progress. These experimental platforms are well suited for the rapid screening of compounds and allow the evaluation of physiological effects through changes in the spontaneous activity patterns.

### **HV2.5      Neuronal networks on microelectrode arrays: applications to toxicology and biosensors**

**Guenter W. Gross**

Center for Network Neuroscience, Dept. of Biological Sciences, University of North Texas, Denton TX, USA

Nerve cell groups growing in culture on microelectrode arrays allow long-term, multisite monitoring of spontaneous action potential (spike) activity. These ensembles generate complex spatio-temporal spike patterns and constitute dynamical systems that provide effective platforms for observations of the “internal dynamics” of networks. Such cell groups are pharmacologically histiotypic, as they mimic the responses of parent tissue in the animal. The networks show changes in their native activity in response to compounds that alter the normal function of the nervous system. These systems are ready for applications to the domains of neurobiology, neurotoxicology, drug development, and tissue-based biosensors. In each domain, the readout is represented by changes in spike production and spatio-temporal patterns relative to the native activity. This internal control allows utilization of different cultures that do not have identical initial activity. Especially burst patterns and quantifiable variables such as burst rate, duration, period, and integrated amplitude provide a wealth of information on changes in the network dynamics and on the neuronal mechanisms affected. Such model systems allow quantitative acute and chronic neurotoxicological studies, and rapid evaluation of compound efficacy, secondary binding, and general neurophysiological effects. Their use as rapid screening platforms in the void between biochemistry and animal experiments is assured when robotic, multinet network platforms become available.

### V-S1.1 **The infrared organ of the Australian “little ash beetle” *Acanthocnemus nigricans*: morphology of the specialised sensilla**

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The Australian beetle *Acanthocnemus nigricans* (Coleoptera, Acanthocnemidae) approaches forest fires. The reason for this pyrophilous behaviour might be that larval development depends on freshly burned wood.

*A. nigricans* has a pair of infrared organs on the ventrolateral sides of its prothorax just anterior to the coxae of the legs. The main component of an IR organ is a cuticular “sensory disc” with a diameter of about 150 µm which is situated over an air-filled cavity. About 70 cuticular sensilla were found mainly on the outer surface of the disc.

The cone shaped cuticular peg of a sensillum is 1–3 µm long and about 2 µm in diameter. The peg has no pores and is surrounded by a cuticular wall. The single sensory cell of the sensillum shows some similarities to the “bauplan” of a mechanoreceptive sensory cell of a trichoid sensillum. However, three specialisations can be found: (i) The dendritic outer segment is enveloped by a pronounced electron-dense structure, which most likely represents the hypertrophied dendritic sheath. (ii) The membranes of the dendritic inner segment and the soma show distinct infoldings which contain a high amount of mitochondria. These structures show interesting analogies to the dendritic endings of the thermoreceptive sensory cells innervating IR receptors in snakes and in other pyrophilous beetles. (iii) No tubular body can be found.

As this specialised new type of insect sensillum is the only sensory system within the disc, it can be hypothesised that it is responsible for the response of the organ to infrared radiation and may act as a thermoreceptor. Further examinations will have to test this hypothesis.

### V-S1.2 **Chemoreception of secondary metabolites by the rhinophore of *Aplysia punctata***

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Sea slugs of the genus *Aplysia* have been intensively investigated with respect to behavioral and neurobiological studies. Until now very few studies, however, have focused on the olfactory or chemosensory system of *Aplysia*. In general, processing of secondary metabolites by chemosensory systems in marine organisms has not been deeply investigated. Many marine organisms produce secondary metabolites for defence, deterrence and as hunting toxins or pheromones. Sea slugs as well as other marine animals have to rely on chemosensory information from their aquatic environment because the visual sense usually plays a minor role for orientation in shallow muddy waters or the deep sea. Acoustic and mechanosensory senses give only limited information, especially about food quality. Using calcium imaging methods (Fura II ester loading) we tested whether pyrrole alkaloids of *Agelas* sponges, which have been described as feeding deterrents, are sensed by chemoreceptors of the rhinophore of *Aplysia punctata*. We also investigated the functional anatomy of *Aplysia* rhinophores with immunofluorescent techniques. An Antibody to 5-HT, propidium iodide, phalloidin and DiI were used to label neuronal and non-neuronal structures in the rhinophores visualized by laser-scanning confocal microscopy. Serotonergic fibres were present in the tentacle nerve, in the tentacle ganglion, the glomeruli and in between muscle fibers. The calcium responses indicate that chemosensory neurons in the rhinophores sense brominated pyrrole alkaloids, which are known to be food deterrents. The complexity of the responses in the tentacle ganglion suggests that the tentacle ganglion participates in olfactory information processing.

### **V-S1.3 Sound direction affects auditory frequency resolution**

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Since Helmholtz, it is common knowledge that the sound of a tone depends only on the component frequencies, their phase being irrelevant. Part of sound perception is frequency resolution, i.e. the accuracy of recognizing two neighbouring frequencies as two frequencies rather than a beat. We have tested in humans whether a difference in the phase relation of two frequencies between left and right ears affects frequency resolution in humans. Such phase differences result from tones impinging from different directions.

For 17 individuals, two-frequency-tones were presented through earphones. Start and end of the tones were identical, and frequencies had equal intensities, but the phase of the two frequencies were adjusted for each earpiece as if the two frequencies were presented either both frontally or left and right, respectively. Frequency resolution for these two cases was pairwise compared at 100 Hz, 400 Hz, 1600 Hz, and 6400 Hz.

Interindividual variation was considerable. However, when the equal-direction threshold and the different-direction threshold were compared per person, the sign test showed significantly better frequency resolution for the different-direction-sound at 100 Hz and 400 Hz. At 1600 Hz and 6400 Hz, no such difference occurred. This agrees with expectation if phase plays a role. At 100 Hz and 400 Hz, afferent stimulus encoding is phase coupled, so that phase differences between left and right ear can be encoded. The wavelength of 1400 Hz is 21 cm, i.e. equivalent to the diameter of the head, so that the meaning of phase differences is ambiguous. At 6400 Hz, afferent phase coupling has decayed so that no phase information is given to the CNS.

### **V-S2.1 The Bioluminescence of the Euphausiid Shrimp *Meganctiphanes norvegica* (M. Sars) – what is it good for, and how is it controlled by the nervous system?**

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The bioluminescence of most marine species still hides many secrets. Some is known about the biochemical mechanisms of light production. But our knowledge of the behavioural contexts and the neuronal processing mechanisms which lead to the active emission of light is still poor. We investigate the bioluminescence system of the Euphausiid *Meganctiphanes norvegica*, the Northern Krill, in the laboratory as well as in open waters, to elucidate these dark areas of marine biology and neuroscience.

Two deep sea probes, equipped with photomultipliers, enable us to record the naturally occurring bioluminescence at different times of the year in different depth of the Gullmar fjord, Sweden. Our recordings show several thousand flashes every night. These we can compare with recordings from krill populations swimming freely in large water tanks at Kristineberg Marine Biological Station, Sweden, and examine them for a communication system based on light flashes.

Those freely swimming animals we also investigate with a 3D-video-tracking system to find out more about the relationship of spontaneously occurring light flashes and different swimming movements or trajectories, and interactions between individuals.

The intracellular neuronal answers of the nervous system for flashes, as well as the descending commands which eventually cause the light organs to emit light provide us with a functionally window for observations of the modulatory parts of the unpaired nervous system. Especially the serotonergic part of the nervous system plays a vital role in the mechanisms of light emission control.

## V-S2.2 **Masked thresholds in responses of midbrain neurons of the barn owl** Hermann Wagner, Ali Asadollahi, Frank Endler & Mark von Campenhausen

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The ability to localize a sound in a noisy environment is extremely important for most animals and is essential for the survival of some. The barn owl (*Tyto alba*) is an auditory specialist that hunts during the night by passively localizing sounds emitted by prey. In other words, the barn owl needs to detect acoustic signals against interfering noises. This task is much easier to accomplish by using two ears instead of one ear only. Many psychophysical observations have shown that thresholds for detection of a tone masked by a noise decreases 12–15 dB as the tone (or the masker) is inverted in one ear. This lowering of threshold is known as binaural masking level difference (BMLD).

We have measured masked rate versus level functions (mRLF) in 54 midbrain single and multiunits using acoustic stimulation and standard electrical electrophysiology. The signal was fixed at its best interaural time difference (SBD), while a suprathreshold masker (a noise again at its best interaural time difference (NBD)) was present. The responses obtained in this way were compared with the responses to the same stimulus configuration but the signal inverted in one ear (Spi). A detectability index was used for estimating changes in firing rates. As the signal level was increased, mostly increases in the responses were observed in the NBDSBD configuration, while in the NBDSpi the responses decreased in most cases. BMLDs were negative (up to –31 dB) in about 40% of the cases, positive (up to +25 dB) in also about 40% of the cases, or absent (about 20% the cases). Thus, the barn owl's midbrain contains neural correlates of BMLD.

## V-S2.3 **Recurrency in cortical pyramidal cells compared to a recurrent circuit of identified function in the CNS of crickets**

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The recurrent excitatory couplings of cortical pyramidal cells of layers IV and VI represent core building blocks in vertebrate brains which, in line with cortical activity, shift to effective recurrency and back. We use as suitable experimental system the recurrent lateral inhibitory circuit from the auditory pathway in the CNS of the cricket. The recurrency in this circuit becomes active under modulation by octopamine. Only then the circuit expresses the expected time constant. Only matching amplitude modulation frequencies in the sound signal produce a maximum in lateral inhibition. The experimental system convincingly shows that the recurrency is activated principally by neuromodulation which boosts the efficacy of inputs. The modulator increases transmembrane resistance in neuronal dendrites, thereby drastically decreasing amplitude losses during conduction from subsynaptic site to the spike initiation zone. Our experimental system emphasizes that dynamic activation of a recurrent circuit is required to bring to life the inherent time constant. Hypothetically the oscillations observed in cortex by EEG may be explained as prerequisites of cortical processing using recurrent circuits throughout. We assume that neuromodulation of recurrency is under the command of a prefilter which detects in actual sensory activity a subjectively specific frequency of amplitude modulation. Equipment by DFG Wi 363/15-20

**V-S2.4 Neuronal networks on multi-electrode and sensor arrays: Applications in neurobiology and drug testing**

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We report on current applications of multi-electrode arrays and neurosensor chips to various fields in basic and applied sensory biology. Electrically active neuronal networks from embryonic mouse spinal cord or frontal cortex are cultured on glass/ITO- or silicon-based multi-electrode arrays with stable cell-electrode coupling for several months. This allows the monitoring of the onset of electrical activity, of bursting activity stabilization and of the development of histiotypic native and drug-modified electrical activity patterns. The glass neurochip sensor system (CNNS, Denton TX) was extensively used over the last years to monitor states of toxic or metabolic impairment of neurons accompanied by characteristic electrical activity changes. Network activity is classified and characterized at the level of spike and burst patterns using 38 different activity-describing variables to quantify the effects of neuro-active drugs on network electrical activity states. In order to evaluate if changes in the network activity pattern can be used to monitor and different stages of impairments of consciousness in humans, preparations of blood plasma from healthy subjects and coma patients with hepatic encephalopathy (HE) were added to neuronal networks in order to study their influences on the electrical activity patterns. Besides this study, other applications included studies on the effects on the electrical activity of neurotoxins, ammonia and other putative encephalopathy-causing compounds, neurosteroids, benzodiazepines, anaesthetics and anticonvulsive drugs as well as studies on detecting neuronal side-effects of lead substances. A new standard CMOS silicon chip with unique features has recently been introduced. Besides the recording electrodes for action potentials, oxygen sensors, temperature diodes and ion sensitive field effect transistors (ISFET) were integrated to measure oxygen consumption, temperature and pH changes of the cultures at the silicon chip. Based on our results and experience we conclude that multi-electrode systems provide a platform suitable for pharmaceutical drug development, for high-content drug screening, and for safety pharmacology.

Supported by the DFG Innovationskolleg “Komplexe und Zelluläre Sensorsysteme”, the Landesforschungsschwerpunkt Biosystemtechnik and the European Community (EFRE).

**P-1      50 ways to learn an odour – the potential of parasitoids as chemical biosensors**

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Parasitoids can use a range of host- or plant-derived volatiles during host or food location. One way for them to deal with complex and changing odour environments is to employ associative learning. This allows foraging parasitoids to focus on the most reliable cues. Here I survey if the olfactory discrimination and learning capacities enable parasitoids for use as biosensors. The models used here are the endoparasitic wasp *Microplitis croceipes* (Hymenoptera: Braconidae), which parasitises noctuid larvae that feed on over 110 plant species and the egg parasitoid *Oomyzus galerucivorus* (Hymenoptera: Eulophidae), which parasitises highly polyphagous galerucine leaf beetles.

The wasps' reliability for learning and remembering indicator chemicals was tested using different learning paradigmata and rewards (food, host, host products) during associative learning. It will be outlined how the different behavioural responses of parasitoids can be utilised to employ parasitoids as chemical biosensors. A parasitoid's ability to learn compounds embedded in an odour-mix as well as its ability to discriminate between structurally similar compounds was investigated. Besides training and testing the parasitoids with plant odours pertinent to their biology, also novel odours were applied. This was done to determine the spectrum of the parasitoids' potential use as biosensors in different fields of application. These can range from monitoring infestations in agricultural areas to detecting drugs or explosives.





# HT IV Coastal Seas and Estuaries

## Carsten Reise

Professor, Director of the Research Institute Biol. Anstalt Helgoland, List/Sylt, AWI Bremerhaven. The leading specialist of ecology of the German Wadden Sea and a recognised expert for coastal shallow-water ecosystems in general.

## PV History of a transformed and exploited coastal ecosystem

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The shallow Wadden Sea came into existence only 7500 years ago, with its chain of barrier islands, extensive tidal flats and coastal wetlands. A fundamental regime shift commenced when a continuous dike line separated the land from the sea, almost 1000 years ago. While drained arable land is sinking, sea level continues to rise. This growing imbalance requires an ever increasing effort in coastal defence, associated with an expanding petrification of shorelines. Nearshore habitats become squeezed, and mud flats change into sand flats, with a concomitant cascade of ecological consequences.

The conversion of shallow estuaries into deep shipping canals further enhances tidal ranges, current velocities and sediment disturbances. While pristine estuaries had a high material retention and filtering capacity, nitrogen surplus from the land is now flushed right into the sea. This enhances algal production. Introduced species enrich local communities but also cause an advancing sameness among coastal biota worldwide.

Hunting and fishing removed large consumers from the food web, such as gray whales, sturgeon, salmon, haddock and rays. Pelicans and flamingoes disappeared early, but the worst for coastal birds was the 19th century. Since then protection measures have resulted in a partial recovery, while this is not the case with fish and oysters. Present exploitation is on mussels and shrimp. Not only the food web became simplified but the spectrum of exploitable living resources as well. There is a large potential for restoration measures in terms of habitats as well as of lost species.

## **Matthias Strasser**

Research and teaching at the AWI Bremerhaven. Coastal seas and estuaries. Population Dynamics, Ecological Winter Effects, Pre- and Post-Settlement Processes. Pelago-benthic studies to understand the population dynamics of coastal marine invertebrates.

### **PV Marine invertebrate dynamics: Combining pelagic and benthic studies** Matthias Strasser

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Global change, sea level rise, invasive species, human exploitation and coastal protection measures increasingly change and threaten the coastal ecosystems. Therefore, densely populated coastal areas need to be managed to ensure ecosystem health and functionality, and this requires sound knowledge about the natural variability of coastal organisms on adequate spatial and temporal scales.

The life cycle of most marine invertebrates such as molluscs, polychaetes, or crustaceans includes a pelagic larval stage and a benthic adult phase. A comprehensive understanding of the population dynamics of these organisms requires combined studies of both stages. However, larvae drift along as 'planktonic clouds' that are subject to tidal and wind induced currents, and the benthic stages are frequently patchily distributed in soft bottoms, assembled by factors such as predation, migration, or passive transport. Therefore, precise and adequately scaled assessments of larval and benthic stages are by no means an easy task.

We challenge these difficulties by a long term study strategy that combines i) high frequency larval sampling with ii) large scale benthic mapping, and iii) manipulative field experiments to test specific ecological hypothesis. This includes explorations of different sampling strategies for the pelagic and benthic stages to describe the natural population variability and the population development of recent invasive species. In the long run, we intend to model scenarios for ecosystem changes following different options of human ecosystem interference.

**V-S1.1 Persistence of rafting populations of the marine isopod *Idotea metallica***

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The marine isopod *Idotea metallica* inhabits objects floating at the sea surface. This association leads to an efficient passive dispersal with surface currents. *Idotea metallica* persists on rafts that are often spatially isolated for longer time periods as small local populations. Consequently, population persistence is a pre-condition for large scale dispersal of this oceanic species. Rafts can be either biotic (mainly floating macroalgae) or abiotic (e.g. remains of fishing nets or plastic bags) in nature. The two kinds of substrata provide different qualitative food conditions for inhabiting animals. While macroalgal rafts represent a valuable plant food *I. metallica* can feed only on other rafters or on the zooplankton from the surrounding water when associated with abiotic substrata. In laboratory experiments the probability of population persistence was investigated under the influence of two qualitatively different food regimes. Population growth rate was lower and the population density varied stronger in the absence of plant food than under mixed food conditions (animal + plant food) increasing the stochastic risk of population extinction for *I. metallica* on abiotic rafts. Macroalgal rafts, however, are easily destroyed by the feeding activity of associated animals. Compared to the rather coastally distributed *Idotea baltica*, *I. metallica* feeds only little on macroalgae reducing the rate of habitat destruction. In summary, population persistence in *I. metallica* is a compromise between an important uptake of additional plant food and reduced destruction of algal rafts.

**V-S1.2 Adaptation by different quantitative food limitations to life on biotic vs. abiotic floating objects: a case study in *Idotea* species (Isopoda)**

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The two isopod species *Idotea baltica* and *Idotea metallica* inhabit objects floating at the sea surface. *Idotea baltica* is abundant in coastal waters where floating macroalgae represent the most frequent epipelagic substrates. *Idotea metallica*, in contrast, is often found far offshore where the species inhabits persistent abiotic objects such as remains of fishing nets or buoys. These two categories of rafts provide fundamentally different qualitative and quantitative food supply for associated rafters. While macroalgae represent a valuable source of food for herbivorous organisms, abiotic objects have no nutritional value. Here rafters can only feed on other associated organisms or on the plankton from surrounding waters. Due to the patchy distribution of plankton in the oceans, animals on abiotic rafts have to cope with extended phases of food limitation. Consequently it must be expected that *I. metallica* is better adapted to starvation than *I. baltica*. In laboratory experiments individually reared animals of both species were exposed to different quantitative food conditions. Life history traits such as age-dependent mortality, age at reproduction, fertility, and growth were recorded over the entire life span of the animals. Population growth rates were calculated as an estimate of the species' fitness. *I. metallica* proved to be less affected by food limitation and thus better adapted to live on abiotic objects than *I. baltica*. This might have significant impact on the outcome of the competitive interaction between the two species. While *I. baltica* is the superior competitor on floating macroalgae where food is available in access, this situation likely turns into the opposite on artificial rafts where food is limited.

### **V-S1.3 Decomposition in coastal areas**

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Coastal areas serve as fascinating fields for studying ecological processes and interactions, since both marine and terrestrial organisms are involved in such processes and interactions. Among those processes that provide a direct marine-terrestrial link, decomposition of plant detritus is one of the most obvious and best studied.

In intertidal salt marshes with detritus of almost solely terrestrial plants (angiosperms) being colonized and fed on by aquatic (during high tide), semi-terrestrial and terrestrial (during low tide) detritivores, we examined the functional diversity of detritivores belonging to different taxonomic groups (Gastropoda, Decapoda, Isopoda) and revealed strong evidence for species-specific contributions of different detritivores. Intra-guild predation of an omnivorous crab results in complex interactions within the functional group of macrodecomposers.

On sand, pebble or cobble beaches with an extensive wrack line of stranded detritus of marine origin (macroalgae and some angiosperms) that is colonized by, and degraded through the action of, terrestrial and semi-terrestrial detritivores, beach fleas and sand hoppers (Amphipoda) belong to the most abundant colonizers of stranded seaweeds in the wrack line. Along with microbial degraders, they consume hundreds of grams of wrack per day: wrack does not accumulate, and nutrients are both washed back to the sea and transferred to the terrestrial system. Several predators make their living in this land of milk and honey – both shore crabs and rove beetles heavily prey upon wrack amphipods. We propose a complex food web based upon the frequent subsidy of abundant marine detritus during high tides.

### **V-S2.1 Sponge diversity and community structures – changes along environmental gradients**

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Sponges (phylum Porifera) are common filter-feeders widely distributed in almost all benthic habitats. As slow growing sessile organisms and because of their sensitivity against environmental stress, sponge species composition changes along environmental gradients. Their community structure and diversity could be linked to environmental parameters in the Limski kanal, an 11 km long fjord-like bay and a relict of a pliocenic river located north of Rovinj, Croatia. 51 sponge species could be identified in the Limski. The sponge community was recorded at 12 locations along the channels by means of vertical and horizontal transects and its diversity was calculated. The substrate was recorded and classified in 6 categories.

The communities at the entrance resemble each other, like those at the end do, where sedimentation is very high. Only species adapted to this peculiar situation can survive in this environment. The communities in the middle of the channel are more heterogenous though most of them group together in a similarity comparison. Photophilic species are the most abundant sponges in the Limski kanal. Therefore depth (light) is the most important factor influencing the community structure followed by the position along the kanal, which is linked to the kind of substrate, the sedimentation and other hydrographic factors.

Diversity is higher on the southern side and reaches its maximum in the middle of the channel. It decreases towards the opening and the end and rises on both sides from shallow to deeper water as long as suitable substrate is provided. Hard substrate is crucial for the development of a diverse sponge fauna but the surrounding habitat and the size of loose rocks do not matter in a certain range.

### V-S2.2 **Species-specific effects of *Hydrobia* spp., *Marenzelleria viridis*, *Corophium volutator* on bioturbation and phosphate flux from the sediment**

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We investigated the impact of three macrofauna species, *Hydrobia* spp., *Marenzelleria viridis* and *Corophium volutator*, on processes relevant to the biogeochemistry of their subtidal sediment habitat. Animals were kept in the laboratory in microcosms at their natural abundances during 10 days. The effects of each species were investigated in 4 parallels for single species and in species combinations. We observed species-specific effects on oxygen distribution (microprofiling), particle mixing (bioturbation), development of surface topography structure, and the flux of dissolved inorganic phosphate to the overlying water. *C. volutator* increased oxygen availability in the sediment by irrigation activity and yielded highest particle mixing coefficients. When species acted in combination, their combined effects could not be described by simple arithmetic. Particle mixing was lower than for *C. volutator* when *M. viridis* and *C. volutator* were combined. Phosphate release in combinations depended on the identity of species; it both surpassed and fell short of the highest release by single species *M. viridis* (HC, HM < M und CM, HCM > M). Our results illustrate the impact of diversity on ecosystem functioning and support the notion that identity of species is important for the way processes function.

### V-S2.3 **Spatial and temporal variabilities of nematodes in the eulittoral zone of a sandy beach on northern Crete, Greece**

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Meiofauna was sampled ten times from February to July 2000 at two stations (A & B) with a spatial distance of 1.6 to 3.6 m on an exposed sandy beach of northern Crete, Greece. Copepoda dominated the meiofauna, while nematodes were the second most abundant group. The two stations differed significantly in abundance, diversity and genus composition of the nematodes and therefore exhibited discrete communities. At the less exposed Station A the nematode abundances were 4 to 5 times higher but less diverse compared to the wave exposed Station B. While at Station A the genera *Enoplolaimus* and *Epsilonema* dominated the nematode community, at Station B *Theristus* and *Odontophora* were more important. The community at the less exposed Station A showed a higher percentage of predatory nematodes compared to Station B, which was probably the result of the higher supply of prey organisms. The higher disturbance due to the more exposed state of the sediment did not allow the establishment of a more abundant and complex nematode community at Station B.

Furthermore, total nematode abundance, community structure and diversity were significantly different among sampling dates. Lowest numbers in winter and a rapid increase following a peak in food availability due to the sedimentation of a spring phytoplankton bloom. Both stations exhibited two discrete communities, one winter and one spring group. This could be drawn back to reproduction strategies of *Epsilonema* and other selective particle feeders in response to enhanced food concentrations by the sedimented phytoplankton.

Analysis of the vertical distribution pattern showed that nematodes were most common in 8 to 13 cm sediment depth but showed distinct temporal and spatial variabilities concerning their median depth. This was a function of the degree of exposure, sedimentary parameters, oxygenation of the sediment and food availability.

## V-S2.4 Ostracods (Crustacea) as palaeo-proxies for the evolution of the southern Baltic Sea

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Ostracods are classical tools of micropalaeontology. They are especially suitable for palaeoenvironmental reconstruction in brackish water environments because of their high abundance and diversity under these highly variable and often stressed conditions. A large ecological data set gained studying living ostracod associations and thanatocoenoses from surface sediments of about 700 stations from the southern Baltic Sea gives now a base to analyse past environments more in detail.

The following methods are refined and developed to use ostracods as tools for palaeoenvironmental reconstruction in Holocene brackish water conditions: 1. Grouping of different ecological forms (e.g. freshwater vs. brackish water and marine forms, or proportion of phytal forms). 2. Estimation of abiotic parameters by known tolerance limits of species from Recent ecological studies (e.g. salinity, water temperature, oxygen level). 3. Estimation of abiotic parameters through transfer functions based on association composition (e.g. salinity, C<sub>org</sub> content of sediment). 4. Morphological analysis of ostracod valves of some species (e.g. water chemistry indication by nodding or sieve pore shape in *Cyprideis torosa*). These methods make possible quantitative estimations of salinity and shallower water depth as well as trends for water temperature, oxygen concentration, habitat structure, trophic status, water movement and erosional/depository processes. Such data are important for the reconstruction of climatic changes, sea level variation, estimation of anthropogenic impacts on ecosystems, sedimentary processes and ecostratigraphic purposes. We are able now to trace back the history of the southern Baltic Sea and its ostracod associations down to the Ancyclus stage more than 8000 years before.

## V-S2.5 Light emission and its pattern in time and space in a coastal polychaete, *Eusyllis blomstrandii* (Annelida)

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Bioluminescence is frequent in marine animals, but its biological functions are known in only a few cases, e.g., in the polychaete genus *Odontosyllis* where the sexes locate each other for mating by light signals. *Eusyllis blomstrandii*, a related syllid from the sublittoral in the North Sea, is likewise bioluminescent. Its bioluminescence is evoked by mechanical irritation. Light is emitted in a characteristic spatial pattern and temporal sequence. All the trunk segments are capable of emitting light flashes mainly from epidermis patches surrounding the dorsal parapodial cirrus. Particularly bright light can be emitted from the last eleven or so segments ("tail"). Flashes last about 70msec and occur in series at a frequency of 4.5–8 Hz, with amplitudes increasing rapidly at the start and then decreasing slowly in amplitude and frequency. At low excitation, low intensity flashes are emitted in the main part of the trunk. At continuing or increasing irritation, light emission is taken over by high intensity flashes in the "tail" part, thus probably focussing the attention of a possible enemy towards the posterior end. Tails are readily autotomized and the luminescence system of such fragments is particularly sensitive to mechanical stimulation. Bioluminescent display in *Eusyllis* therefore very likely serves a decoy function with the risk of losing the "tail" which however can quickly be regenerated. Light emission has not yet been monitored during sexual activities in this species.

A grant of Deutsche Forschungsgemeinschaft/Bonn (Fi 182/21-1) to A. Fischer/Mainz, film work by the IWF/Göttingen and the supply of living worms and seawater by H.D. Franke/Helgoland and the AWI/Bremerhaven are gratefully acknowledged.

# **HT V Temperature-Dependent Biogeography of Aquatic Ectotherms: from Genes to the Effects of Climate Change**

**George Somero**

Robert and Lucile Packard Professor of Marine Biology, Director of Hopkins Marine Station, Pacific Grove, CA; Member of the National Academy of Science USA. Research: Linking Biogeography to Physiology: Evolutionary and Acclimatory Adjustments of Thermal Limits. Biochemical adaptations: from protein thermal stability to hypoxia-induced patterns of gene expression. Author of the textbook “Biochemical Adaptation” (2002) together with Dr. Peter Hockachka.

## **HV1.1 Linking biogeography to physiology: evolutionary and acclimatory adjustments of thermal limits**

**George Somero**

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The strong correlation noted between habitat water temperature and thermal tolerance limits of marine and freshwater animals suggests that temperature-adaptive physiological variation plays a major role in setting biogeographic and vertical patterning. Using examples from several taxa of invertebrates and fishes, I show that species from warm habitats may live closer to their upper thermal limits than related species (congeners and confamilials) from cooler habitats. Warm-adapted species also may be less able to increase their thermal tolerance limits during warm-acclimation than cold-adapted relatives. cDNA microarray studies reveal that thermal acclimation entails pervasive shifts in gene expression in eurythermal fishes. Transcriptional changes made in response to diurnal changes in temperature differ from those observed during long-term thermal acclimation to constant temperatures. Antarctic notothenioid fishes have lost critical temperature-acclimatory gene regulatory responses during evolution in cold, thermally stable Antarctic waters. Loss of these gene regulatory capacities may account, in part, for the extreme stenothermality of these species.

## **Lars Tomanek**

Diploma 1995, Universität Konstanz; Ph. D. 1999 Oregon State University; Postdoctoral fellow 1999–2003 Stanford University, Hopkins Marine Station, Pacific Grove, CA; Postdoctoral fellow 2003 University of California, Davis. Research: Evolutionary variation and ecological importance of heat-shock protein expression. Most comprehensive example for the ecological importance of interspecific variation in heat-shock protein synthesis.

### **HV1.2 The heat-shock response: its evolutionary variation and ecological importance**

Lars Tomanek

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Heat-shock proteins (Hsps) are induced at the upper end of the physiological temperature range that an organism can withstand and therefore contribute to setting the thermal limits that determine biogeographic range boundaries in marine ectotherms. Several species of the marine gastropod genus *Tegula* are found along steep thermal gradients within the intertidal zone and along latitudinal temperature gradients. Thus they provide an ideal comparative system to study the evolutionary variation and the ecological importance of heat-shock protein synthesis. Interspecific differences in the onset, peak and upper temperature of Hsp synthesis correlate positively with the maximal temperatures that are typical for the vertical as well as biogeographic distribution ranges of *Tegula* congeners. This variation was shown experimentally to prevent low-intertidal to subtidal species from occupying the mid-intertidal zone. Using two-dimensional gel-electrophoresis I showed that the Hsp complement consists of over twenty isoforms of various size classes. In general, acclimation to higher temperatures shifts the rate and onset of synthesis of Hsps to a greater degree in the more heat-tolerant mid-intertidal than in the heat-sensitive subtidal species. However, acclimatory plasticity is isoform specific and can range from no to a shift in onset temperature by several degrees Celsius within one Hsp size-class. Our data indicate that species that occupy thermally highly variable environments, e.g., the mid-intertidal zone, are living close to their thermal limits and may be more affected by global warming than species from thermally less variable habitats.



**Hans-Otto Pörtner**

Universities Münster & Düsseldorf, PhD in animal physiology 1983, habilitation 1990; postdoc Dalhousie and Acadia Universities, Nova Scotia, research fellowship DFG; Lovelace Medical Foundation, Albuquerque, NM, Heisenberg fellow. Current Position: Professor and Head Div. of Ecophysiology and Ecotoxicology, Alfred Wegener Institute for Marine and Polar Research, Bremerhaven, FRG. Research. Physiological and biochemical mechanisms limiting thermal tolerance and temperature dependent biogeography in invertebrates and fish. Cellular and whole animal energy budgets in various thermal regimes. Molecular mechanisms of thermal adaptation and limitation.

**HV1.3 Cod and climate: A role for physiology in explaining recent change?**

Hans-Otto Pörtner

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In linking molecular biology with ecology as well as evolutionary biology, functional, i.e. physiological analyses become increasingly important for an integrative understanding of the patterns of evolution and ecology. This task is challenging especially at the highest levels of functional complexity found, e.g. in animals. Integrative physiology, combined with molecular approaches, is expected to provide a deeper understanding of the evolution of molecular, cellular and organismic functions and the genetic basis of adaptability. By identifying the tradeoffs and constraints involved in environmental adaptation the principle reasons become accessible that limit each species to specific habitats. Such an approach will also give access to the mechanistic bases of organismic responses to environmental alterations, including climate change.

Accordingly, our physiological studies at molecular, cellular and organismic levels currently aim to clarify the mechanistic basis of bio-geographical patterns on large scales, i.e. in a latitudinal cline, as they are determined by the temperature regime and its interaction with other abiotic factors in the marine realm. Key mechanisms as well as constraints and trade-offs involved in thermal adaptation have recently been identified leading to the concept of oxygen limited thermal tolerance. The resulting model has been applied to develop a causal understanding of the effects of climate oscillations on cod populations in a latitudinal cline. From a wider point of view the bio-energetic consequences of thermal adaptation and the mechanisms involved may have important implications at the ecosystem level, by modifying energy budgets with consequences for growth, reproductive output, the capacity for motor performance, lifestyle strategies and possibly, even biodiversity.

### Ian A. Johnston

First Class Honours B.Sc. (Biological Chemistry & Zoology) 1970, prize best Zoology undergraduate, PhD Zoology 1973, all University of Hull. Chandos Professor of Comparative Physiology (since 1997). Head of Division of Environmental & Evolutionary Biology (since 1997), School of Biology, Director of The Gatty Marine Laboratory (since 1985), all University of St Andrews. A wide range of studies (more than 220 original research publications and reviews in leading peer reviewed journals since 1972) is being conducted on the structure, function and evolution of fish muscle. Temperature-induced plasticity of myogenesis in fish.

#### HV1.4 The influence of temperature on muscle architecture in fish: evolutionary adjustments and developmental plasticity

Ian A. Johnston

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The maximum diameter ( $D_{\max}$ ) of muscle fibres is thought to be determined by diffusional constraints, which are a function of temperature and the maximum metabolic load. Antarctic notothenioid fish have muscles containing giant fibres, reaching 200  $\mu\text{m}$  diameter in slow muscle and 600  $\mu\text{m}$  diameter in fast muscle. The evolution of these giant muscle fibres probably reflects a relaxation of diffusional constraints at low temperatures. We have shown that giant fibres are associated with a reduction in the maximum fibre number ( $\text{FN}_{\max}$ ). Using phylogenetically based statistical methods we estimated size-corrected ancestral values of  $\text{FN}_{\max}$  and found evidence for a progressive reduction in trait values in the lineage leading to the icefishes (Family Channichthyidae) (Johnston et al., 2003).  $\text{FN}_{\max}$  in the basal notothenioid, *Eleginops maclovinus*, was only 7.7% of that in the icefish *Chaenocephalus aceratus* that reaches a similar maximum size (85cm). Our working hypothesis is that reducing fibre number and increasing fibre size serves to reduce the energy costs of maintaining ionic homeostasis, in this case perhaps serving to compensate for additional energy costs associated with adaptation to the Antarctic environment. Anadromous fishes have invaded freshwater habitats in boreal regions since the end of the last Ice age. In the absence of competition, the diversification of different morphs has occurred to utilise different habitats and food resources. In the case of the Arctic charr (*Salvelinus alpinus* L.), dwarf morphs have arisen on multiple occasions. Four distinct morphs of arctic charr including a dwarf form, are found in Lake Thingvallavatn, Iceland. The morphs spawn in different places and different times of the year causing some variation in the temperature for embryonic development. We have found that  $\text{FN}_{\max}$  is reduced in the dwarf compared to the large benthic and piscivorous morphs. The reduction in  $\text{FN}_{\max}$  observed in the dwarf morph could reflect temperature-induced developmental plasticity in fibre number or some genetic difference in the gene networks regulating fibre recruitment. Recent research to distinguish between these possibilities will be described.

Johnston, I.A., Fernandez, D., Calvo, J., Viera, V.L.A., North, T.W., Abercromby, M. and Garland, T. Jr. (2003). Reduction in muscle fibre number during the adaptive radiation of Notothenioid fishes: a phylogenetic perspective. *J. Exp. Biol.* 206, 2595-2609.

## Michal Horowitz

Ph.D. 1971, Hebrew Univ., Lecturer 1976, Senior Lecturer 1978; Associate Prof. 1985, full Prof. 1990, Dept. of Physiology, Haddassah Medical School, The Hebrew University. – Work on acclimation of the heart to chronic heat and cardioprotection. Intrinsic changes in cardiac properties are an integral component of the heat acclimation process. Adaptation is manifested by improved mechanical performance and increased cardiac work efficiency leading to an extended “maintenance activity” under conditions of energy [supply/demands] imbalance. Collectively, these allow better coping with hostile peripheral demands and adverse environmental conditions as well as enhanced endurance during ischemic/reperfusion insults (Crosstolerance).

### HV1.5 Role of HIF-1 in heat acclimation

Michal Horowitz<sup>1</sup>, Millet Treinin<sup>2</sup>, Zohar Bromberg<sup>1</sup>, Judith Shlaier<sup>1</sup> & Alina Maloyan<sup>1</sup>

<sup>1</sup>Laboratory of Environmental Physiology and <sup>2</sup>Dept of Physiology, Faculties of <sup>1</sup>Dentistry and <sup>2</sup>Medicine, The Hebrew University, Jerusalem, Israel

Persistent exposure to environmental heat stress upregulates protective mechanisms, leading to enhanced heat endurance. This process, ‘heat acclimation’ leads also to the generation of non-thermoregulatory beneficial effects displayed by increased tolerance to a multitude of environmental stressors, such as heavy metals, hypoxia, hyperoxia, ionized irradiation, etc. The latter protective feature, namely adaptation to a stressor without prior exposure to that particular stressor (exaptation) is defined as ‘cross-tolerance’. It reinforces coping with the new environment. Our data on mammalian thermal acclimation indicate that reprogrammed expression of genes coding for heat shock proteins (HSP 70 family) and energy metabolism enzymes play a pivotal role in this adaptive process. Our findings of constitutive elevation of HIF-1a (hypoxia inducible factor), and several HIF targets in heat acclimated rats and mice imply a role for this transcription factor in the acclimation process. The ability of *C. elegans* to undergo heat acclimation and the relative ease of genetic and molecular manipulations in this species makes it worthwhile model for addressing questions pertaining to heat acclimation and thus to identify heat-acclimatory pathways conserved through evolution. We discuss in this presentation the role of HIF-1 vs HSP 70 in heat acclimation. The *hif-1* loss-of-function *C. elegans* strain did not show acclimation and cross-tolerance to cadmium, while non-acclimated overexpressing HIF-1 mutants had greater heat endurance than the wild-type nematode which like mammals shows elevated HIF-1 and HSP72 levels following heat acclimation. Mutants that demonstrated marked ability to acclimate such as *daf-2* (insulin receptor pathway) showed upregulation of both HIF-1 and HSP 70. HSP70 upregulation in “acclimated” *hif-1* mutants was also observed; however, it was insufficient to improve heat/stress tolerance. Preliminary finding showing that HSF1 silencing did not abolish *C. elegans* ability to acclimate supports this phenomenon. We suggest that HIF-1 upregulation is essential for acclimation, while HSP72 upregulation in the absence of HIF-1 is inadequate. HIF-1 upregulation is both an evolutionarily conserved and a necessary component of heat acclimation.

## **Lloyd Peck**

Professor at the Biological Sciences Division, British Antarctic Survey, Cambridge UK. Field: Thermal limits in polar ectotherms. Studies on cold-blooded Antarctic marine species show they have possibly the most restricted physiological temperature ranges of any animals on Earth. Most species die in experiments at temperatures between 5°C and 10°C; the more sensitive die between 4°C and 5°C. However, measurements on the end products of metabolism and on blood oxygen have proved that tissues change to anaerobic metabolism at even lower temperatures. The transfer to anaerobic metabolism represents a time-limited situation that is unsustainable. It has been termed the critical long-term physiological limit. In some Antarctic marine species this occurs at 2°C.

### **HV1.6 Thermal limit in polar ectotherms**

Lloyd Peck

Cambridge, UK

# HT VI Ontogeny of Behaviour

**Hubert Schwabl**

Teaching and research at the School of Biological Sciences, Washington State University, Pullman, WA. Research on the influence of environmental factors on the individual prenatal development in higher vertebrates, e.g. neuroendocrinological control of reproduction and development in birds, including the influence of maternal hormones.

**HV Prudent Mothers, Hormones, and Development**  
Hubert Schwabl

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# HT VII Molecular Evolution Meets Conservation Biology

**Godfrey M. Hewitt**

Professor at the School of Biological Sciences, Centre for Ecology, Evolution and Conservation (CEEC), University of East Anglia. Research covers Evolution and conservation, genetics, phylogeography and colonization, hybrid zones. My work seeks to understand the distribution of genetic diversity and the processes of genetic divergence and speciation. To this end my group primarily uses DNA markers in insect and mammal species along with computer simulation analysis. We are particularly interested in the postglacial colonization of Europe and the genetic diversity in domestic animals.

**PV      The structure of biodiversity – insights from molecular phylogeography**  
Godfrey M. Hewitt

Biological Sciences, UEA Norwich, UK [g.hewitt@uea.ac.uk]

DNA techniques are greatly advancing our knowledge of the present distribution of genetic diversity globally, and how it evolved. There are concomitant advances in analytical methods to extract useful information from these new data. This is greatly enhanced through combination with recent paleoclimatic studies for the Pleistocene and Holocene. Such phylogeographic studies are reviewed from Arctic, Temperate and Tropical regions, seeking commonalities of cause in the resulting genetic patterns.

The frequent major climatic oscillations in the last 2 My caused repeated changes in the ranges of those taxa that survived, with extensive extinction and recolonization in higher latitudes and altitudinal shifts and complex refugia nearer the tropics.

As a result of these past dynamics, the genetic diversity within species is highly structured spatially, with a patchwork of genomes divided by often coincident hybrid zones. In Temperate regions like Europe and North America there is much more diversity in the south, where it has accumulated in refugia over many ice ages, and much less in the north, where it was lost during postglacial colonization. These northern places have been colonized by species from different southern refugia, and have had little time to become closely coadapted. Furthermore, this loss of diversity in the north is implicated in the present reduction of population abundance in some species. Mountain ranges in warm Temperate and Tropical regions would seem to be important for the survival of lineages through climatic changes, and hence for genome divergence and speciation.

Such understanding of the distribution of biodiversity carries serious implications for the theory and practice of conservation.

## **Simone Sommer**

Diplom 1994 and PhD 1998 Universität Tübingen; scientist at Zoologisches Institut und Zoologisches Museum, Universität Hamburg. BMBF-Projekt „Konsequenzen von Habitatfragmentierung auf die genetische Diversität, Parasitenresistenz und Populationsökologie von Kleinsäugetern in der Mata Atlantica, Brasilien.“

### **HV            The importance of immune gene variability in ecology and conservation** **Simone Sommer**

Ecology & Conservation, University of Hamburg, Martin-Luther-King-Platz 3, D-20146 Hamburg, Germany

Increasing habitat fragmentation has focused attention on the impact of increased subdivision on population genetics which quite often results in a loss of genetic diversity due to genetic drift and inbreeding with negative effects on fitness parameters. In vertebrates growing evidence suggests that such genetic diversity is particularly important at the level of the major histocompatibility complex (MHC) because its gene products play an important role in immune functions. Loss of variability could affect the vulnerability to parasites and pathogens by two different ways, either directly by a reduced number of heterozygous MHC loci and therefore a decreased effectiveness in dealing with a wide variety of pathogens, or indirectly as a result of the greater fitness of outbred individuals that are heterozygous across much of their genomes, including their MHC loci. Up to now, most of the studies investigating the potential selective force and the effective mechanisms driving MHC-polymorphism have been conducted in humans or in model organisms under laboratory conditions. Studies in free-range, wild animal populations are still very limited.

The role of MHC genes in molecular adaptation processes and conservation was investigated in lemur and rodent species by analysing the variability of the MHC class II DRB gene exon 2 that composes major parts of the functionally important peptide binding groove. The number of different nematode morphotypes per individual (NNI) and fecal egg counts (FEC) was taken as a measure of the intensity of parasitism. Studies on similar topics in different phylogenetic radiations living in different biogeographic areas should make it possible to deduce general rules on evolutionary relevant processes how natural selection promotes local adaptation at the gene level despite the counteracting actions of migration and genetic drift.



### V-S1.1 Conservation genetics of the European wildcat (*Felis silvestris silvestris*) in Germany

I. Eckert & G. B. Hartl

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West European wildcat populations are considered to be endangered by both hybridisation with domestic cats (*Felis silvestris f. catus*) and loss of genetic variability. In order to investigate the genetic integrity of wildcats in Germany, we analysed mitochondrial and nuclear DNA of wild and domestic cats from various populations. A total of 96 wildcats and 148 domestic cats were analysed. Wildcat samples came from the three largest populations in Germany (Harz, Eifel, Pfalz) as well as from smaller populations, which were expected to be more vulnerable to genetic depletion or hybridisation. We sequenced 322 base pairs of the mitochondrial control region (HV1) and analysed 8 microsatellite loci. The results exhibited a relatively high genetic variability in wild and domestic cats and suggested a low level of gene flow between both forms. The bigger populations Harz and Eifel both proved to be suitable as founder populations in the course of reintroduction programmes. Within the smaller wildcat populations, a reduction of genetic variability was detectable with regard to the nuclear DNA. Differentiation between wildcat populations was high, due largely to the lack of genetic exchange between the Eastern and Western populations.

This project was supported by the DFG.

### V-S1.2 New insights into Asian and western honeybee populations revealed from sex-determining alleles

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Here we present the first study of complementary sex determiner (*csd*) alleles of different Asian bee species and the western honeybee of the genus *Apis*. *csd* is the initial signal of haplo-diploid sex determination in *Apis mellifera* and is under strong overdominant selection in which homozygotes have zero fitness. We have isolated and sequenced several alleles of *csd* by RT-PCR from Asian and western honeybee populations.

Evidence for balancing selection acting on *csd* is given by the striking nucleotide polymorphism with an excess of nonsynonymous over synonymous substitutions per site in distinct regions of *csd*-alleles. We show that long term persistence time of *csd*-alleles in populations is supported by a pattern of so called trans-specific evolution, in which *csd*-alleles from one *Apis*-species are more closely related to *csd*-alleles found in another *Apis*-species. The unique evolutionary properties of balanced genetic polymorphism are thus an excellent source to interfere the history of populations. Because the number of *csd*-alleles that are maintained in a population depends directly on population size, *csd*-alleles can be used to estimate the size of historic and present populations. Furthermore, the *csd*-alleles are a substantial basis for the conservation biology of bee populations.

**V-S1.3 The influence of local extinctions on genetic diversity:  
The phantom midge as an example**  
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Eine häufig formulierte Hypothese ist, dass lokale Aussterbeereignisse zu einer Verringerung der genetischen Diversität führen. *Chaoborus* ist hervorragend geeignet diese Hypothesen vergleichend zu testen. Arten, wie *Chaoborus crystallinus*, *C. obscuripes*, *C. americanus* und *C. pallidus*, leben ausschließlich in fischfreien Tümpeln. Die Arten *C. flavicans*, *C. punctipennis*, *C. astictopus* und *C. trivitattus* hingegen leben hauptsächlich in Seen. Es konnte in der Vergangenheit gezeigt werden, dass die Populationen der Tümpel-Art *C. crystallinus* einer Metapopulation mit lokalen Aussterbeereignissen entsprechen, während die Populationen der See-Art *C. flavicans* fast permanent sind und mit einer Stamm-Satelliten-Population verglichen werden können.

Durch einen Vergleich der Arten kann so zum ersten Mal getestet werden, welches die Implikationen lokaler Aussterbeereignisse über evolutionäre Zeiträume hinweg sind. Die obige Hypothese konnte nur zum Teil unterstützt werden, da die durchschnittliche genetische Diversität der Metapopulationsarten geringer war als die der permanenten Populationsarten. Auf der anderen Seite war aber die totale genetische Diversität nicht signifikant verringert. Jedoch sind die Populationen der Metapopulationsart genetisch differenzierter voneinander als die Populationen der Arten mit permanenten Populationen. Insgesamt bedeutet dies, dass in einer Metapopulation die einzelnen Populationen einen größeren Beitrag zu der totalen genetischen Diversität der Art leisten und so der Verlust von genetischer Information, verursacht durch lokale Aussterbeereignisse, kompensiert werden kann.

**V-S1.4 Determining the impact of historic and recent processes on the level of differentiation between European populations of the common vole, *Microtus arvalis* (Rodentia: Arvicolinae)**  
Gerald Heckel, Sabine Fink & Reto Burri

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The genetic structure of populations is influenced by the deeper history of a species as well as recent processes like dispersal patterns or population dynamics. In this study, we aim to disentangle the effects of these factors on *Microtus arvalis* populations with a set of molecular markers with different mutational properties and modes of inheritance. In a first step, we determined the extent of genetic variation in *M. arvalis* voles from more than 50 locations throughout Europe by analyzing sequence data from the mitochondrial cytochrome b gene. In a second step, we examined the highly variable mitochondrial control region in combination with a panel of nuclear microsatellites in several populations from each of the evolutionary lineages detected in order to infer the genetic structure among populations. Highly significant genetic structures among populations were detected for both marker types at the European and at the regional scale. Differentiation among evolutionary lineages was related to the level of genetic structure among populations for both marker types, but it explained a much higher proportion of variance for the control region than for the microsatellite data. Isolation-by-distance was detected for the microsatellite but not for the control region data set, which is consistent with a male biased dispersal pattern. These results suggest that *M. arvalis* populations are evolutionary largely independent from each other. The impact of dispersal and reproductive patterns appears to be restricted to the local scale, which results in small effective population sizes and a high potential for non-equilibrium situations.

**V-S1.5 Use of molecular methods to resolve European reptile species complexes**Ulrich Joger<sup>1</sup>, Daniela Guicking<sup>2</sup>, Peter Lenk<sup>3</sup>, Zoltan T. Nagy<sup>2</sup> & Michael Wink<sup>2</sup>

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In systematic zoology, DNA sequencing is primarily used for the reconstruction of evolutionary processes, both intra- and interspecifically. If mitochondrial marker genes are used, there is no marked difference between subspecies and species levels. Because of lack of recombination, even sympatric occurrence of mitochondrial haplotypes does not help. Genetic distances, which are indicators of both separation time and divergence, may give a rough estimate for the taxonomic level attained. If a phylogenetic species concept is applied, mitochondrial clades may be defined as species. This concept is especially useful in cases of allopatric distribution. Under the biological species concept, the additional use of nuclear markers (of morphological or molecular kind) can help to estimate gene flow between populations defined by mitochondrial haplotypes. We studied the distribution of allozyme frequencies and cytochrome b haplotypes across a contact zone of two geographical groups of Green lizards (*Lacerta viridis* complex). Concordant gene trees plus an asymmetry in allozyme similarity indicated that a separation into two biological species, *L. viridis* and *L. bilineata*, had already taken place. Southern Italian Aesculapian snakes (*Elaphe longissima* complex) were found to represent a separate clade in a cytochrome b tree. In this case a morphological character analysis made sure that there was no significant gene exchange between *E. longissima* and its sister species, *E. lineata*. A simple but effective molecular technique for resolving species complexes is ISSR genomic fingerprinting. We used ISSR to complement mitochondrial DNA phylogeography in the Italian racer, *Hierophis viridiflavus*, and in the Dice snake, *Natrix tessellata*. Despite a general concordance between mitochondrial and ISSR trees, hybrid individuals were detected between Western and Eastern groups in *H. viridiflavus*, as well as in several subgroups of *N. tessellata*, but not between Greek and northern Balkan *tessellata*. As Greek *tessellata* also show an extremely high genetic divergence from other populations, it may be concluded that the Greek Dice snakes represent a separate, yet undescribed species. A closer focus on the contact zone is likely to resolve the issue.

**V-S1.6 Phylogeographic survey of *Gasterosteus aculeatus*: evidence for a new migration hypothesis**

Peter Martin, Miriam Blank &amp; Ralf Bastrop

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The Threespine Stickleback *Gasterosteus aculeatus* species complex serves as a model system for phylogenetic analyses for more than ten years now, but still, only a few studies looked at the situation in Europe with a phylogeographic approach. This work reports the results of an analysis using a combined 1720 bp long sequence of two mitochondrial genes (cytochrome b, NADH-dehydrogenase subunit 6) from 210 individuals collected from 69 localities in Europe. The evaluation of the dataset shows an unexpected high level of genetic variation which leads to define at least four different clades and to refuse the former opinion of an extinction of Atlantic populations during the Pleistocene, followed by a recent reinvasion from the Pacific. By combining our dataset with another 43 cyt b- haplotypes found in the genebank (mainly from Pacific individuals) in phylogenetic analyses a new hypothesis of a postglacial migration is postulated.

**V-S1.7 Comparative phylogeography of the land snail genus *Candidula* (Hygromiidae: Gastropoda)**

Markus Pfenninger<sup>1</sup>, Carsten Nowak<sup>1</sup> & Frédéric Magnin<sup>2</sup>

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The comparative analysis of phylogeographic patterns and processes of related taxa gives insights into the mechanisms shaping their respective present day species ranges. Land snails are particularly suited for this venue, because the inferences drawn from molecular markers can be compared to the fossil record. Here, the historical events and ecological processes shaping the present day distribution of the small land snail species *Candidula unifasciata*, *C. rugosiuscula* and *C. gigaxii* were compared. The analysis showed that the present day distributions are the result of i) the postglacial transformation of the European landscape, not the least due to human activities and ii) climatical tolerance limits of the respective species.

**V-S1.8 Inferring population history from genealogies – the case of European long-eared bats *Plecotus* (Chiroptera)**

Rudolf B. Zahner, Andreas Kiefer, Nicole Beer & Michael Veith

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Population history of populations that postglacially re-expanded into Central Europe may largely depend on their ecological adaptation. Species adapted to the cold are likely to have survived Pleistocene glaciations in multiple northern refugia, whereas species adapted to a warmer climate may have re-immigrated from southern refugia. To test this hypothesis of contrasting expansion patterns we compared the genetic population structure for differentially adapted species: the brown long-eared bat (*Plecotus auritus*) which is adapted to mountainous areas up to 1200 m a.s.l. and the grey long-eared bat (*Plecotus austriacus*), which is a typical lowland form. We sequenced a part of the mitochondrial control region (d-loop) for more than 400 individuals of both species from over 50 sites, most of them from Rhineland-Palatinate. Both phylogeographic patterns were in line with our hypothesis of multiple versus single sources of Central European populations.

**P-1 Biological and structural characteristics of the Socorro Dove (*Zenaida graysoni*) population in the Bird Park Marlow and discovery of a genetic influx by the related Morning Dove (*Zenaida macroura*)**

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The Socorro Dove went extinct on Isla Socorro between 1975 and 1985 but is still found in aviaries in the USA and Europe. In the late 1980s, aviculturists and ornithologists created a breeding programme to produce a sufficient large number of birds which could finally be re-introduced to Isla Socorro. But the Socorro Dove previously hybridized with the closely related Mourning Dove either in the field or during captivity. Therefore it is necessary to carry out tests to ensure that birds to be re-introduced are pure-bred. The 17 individuals of the breeding population of the bird park Marlow (Germany) have been screened considering behaviour, bioacoustics, morphology, and genetics. Two individuals of the population did not integrate into the species characters of *Zenaida graysoni* by their genetic pattern. The remaining Socorro Dove stock of the bird park Marlow seems to be pure-bred and can be re-introduced to Socorro Island.

# SG1 Studiengruppe Entwicklungsbiologie

## P-1 The role of the moulting cycle on the hypoxic induction of *Daphnia magna* haemoglobin

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The water flea *Daphnia magna* exhibits a remarkable scope for adjusting the systemic oxygen supply to the tissues under different ambient oxygen tensions and varying metabolic requirements. In this oxyregulatory system, haemoglobin (Hb) represents a key component, which can be adjusted both in concentration and oxygen affinity. While a variety of studies have focussed on the influence of ambient oxygen tension on Hb-related parameters, the impact of internal factors such as the moulting and reproduction state on the oxyregulatory abilities of the animal has not been studied in detail so far.

To analyse the role of the moulting cycle on oxygen-transport physiology, a test group of premoult animals was transferred from normoxic to hypoxic conditions (15 % air saturation) and was kept under these conditions over a complete moulting cycle. A control group was kept under normoxic conditions.

In both groups, the Hb concentration, the mass-specific oxygen consumption rate, and the critical oxygen tension increased steadily while progressing through the moulting cycle. The transition into the next moulting cycle was associated with a sharp drop in all parameters. We suggest that a dilutional effect caused by the growth-related water uptake during ecdysis as well as the reduction of metabolically active material due to egg deposition is responsible for the oscillations observed in these parameters. Besides these moult-related effects, we found a fast hypoxia-induced increase in Hb concentration and oxygen affinity, which is already present after one day of hypoxic exposure. A modification in Hb subunit composition responsible for the changes in oxygen affinity was first detectable after three days of hypoxic exposure.

**P-2 An SEM study of the embryogenesis of the oligochaete *Enchytraeus coronatus* – aspects of annelid and oligochaete development**

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Bilaterian animals are divided into three major clades. Among the Deuterostomia and Ecdysozoa there are well-established model systems (e.g. various vertebrate species, *Drosophila* or *Caenorhabditis*). A high variety of taxa, combined as the lophotrochozoans, are less well studied. A member of the lophotrochozoans are the annelids, one of the largest and most widely distributed animal phyla with over 15,000 species worldwide, which undergo a type of embryogenesis that is well known as spiral cleavage. This cleavage mode is thought to be an ancestral character in bilaterian evolution. The reconstruction of the morphology and embryology of the early bilaterians strongly requires investigations on lophotrochozoans. Therefore annelids, as members of this important group, may represent a good model for studying developmental processes such as segmentation or mesoderm formation in the light of bilaterian evolution.

We have chosen the soil-living annelid *Enchytraeus coronatus* for developmental studies. To introduce this system and to make it accessible for further studies we analyzed the early cleavage pattern and followed morphogenesis until hatching by an SEM analysis. Combined with a variety of histological techniques we were able to introduce a first timetable of development for *Enchytraeus coronatus*.

Those findings were compared with hirudinean and polychaete embryogenesis, which has been studied intensively.

**P-3 Paternity study by microsatellite analysis of a female coelacanth (*Latimeria chalumnae*) from mozambique and its 26 embryos**

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*Latimeria chalumnae* is one of the two recent coelacanth species. Until the discovery of a living coelacanth near East London, South Africa in 1938 it was thought that coelacanths became extinct 70 million years ago. Up to now about 250 fish have been caught and approximately 150 living fishes observed by submersible. The total population of *L. chalumnae* is estimated to be only a few hundred. Consequently *Latimeria chalumnae* has to be regarded as endangered species. Thus it is important to analyze genetic diversity and population structure. Microsatellites are appropriate tools for such studies. In addition, not much is known about their reproductive biology. They are ovoviviparous and have a gestation period of approximately 13 month. A pregnant female, caught off Mozambique in 1991, carried 26 embryos. It provided the first opportunity to study paternity in coelacanths.

In this study we have analyzed the microsatellite genotype of the female and all 26 embryos. So far we investigated 9 informative loci. The genotypes revealed that in general the genetic diversity on the microsatellite level is not very high. Reconstruction of the paternal genotype indicated only one father for all embryos. Thus, there is no evidence for multiple paternity. Noteworthy the father and mother differ at seven of nine loci.

**P-4 Is 17beta-Estradiol involved in reproduction of nereids (Annelida: Polychaeta)?**

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The steroid hormone 17beta-Estradiol (17E) plays a key role in the endocrine control of the reproductive process in vertebrate females. 17E, and estradiol receptor have also been recently reported from invertebrates. In the mollusc *Octopus vulgaris*, 17E is synthesized by the somatic cells of the gonads and induces vitellogenin (Vg) synthesis, which is similar to oviparous vertebrates. Vg is the protein precursor of the yolk protein vitellin, which serves as nutritive resource for the developing embryo. In nereid worms, Vg is secreted by specialized coelomic cells (elaecocytes) into the coelomic fluid from where it is taken up by the oocytes. The hormonal regulation of this process remains unclear. We hypothesize that 17E is present in the coelomic fluid of nereid polychaetes and might regulate the synthesis and secretion of Vg. We test this by enzyme immuno assay on cell and coelomic fluid samples from *N. virens*, a large nereid polychaete. In the coelomic fluid of juveniles and females, 17E concentrations of 30pg.ml<sup>-1</sup> and 14pg.ml<sup>-1</sup> respectively were found. In addition, a putative estradiol receptor protein (68kDa) was detected by immunoblot in protein extracts from eleocytes using anti-estradiol receptor antibodies. These are the first hints of an involvement of 17E in the reproductive control of nereid polychaetes.

Acknowledgments: J. García-Alonso is supported by a DAAD fellowship

**P-5 Apoptosis during Metamorphosis of *Hydractinia echinata***

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Programmed cell death is present during metamorphosis of *Hydractinia echinata*. Using an in vitro system as well as in vivo bioassays we describe the relevance of caspase 3. A) Using an antibody against the active form of caspase 3 we show the time course of activation of the enzyme during metamorphosis. B) Caspase-mediated apoptosis was blocked by a cell-permeable caspase-3 inhibitor (X17-DEVD-CHO) in larvae prior to and during metamorphosis. Caspase inhibition interfered with metamorphosis and reduced this process reversibly and in a dose-dependent manner. C) Using mitochondrion selective probes we show potential changes in mitochondrial membrane during the process of apoptosis.

These results indicate an active involvement of mitochondria and a biochemically active caspase 3 during metamorphosis of *H. echinata*.

**P-6 Comparison of brain development in honeybee workers and queens**

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In honeybee colonies, queens develop from fertilized eggs that are not different from eggs that develop into workers. As in other polyphenisms, the developmental switch does not depend on genomic differences. Queens are larger than workers, differ in their behavior, live much longer, and develop significantly faster. These differences are determined by environmental factors during postembryonic development, primarily via nutrition during the larval period. The developmental trajectory of worker into a queen can be determined as late as the third day of larval development. Afterwards, the developmental pathway is fixed for the worker phenotype. Pupal stages proceed over 10–11 days for workers (2 prepupal and 9 pupal stages) and only 6–7 days for queens (1 prepupal stage and 6 pupal stages). In this study we comparatively analysed the differentiation of the brain in workers and queens. Freshly capped and developmentally synchronized worker and queen brood cells were reared in incubators at 34.5°C, the temperature normally maintained by endothermic heat production of adult workers. At each day of pupal development, brains of workers and queens were dissected and labeled with fluophore-conjugated phalloidin and an antibody to the synaptic-vesicle protein synapsin. Phalloidin binds to f-actin, which plays an important role during neuronal growth. In mature neurons, actin microfilaments are most abundant in presynaptic terminals and dendritic spines. Neuroanatomical analyses focused on the olfactory pathway and revealed clear differences in the differentiation of the antennal lobe synaptic neuropil and olfactory input regions in the mushroom body calyces.

**P-7 Cranial muscle development in the African dwarf clawed frog,**

*Hymenochirus boettgeri* (Anura: Pipidae)

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Vertebrate head development has received much attention in the last years, but there are few modern studies on the development of cranial muscles.

Here we investigate the morphology and morphogenesis of cranial muscles in *Hymenochirus boettgeri*, a close relative of *Xenopus laevis*. *H. boettgeri* larvae are unique among anurans in being predatory and suction feeding, and have a specialised head including a tube-like extensible mouth. One aim of our investigation was to document how the specialised muscles which are functional during feeding develop, and to relate this to the pattern found in the suspension feeding *X. laevis* larvae. We used dissection of the heads of larval specimen, clearing and staining and histological serial sectioning. Furthermore we detected desmin expression in whole-mount stained embryos using optical sectioning via confocal laser scanning microscopy. This gives us a three dimensional image of cranial muscle architecture. All larval muscles are fully developed at stage 45 (Nieuwkoop and Faber). All muscles of the mandibular and hyoid arch develop much earlier than stage 39. Muscle fibre formation starts later in the m. subarcualis obliquus and branchial constrictors. M. orbitohyoideus, M. quadratohyoangularis, M. interhyoideus and the Mm. levatores mandibulae develop from separate anlagen. A full description of the pattern of cranial muscle development is given. We compare our data with results from other studies on vertebrate cranial muscle development. To complement our studies muscle innervation patterns were investigated using antibodies against acetylated tubulin and optical sectioning.



**P-8 Signalling by a FGFR-like receptor tyrosine kinase is essential for bud detachment in *Hydra***

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FGF/FGFR signalling is essential for morphogenesis in higher evolved triploblastic organisms. We present data on a cnidarian receptor tyrosine kinase, Kringelchen, isolated from the freshwater polyp *Hydra vulgaris*, which shares characteristic features with FGFR from triploblasts. This gene is expressed in a highly dynamic pattern during budding: First, a diffuse expression in the budding region is detectable. During evagination the expression is restricted to the tip of the bud and a ring at the bud's base. The tip expression is switched off when head structures start to form. After bud detachment a ring of expressing cells persists in the parent animal for a few hours. Head regeneration, which interferes with bud detachment, leads to a strongly distorted expression pattern. The function of Kringelchen signalling during budding was further analysed by inhibition experiments: Both the FGFR-specific inhibitor SU5402 and treatment with anti-sense oligonucleotides inhibited bud detachment, which requires decrease of the positional value at the bud base.

Since in developing aggregates of hydra cells gene expression is restricted to areas where either head or foot structures form, the data suggest that FGFR signalling is tightly linked to alterations in the positional value, which are prerequisite for structure formation and bud detachment.

This work was supported by DFG grants Ha 1732/4, Ha 1732/8 and GK484

**P-9 Cranial muscle development in *Xenopus laevis* (Anura: Pipidae)**

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*Xenopus laevis* is a model organism and its adult morphology, early development and metamorphosis have been studied extensively. The development of cranial muscles has, however, received much less attention. Therefore a study of their differentiation and morphogenesis was undertaken as part of a larger project on the evolution of cranial muscle development in frogs, salamanders and lungfishes. A new staging table with increased resolution (compared to Nieuwkoop and Faber) was developed based on external characters. Staged specimens were serially sectioned and stained with either Azan trichrome or antibodies against myosin to document cranial muscle development. Cleared and stained specimens were used to describe the orientation of the muscles in the larval head. The eye muscles differentiate early, before hatching. They are followed by the first ventral muscle (m. interhyoideus) and shortly thereafter by the remaining ventral jaw muscles (m. intermandibularis and m. geniohyoideus). Around the same time the development of the lateral jaw muscles starts. The development of the gills and their muscles does not begin until several hours after hatching. The development of muscles and cartilages is related to the order in which they must start to function. Shortly after the mouth is broken through the blood circulation in the gills starts, and the m. interhyoideus is needed to for the ventilation of the gills. The tadpoles start feeding several hours after this event, which explains the later development of the lateral jaw muscles.

**P-10 Cell proliferation dynamics during the regeneration of *Dorvillea bermudensis* (Polychaeta, Dorvilleidae)**  
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From the annelid subtaxa some members of the Oligochaeta and Polychaeta are able to reproduce asexually by fragmentation and subsequent epimorphic regeneration. For the latter formation of a blastema is decisive. It can either be built by a stock of totipotent stem cells existing since the embryonic development or by formerly differentiated cells, that dedifferentiated and regained mitotic activity. Stem cells, however, are only reported for Oligochaeta.

BrdU pulse-chase experiments were carried out in order to examine whether the blastemata in the polychaete *Dorvillea bermudensis* were built by one or the other process. Adults or artificially fragmented specimens were 30 min BrdU pulsed, chased for different intervals and investigated by cLSM.

In adults, S-phase cells were stained in the entire animals; a repetitive pattern, however, did not occur. Because the distance between the posterior proliferation zone and actual location exceeded the distance a cell could migrate during the pulse, these cells might be stem cells. First S-phase cells in the anterior blastema are observable 16 h after amputation. This late onset might be due to preceding wound closure or indicate the time needed for dedifferentiation. In the anterior end proliferation is not restricted to a proliferation zone, but to the regenerate itself. For the ectoderm it was clearly demonstrated that the germ layer keeps its identity; this can also be assumed for the entoderm and mesoderm, but for these two it has to be verified with additional methods.

# SG2 Studiengruppe Evolutionsbiologie

**Heike Wägele**

Lehrstuhl für Spezielle Zoologie an der Ruhr-Universität Bochum. Research: Studies, applying a variety of different methodical approaches, on the phylogenetic relations of the fascinating marine Gastropod taxon Opisthobranchia, including the Cephalaspidea s.l., Anaspidea, Sacoglossa, Tylodinoidea, Pleurobranchoidea and Nudibranchia.

**PV Schnecken ganz anders – die Schokoladenseite einer „schleimigen“ Tiergruppe. Zur Evolution der Opisthobranchia**  
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**V-S1.1 Life-history theory revisited: genetic correlations among body size, egg size and development time**  
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The existence of trade-offs between different traits is fundamental to all theories about life-history evolution. One prominent example is a proposed negative correlation between short development time and large size, with the former trait promoting rapid reproduction and the latter fecundity and competitive ability. Genetic correlations caused by antagonistic pleiotropy may contribute to the maintenance of such trade-offs. Therefore, we investigated genetic correlations among life-history traits by comparing lines of the tropical butterfly *Bicyclus anynana* artificially selected for large versus small body size, large versus small egg size, and long versus short development time. While some results are consistent with current life-history theory, others are not and thus challenge common wisdom. For instance, large pupal size was associated with large egg size and long development, but small pupal size was not associated with small egg size and shorter development. Likewise, selection for long development time did not yield larger individuals. The limitations to the independent evolution of life-history traits caused by genetic correlations appear to be rather weak, and an independent optimization of life-history traits appears to be possible at least to some degree.

**V-S1.2 E-Voluzzer: Hydropneumatic biosimulation for computer-based modeling and simulation of evolutionary transitions**  
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The hydraulic properties of fluid filled body cavities of invertebrates are unquestioned since Clark published his book about “Dynamics of Metazoan Evolution” in 1964. However, hydraulic mechanisms of shape generation are much underestimated for structural-functional and evolutionary investigations. One reason for this might be that it is quite difficult to analyse and describe the interactions of hydraulic systems, and that up to now there was not a single computer graphic application that used the metaphor of a fluid filled cavity for modelling an organism. We have developed a new application (called e-Voluzzer) which represents a hydropneumatic biosimulation. By use of e-Voluzzer we are able to model the shape of an organism as a hierarchical set of hydraulic systems (so called hydropneus) which are rooted in one basic hydropneu (called ‘main’). This hydropneumatic model of an organism can then be used to simulate movements and interaction of the various fluid filled cavities during movements in realtime. Moreover the model can be transformed during simulation, which means that evolutionary transformations can be visualised.

We will demonstrate e-Voluzzer by modelling the body shape of metameric and oligomeric animals and simulating the mechanical interactions during movements. Additionally, we will present an evolutionary transition which shows how the simulation of interacting hydraulic systems are performed during morphological transformations.

**V-S1.3 Functional Changes in the Family of Type 3 Copper Proteins During Evolution**  
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Phenoloxidasen (Tyrosinases) and hemocyanins are closely related proteins in evolution as evident from sequence analysis. They share a common active site, which is a type 3 copper center made up from two copper atoms coordinated by six histidines. Despite these similarities their functions have long been thought to be totally different. While hemocyanins are oxygen transport proteins found in the hemolymph of many molluscs and arthropods, phenoloxidasen are enzymes found in almost all organisms with many different functions. They catalyze two different reactions at the same active site. The catalyzed reaction, the o-hydroxylation of tyrosin to DOPA and its subsequent oxidation to Dopaquinone, is the first step in the production of the brown pigment melanin. Thus phenoloxidasen (tyrosinases) are responsible for the brown color of skin and hairs. Furthermore they play an important role in the innate immune response of invertebrates and in the sclerotization of the arthropod exoskeleton.

However, recently it was shown for several crustacean and chelicerate species that hemocyanin can be activated to be a phenoloxidase using detergents or protease as activating agents. We have proposed that in some chelicerate species hemocyanin has taken the place of the phenoloxidase, since these species are lacking a phenoloxidase in their hemolymph. Thus hemocyanin could participate in the immune defence of these animals. Hemocyanin has developed in evolution from phenoloxidase. Now there is much evidence that the change in function was not total in all animals. In addition recently another role for hemocyanin in the immune response has been observed. In some crustaceans antimicrobial peptides can be cleaved off the C-terminus of hemocyanin upon stimulation with pathogens.

Here we will present a summary of the evolution of phenoloxidase and hemocyanin with respect to their structure, function and the innate immune response.

## V-S2.1 **Placental development of *Petromus typicus* and its bearing to the evolutionary history of hystricognath Rodentia**

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*Petromus typicus* is of special interest for revealing the evolutionary history of Hystricognathi, because it probably retained several plesiomorphic characters of this taxon. Within this context, characters of fetal membranes and their ontogeny are regarded as most important. Information on *Petromus* became only recently available, derived from a laboratory breeding group established by the author. Key results of this current project are presented with special reference to placental development during pregnancy. The differentiation of the offspring during pregnancy is slow in the beginning, but becomes more rapid close to parturition which occur 12 to 13 weeks after copulation. *Petromus* possesses a complete and very early inverted yolk sac that may take up histiotrophe from the uterus to supply the yet poorly developed embryo. During mid term, the close association between yolk sac and uterus becomes lost, and the chorioallantoic placenta begins to take over as the main region for fetomaternal exchange. A major change of the function of the yolk sac is indicated. Regions of the yolk sac establish an intimate contact to the chorioallantoic placenta, suggesting transfer of matter between these two placental types. In conclusion, the yolk sac placenta and the chorioallantoic placenta collaborate in supplying the embryo. The results of cladistic analysis including data from the literature by applying MacClade suggest that the mentioned characteristics of the fetal membranes are part of the stem species pattern of Hystricognathi. Their significance for evolutionary scenarios of Hystricognathi will be discussed.

## V-S2.2 **Evolution of female mating preferences in a cave-living fish (*Poecilia mexicana*: Poeciliidae: Teleostei)**

Martin Plath & Ingo Schlupp

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Cave-dwelling animals are unique model systems to study the effects of continuous darkness on the evolution of female mating preferences. Are formerly visually mediated preferences reduced once a species has colonized a lightless habitat? We examined the preference of *Poecilia mexicana* females to associate with (A) a large or a small male and (B) a well fed or a starved male in simultaneous choice tests. Females were tested under three experimental conditions: (i) The females perceived multiple cues from the males, (ii) only non-visual cues could be perceived in darkness, and (iii) only visual cues were presented. We used three populations strongly differing in their ecology: the first population occurs in a mostly clear river, the second one in a milky creek outside a cave, and the third population occurs in a limestone-cave. We found: (A) Surface females have a visual preference for large males. The visual preference is maintained in the cave form. Unlike the surface females, cave females prefer large males even in darkness. The determination of male body size is taken over by a non-visual sensory system, probably the lateral line. (B) The river dwelling females do not prefer well fed males. Cave entrance females have a visual preference. In the cave form, females exhibit a preference under all three conditions. A morphological comparison demonstrated that wild caught males from river habitats are typically in a good nutritional state. At the cave entrance, males were slightly malnourished. Inside the cave, males showed even stronger signs of malnutrition. The evolution of the female preference for good male nutritional state appears to be related to the indicator value of malnutrition in the different habitats.

### **V-S2.3 The new animal phylogeny: integration of molecular and morphological aspects**

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The “New Animal Phylogeny” – collected results from molecular systematics – is nowadays discussed as highly contradictory to “traditional” models of metazoan bauplan evolution. Most controversial implications of the New Animal Phylogeny are 1) the tripartition hypothesis, deviding Bilateria into three superphyla called Deuterostomia, Ecdysozoa and Lophotrochozoa, 2) the Urbilateria hypothesis, proposing a relatively complex – probably metameric – bilaterian ancestor.

Until recently, the New Animal Phylogeny has usually been compared to Hyman’s phenetic interpretations and more actual cladistic studies, always revealing irreconcilable differences. However, if morphological reconstructions deduced from structural-functional investigations are considered, the situation changes: Central results of the molecule-based “New Phylogeny”, especially the tripartition hypothesis and the Urbilateria hypothesis, gain support in this case. Most of these reconstructions are anagenetic models, and therefore often difficult to superimpose on a phylogenetic tree (as offered by the genetical studies). Detailed re-analysis of structural-functional transformations, as they are represented by anagenetic scenarios, is required before uniting them with phylogenetic branching orders. Remarkably, it can be shown that in the second half of the 20th century several authors developed sound morphology-based models which precede nearly all main implications of recent molecular analyses (including even the Articulata versus Ecdysozoa-controversy). As a result, the New Animal Phylogeny can be described as an evolutionary scenario which is supported by conclusions from two independent approaches: Structural-functional analyses and molecular systematics.

### **V-S2.4 Evolution of clutch size along latitudinal gradients: revisiting Ashmole’s hypothesis**

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Birds display a latitudinal gradient in clutch size. Ashmole’s hypothesis explains this geographic pattern by latitudinal differences in seasonality of resources resulting in different levels of winter mortality. The main problem with his hypothesis is that he does not take into consideration trade-offs for reproduction. Applying a simulation approach and concepts of life-history theory, we therefore re-evaluate his hypothesis. In particular, we analyse four alternatives for mechanisms that may generate a gradient in clutch size: (1) differences in levels of seasonality of resources causing winter mortality and no costs for reproduction (= Ashmole’s hypothesis), (2) differences in levels of seasonality of resources and costs for reproduction which may act on juveniles and/or adults, (3) no differences in levels of seasonality of resources but costs for reproduction, and (4) no differences in levels of seasonality of resources and no costs for reproduction. To model cost of reproduction three general cost functions were assumed: linear, hyperbolic or exponential decrease in future survival of individuals for increasing clutch sizes. Whereas the mechanisms implemented in alternatives (1), (3) and (4) did not generate a gradient in clutch size, those given in alternative (2) were able to generate this pattern. This suggests that Ashmole identified seasonality of resources as one important mechanism for geographic variation in clutch size, but did not recognize cost of reproduction as second mechanism. In the situations where a latitudinal gradient in clutch size build up in our simulations, widely accepted differences and correlations among life-table variables of tropical and temperate avian species did hold.

**V-S2.5 Long term fitness effects of early developmental stress**

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The social and ecological conditions that individuals experience during early life can have profound effects on their development and life history. In birds, it has been shown that nestlings raised in enlarged broods have reduced growth and as adults remain smaller than nestlings that did not suffer such stress during early development. Conditions experienced during early development then may affect reproductive performance later in life either in terms of mating success and number of offspring or in terms of offspring quality. Here, we studied long term fitness effects of early developmental stress mediated by different experimental brood sizes in zebra finches, *Taeniopygia guttata*. We cross fostered chicks to create nests with different brood sizes. Condition of offspring raised in these nests decreased with increasing brood size. In this contribution, I show results from a subsequent breeding experiment in which the females that were raised in different brood sizes were allowed to breed themselves after having reached sexual maturity. The results on breeding success, offspring biometry, and offspring condition reveal long term effects of early developmental stress experienced by the mother.

**V-S2.6 The effect of ploidy level on fitness in parthenogenetic flatworms**

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The impact of polyploidy on evolution in plant and animal kingdom is still unsettled. The adaptive significance of polyploidy can only be inferred by comparing different ploidy types in order to extract the effect of ploidy on fitness. However, differences in genetic background, habitat or reproductive mode, may interfere with ploidy effects. Here we present a system of triploid and tetraploid parthenogens of the planarian flatworm *Schmidtea polychroa*, where any fitness differences are likely to be due to different ploidy levels. Triploids and tetraploids occur in the same habitat, are both autopolyploids and parthenogens and even share the same genetic background due occasional sexual processes. We compared both ploidy types in body size, number of offspring, number of cocoons and duration until hatching.

Contrary to the general assumption of a positive correlation between fitness and ploidy level, we showed that triploids produced 58% more offspring than tetraploids. This is likely caused by differences in fecundity as the cocoon production is higher in triploids than in tetraploids while the number of offspring per cocoon is equal.

A deterministic model shows that despite of large fitness differences stable coexistence of triploids and tetraploids can be achieved, but only when observed rates of recurrent origin of tetraploids from triploids and *vice versa* (= "occasional sex") are implied. We discuss the impact of fitness differences and recurrent origin of triploids and tetraploids on the evolution of polyploidy and parthenogenesis in this species.

**V-S2.7 Impact of a social parasite on its host: field manipulations indicate a geographic mosaic of coevolution**  
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According to the geographic mosaic of coevolution theory, host-parasite interactions should vary between local communities due to differences in the strength of reciprocal selection pressures, leading to a patchwork of co-evolutionary ‘hot’ and ‘cold spots’. Such a geographic structure has been demonstrated for the interaction between the North American slavemaking ant *Protomognathus americanus* and its *Leptothorax longispinosus* host. A community in New York state with high host and slavemaker densities was shown to represent a coevolutionary hot spot with strong selection pressures, while another location in West Virginia was characterized as a ‘cold spot’. For example, demographic analyses revealed strong associations between the presence of social parasite colonies and the social organization, colony size and allocation patterns in the host at the New York site, while no such relationship was found in West Virginia. Correlational field studies, however, lack the power to disentangle cause and effect, and we hence manipulated slavemaker density in both sites in a long-term cross-fostering field experiment. Thus, we could not only directly study the impact of slave raids on both host populations, but also compare the effect of sympatric or allopatric parasites. Host density strongly decreased in West Virginian plots with local slavemakers in comparison to either parasite-free plots or those with New York social parasites, while at the ecological favorable, high density New York site, host nest density was unaffected by our treatments. We currently analyze the demographic and genetic composition of host colonies in response to our field manipulations, but our results already indicate strong geographic differences.

**V-S2.8 Gut feelings in tadpoles: physiological costs of predator induced plastic responses**  
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In a great variety of species specific defence traits are not expressed under lacking predation pressure, demonstrating that predator induced plastic responses are common. Costs associated to these responses are required to explain why the defence traits are not always expressed. Many models assume that these cost stem from reduced feeding. I experimentally investigated the effects of predator exposure on intestinal morphology, ingestion rate and digestion rate in tadpoles. Predator exposed tadpoles spent 30% less time feeding than non-exposed tadpoles, but in the reduced time spent feeding they ingested more food, and digested food more efficiently. At the same time they tended to have lower growth rates, demonstrating that the assumptions of models predicting increased ingestion with increased feeding and models predicting maximising ingestion to maximise growth are wrong. The high ingestion and digestion rate of predator exposed tadpoles is most likely explained by a physiological response, like a high metabolic rate. The impact of costs of avoiding predators, like reduced feeding activity, can be minimised by altering the intestine morphology and increase the ingestion and digestion rate. However complete physiological compensation for the costs of avoiding predators is apparently not possible, because individuals exposed to predation pressure usually grow slowly.



**V-S3.1 Reproductive resource allocation in a butterfly**

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The pattern of resource allocation to reproduction has critical consequences for individual fitness and is fundamental to numerous fields of research in behavioural, evolutionary and population ecology. Resource allocation in holometabolous insects such as butterflies is particularly interesting because diets and energetic needs change between life stages (e.g. herbivorous larvae and frugivorous adults). Given the need for resource congruence, storage, foraging and reproduction are linked strategies for such insects. Understanding the relative importance of stored (larval-derived) versus current (adult-derived) resources is thus a critical element for disentangling the functional basis of reproductive patterns.

We explore the link between resource availability and reproduction in the tropical fruit-feeding butterfly *Bicyclus anynana* by independently manipulating access to larval and adult food. Larval food stress induced predictable responses in life history traits, prolonging development time and reducing growth rate and pupal mass. Furthermore, early fecundity was significantly reduced, mediated by the concomitantly decreased body size. Adult food stress also reduced fecundity, but more interestingly interacted with levels of larval food stress. Females being stressed during larval development were not additionally affected by adult food stress, whereas females being fed ad libitum as larvae had to suffer reduced fecundity when access to adult food was limited. This interaction is apparently caused by the constraints imposed by the amount of resources accumulated during the larval stage. Effects of food limitation on egg size were less pronounced and less consistent.

**V-S3.2 Specificity of fragrance phenotypes of male orchid bees: patterns and possible mechanisms**

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Male orchid bees collect volatile chemicals and store them in specialized cavities in their hind tibiae. Although the purpose of these substances is still obscure, a signalling function in the context of mating behaviour seems likely.

Here we investigate the tibial contents of 110 individual males of three species of *Euglossa* from six localities in Panama and Costa Rica, and ask to what extent the fragrance composition is determined by species affiliation and/or by the local environment. GC/MS revealed more than 200 different terpenoid and benzenoid compounds of likely external origin. These compounds were distributed among individuals in a non-random way, both qualitatively and quantitatively. Multidimensional Scaling (MDS) based on quantitative Bray-Curtis similarities produced distinct clusters for each of the three species, *E. tridentata*, *E. imperialis*, and *E. cognata*, with surprisingly little substructure related to locality. The only exceptions to this pattern were *E. tridentata* from the tiny Costa Rican offshore island, Isla del Caño. These individuals had only very small amounts of fragrances in general and seemed to have been deprived of their species' preferred scent sources. Within species clusters the average similarity of individual fragrance composition to that of conspecifics increased with the total amount of fragrances collected. Our results demonstrate that specificity is an emergent property of the acquired 'bouquets' and suggest tentatively a role in species recognition during courtship. The findings also raise successive questions concerning sensory and behavioural mechanisms that mediate the accumulation of specific and complex odour blends.

**V-S4.1 Testing the sensory exploitation hypothesis: The evolution of a pheromone in males of the European beewolf *Philanthus triangulum* (Hymenoptera: Sphecidae)**

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The evolution of pheromone communication is still not well understood. The sensory exploitation hypothesis predicts that male sexual signals might evolve according to pre-existing sensory abilities of the females. Here we present the first results testing the sensory exploitation hypothesis in a solitary wasp, the European beewolf. Females hunt exclusively honeybees as provisions for their larvae. Males scent mark territories to attract females. The co-occurrence of (Z)-11-eicosen-1-ol in the male pheromone and in the alarm pheromone of honeybees suggests that males might exploit the sensory ability of females. Our results, obtained by chemical analysis and behavioral assays, support a three step scenario for the evolution of the male pheromone. First, (Z)-11-eicosen-1-ol can be found on the cuticles of honeybees and in the air surrounding foraging honeybees. Thus, foraging honeybees smell of (Z)-11-eicosen-1-ol and beewolf females could use this characteristic odor as a kairomone. Second, olfactory cues are responsible for eliciting attacks on honeybee prey and (Z)-11-eicosen-1-ol plays a crucial role in the identification of the honeybees. Females therefore seem to possess special sensory (olfactory) abilities that evolved to maximize their success in detecting and capturing honeybees. Third, a reanalysis of the pheromone revealed an extensive congruence between the male pheromone and the cuticular hydrocarbons of honeybees (8 of the 11 components of the male pheromone also occur on honeybees). This congruence strongly supports our hypothesis that beewolf males evolved a pheromone that exploits the females' pre-existing sensory sensitivity.

**V-S4.2 Age-dependent modulation of song behaviour and the size of the song control system in canaries (*Serinus canaria*)**

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In songbirds there is considerable interest in the relationships between song behaviour and the size of the song control system in the forebrain. Thereby, male domesticated canaries (*Serinus canaria*) have become a classical example to study these brain and behaviour relationships. Earlier studies on canaries have reported that, song repertoire size increased with age and positive correlations were obtained between repertoire size and the volume of song control nuclei such as HVC and RA. Here we present data that did not support these relationships. We recorded songs from one and two year old male canaries that lived in a mixed-sex aviary population. We found that repertoire size, number of sexually attractive (sexy) syllables and size of song nuclei did not differ between one and two year old males. Neither did we find significant correlations between syllable repertoire size and the size of the song control nuclei. However, HVC size was positively correlated with the proportion of sexy syllables in the repertoires of two year old males. Therefore, male canaries are likely to modulate vocal performance by modifying the control of syllables with age rather than by increasing repertoire size or neural space, which promotes the differentiation of sub-repertoires. We further are able to compare these results with earlier findings of song control in a natural population of free-living wild canaries that advances our understanding of long-term song modulation in songbirds.

**V-S4.3 A sexual preference modified by an audience effect**Ingo Schlupp<sup>1,2</sup>, Ashley Rioux<sup>2</sup>, Katja Heubel<sup>1</sup> & Michael J. Ryan<sup>2</sup><sup>1</sup>Universität Hamburg, Biozentrum Grindel, Martin-Luther-King Platz 3, D-20146 Hamburg [schlupp@uni-hamburg.de]; <sup>2</sup>University of Texas at Austin, Section of Integrative Biology, Austin, TX 78712, USA

Recent studies have indicated that female sexual preferences are influenced by the social context, especially other females. Here we investigated how the sexual preference of males is influenced by the presence of a male audience. In typical, simultaneous choice tests males of the Sailfin molly (*Poecilia latipinna*) were given a choice between females of the same species and females of another species, *Poecilia formosa*, which uses *P. latipinna* sperm to trigger embryogenesis of its ameiotic eggs. We find that (1) males significantly alter their sexual preference in the presence of another male, but not in our control experiments with a heterospecific audience, (2) this effect is not size dependent, (3). We conclude that males modify their sexual behaviour in the presence of an audience and that signalling interactions leading to mate choice are better understood in the context of communication networks.

**V-S4.4 Turbidity affects association behaviour in male Sailfin mollies (*Poecilia latipinna*) (Teleostei)**Katja U. Heubel<sup>1,2</sup> & Ingo Schlupp<sup>1,2,3</sup><sup>1</sup>Biozentrum Grindel, Universität Hamburg, Martin-Luther-King-Platz 3, D-20146 Hamburg, Germany [kheubel@uni-hamburg.de]; <sup>2</sup>Section of Integrative Biology C0930, University of Texas, Austin, TX 78712, USA; <sup>3</sup>Zoologisches Institut und Museum, Universität Zürich, Switzerland

In nature, communication always occurs in an ecological context. When signalling, individuals have to cope with environmental background noise. Turbid water interferes with visual communication in poeciliids. We studied male mate preferences in the sexual/asexual mating complex of the gynogenetic Amazon molly *Poecilia formosa* in clear and turbid environments. The sexual-parasite *P. formosa* “seduces” other closely related males to obtain sperm to trigger embryogenesis but the male genome is excluded from producing clonal all-female offspring. In mixed populations, males mate with conspecific sexual females and heterospecific asexual females. In South and Central Texas, *P. formosa* lives in syntopy with *Poecilia latipinna* as its sexual host species. We sequentially measured association time of *P. latipinna* males with conspecific sexual and heterospecific asexual females in clear and turbid water. We found that turbidity has an influence on male mate choice behaviour. Males spent less time with any kind of female stimulus in turbid water. There was no preference for conspecific sexual females – neither in turbid water nor under clear conditions. Also, origin of males and acclimatisation to turbid water had no effect. We discuss how turbidity as a source of visual noise might affect communication among individuals and how this environmental factor might contribute to the stability of this sexual-asexual mating complex in nature.

**P-1 Ultrastructural investigations on Holothyrida (Acari: Anactinotrichida)**

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Holothyrida (= Tetrastigmata), represent besides Opilioacarida, Ixodida, and Gamasida one of the high ranking anactinotrichid groups. Here, the following structures were investigated fine structurally, mostly for the first time, using a yet undescribed Tasmanian species of *Allothyrus*. The gnathosoma shows features typical of anactinotrichid mites, e.g. an infracapitular gutter and sternapophyses. The lateral lips are provided with conspicuous spines and the labrum bears numerous short denticles. The chelae are elongated, partly saw-like structures. Typical tracheae start from one (!) pair of lateral stigmata. These stigmata are located in a conspicuous peritreme. It likely helps a plastron function. Large paired glands open at the dorso-lateral surface of the opisthosoma (Thon's organs). They are composed of large cells of differing ultrastructure and discharge their secretions in a conspicuous branching system of ducts. A peculiar paired deep pit, called peridium, is located close to the bases of legs IV. It is filled with numerous spines and is connected to several glandular units. The heart is a short tube composed of a simple layer of muscle cells. The male genital system develops spermatozoa of the vacuolated type, which are delivered via paired vasa deferentia. A large accessory genital gland is opening into the area where the vasa join to form the ductus ejaculatorius, which leads to the medioventrally located genital opening. The presence of a heart and vacuolated sperm supports the interpretation of Holothyrida as an early derivative anactinotrichid taxon. Instead, the, e.g., existence of typical peritremes is consistent with the interpretation that Holothyrida is the sister group of Gamasida.

**P-2 The role of vocalisations for speciation in small nocturnal malagasy primates**

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The grey mouse lemur (*Microcebus murinus*) and the golden brown mouse lemur (*Microcebus revelobensis*) represent genetically distinct sibling species which reveal only slight differences in morphometric patterns and habitat use. In some areas of western Madagascar, these cryptic nocturnal primates occur sympatrically. Selection should favour the diversification of signalling and recognition systems in coexisting sibling species to guarantee the recognition of conspecifics and assortative mating. We compared the vocalisation of both species to identify the degree of interspecific acoustic variation. The response to conspecific and heterospecific calls was studied by playback experiments in order to gain insight into the respective recognition mechanisms. Vocalisations used for long distance communication showed a different level of interspecific distinctiveness. Calls given during rallying sleeping group members and during mating differed between species with regard to syntax (syllable form and structure), whereas calls used in attention and alarm contexts were statistically similar. In playback experiments, the grey mouse lemur did not differentiate between the heterospecific, statistically indiscriminate calls, but between the species-specific calls. They exhibited significantly stronger reactions towards conspecific than towards heterospecific calls differing in syntax. The evolution of species-specific vocalisations in an area of sympatry might reduce reproductive costs of hybridisation by acting as a premating isolation mechanism. Supported by DFG.

**P-3 Occurrence and evolution of hemocyanins in insects**Silke Hagner-Holler<sup>1</sup>, Axel Schoen<sup>2</sup>, Heinz Decker<sup>3</sup> & Thorsten Burmester<sup>4</sup><sup>1</sup>Institute of Zoology, Johannes Gutenberg Universität, Mainz [hagnerho@uni-mainz.de]; <sup>2</sup>Institute of Molecular Biophysics, Johannes Gutenberg Universität, Mainz [bioaxel@web.de]; <sup>3</sup>Institute of Molecular Biophysics, Johannes Gutenberg Universität, Mainz [decker@biophysik.biologie.uni-mainz.de]; <sup>4</sup>Institute of Zoology, Johannes Gutenberg Universität, Mainz [burmeste@uni-mainz.de]

Hemocyanins, copper-containing respiratory proteins, serve as oxygen carrier in many arthropods. Insects possess a well elaborated tracheal system. Therefore respiratory proteins appeared to be unnecessary. Hemocyanin had not been reported in insects so far, with the exception of a hemocyanin-like protein in the embryonic hemolymph of the grasshopper *Schistocerca americana*. Nevertheless we identified a functional hemocyanin in 1–3 years old larval and adult stoneflies. The stonefly hemocyanin is composed of two distinct subunits, each containing a N-terminal signal sequence for translocation through the endoplasmatic reticulum, resulting in native polypeptides of 659 and 655 amino acids (77.2 and 76.3 kDa). The stonefly hemocyanin displays cooperative oxygen binding with a moderately high oxygen affinity. Sequence comparisons show that both hemocyanin sequences display the highest identity with the embryonic hemolymph protein of *S. americana*, lower similarity scores were observed with other hemocyanins or hexamerins (insect storage proteins that have lost their ability to bind oxygen). Phylogenetic analyses show that insect hemocyanins (including the *S. americana* embryonic hemolymph protein) are basal to the insect hexamerins, suggesting that the insect storage proteins evolved after the separation of the Hexapoda from a putative crustacean ancestor. The stonefly hemocyanin subunit 2 appears to be of more ancient phylogenetic origin, diverging even before the time the Crustacean and Hexapoda split, and thus rendering the insect hemocyanins paraphyletic. Further examinations revealed a hemocyanin at *Thermobia domestica*, whereas many other investigated insects seem to lack this respiratory protein.

**P-4 Chemical imprinting and sympatric speciation in a slave-making ant**

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Social parasitism, the parasitic dependence of one species of social insect on another, is particularly common in the ant tribe Formicoxenini. Although it comprises only about 350 of a total of more than 11000 described ant species, it contains more than 10 percent of all known parasitic ants. Until now it is unclear, which factors favour the diversification of social parasites.

Previous investigations by Schumann and Buschinger showed that *Chalepoxenus* slave-makers imprint to the odour of their *Temnothorax* slaves. They obtain new slaves predominantly by raiding nests of the species already present in their own colonies and young queens found new colonies mostly by usurping nests of the familiar host species. *Chalepoxenus* live syntopically with several *Temnothorax* species but in a single locality typically parasitize only one of them. By behavioural experiments and gas chromatography we investigated whether such a specialization on a single host species can lead to speciation after accidental switch to another host. To determine whether the presence of a given slave species affects the mating preferences of slave-makers, we reared *C. muellerianus* sexuals with either *T. unifasciatus* or *T. recedens* slaves and conducted mating experiments in flight cages. Furthermore, we analysed the chemical bouquet of parasites and hosts. Our preliminary results show that parasite sexuals from colonies with different slave species were attracted less to one another than to sexuals from colonies with the same host. Accidental host transfer followed by imprinting on the new host species may lead to decreased gene flow among slave-maker subpopulations. Supported by DFG (He 1623/13-1, 2).

**P-5 Phylogenetic reconstruction of howler monkeys: (Primates: *Alouatta*) a coevolutionary relationship between vocal and hyoid bone characters**  
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The purpose of this study was to analyse the phylogenetic relationships of howler monkeys, with the aim to define specie-specific characters. From a total of 172 female and male skulls, 45 characters were measured from 5 species and 9 subspecies. Skulls belong to collections from Tuxtla Gutiérrez Chiapas Museum, Biology Institute at the National Autonomous University of Mexico, and the Natural History Museum of Smithsonian Institution in Washington D.C.

In order to find out if sexual dimorphism generates alternative phylogenetic hypotheses and what characters are under selective pressures, characters and its allometry were statistically analysed regarding gender. Independent contrast analysis showed that width orifice of hyoid bone and low component of emphasised frequency are strongly correlated. Fifty percent of skull's character were informative to resolve the relationships within *Alouatta*. The hyoid bone was the most informative character to establish discrete states. Including both sex for phylogenetic reconstruction, results indicated that the taxonomy of subspecies, should be reconsidered.

Evaluations of male and female cranial characters depict different evolutionary process. This suggests that different degrees of selective pressures for each species generated sexual dimorphism. Dimorphism could be the result of sexual selection or other factors, e.g. territoriality, locomotion, and acoustical environment. On the other hand, evolution of phonatory organ complexity in howler monkeys could be determined by internal selection, more than external selection, so that covariation patterns should to be more informative. More studies about coadaptation and covariability processes in cranial features are necessary.

**P-6 Genotype-specific diversity in the response of *Caenorhabditis elegans* towards *Bacillus thuringiensis***  
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Host organisms may possess complex defences against pathogens and parasites, including an avoidance behaviour, physical barriers and different immunological responses. Recently, the free-living soil nematode *Caenorhabditis elegans* has been introduced as a model for the comprehensive analysis of host defence. We here report on an assessment of the response of different natural *C. elegans* strains towards different natural strains of the Gram-positive soil bacterium *Bacillus thuringiensis*. Our results show that there are significant genotype-specific differences in overall immunity among different host strains. Similarly, host strains vary in their ability to actively evade pathogens. Furthermore, we can show that pathogens generally induce formation of a long-lasting, highly resistant stage, the dauer stage, during host development. Surprisingly, however, dauer stage formation is not induced by one of the most virulent pathogen strains, indicating lack of a suitable pathogen recognition receptor in the host strains. In summary, our results highlight that the *C. elegans* defence comprises behavioural and also physiological components. They also show that there is significant natural variation in the ability of different host strains to cope with pathogen threats. This variation may be exploited in the future for a detailed molecular analysis of the defensive repertoire in this nematode.

**P-7 *Caenorhabditis elegans* as a model system for environmental genomics**

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The nematode *C. elegans* is a very useful model system to study the role of membrane transport proteins for epithelial function, because of its morphological simplicity, its transparency, the availability of the genomic information and the easy applicability of RNA interference (RNAi) for gene silencing (specific degradation of mRNA).

The functional role of specific proteins is assessed by RNAi and investigations of the resulting phenotypes studied: we combine studies on the mRNA level (quantitative RT-PCR) and protein level (transgenic worms with reporter gene expression) with physiological studies on the epithelial cells of pharynx and gut using fluorescent probes.

RNAi effects concerning the morphology are difficult to identify. Methods has been established to specifically stain intestinal cell nuclei with the DNA-selective fluorescent dye HOECHST 33258 and in addition the plasma membrane of gut cells with FM1-43. These approaches are used to collect morphometric data and to investigate differences in the post-embryonal development and morphology of the intestine in untreated worms (wildtype) and RNAi animals.

**P-8 MHC variation in the Eider duck throughout Europe: Founder effects vs. balancing selection**

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After the pleistocene glaciation, Northern Europe has been recolonized by Eider ducks (*Somateria mollissima*) in a stepwise colonization process, as suitable habitat became available following the retreating glaciers. This is particularly evident on Iceland, which had been reinvaded from a presumable Southern Scandinavian refugium via several steps (North Sea, Faroe Islands). In theory, such a repeated founding event should lead to a decrease in genetic variation at every step. The Major Histocompatibility Complex (MHC) determines the immunocompetence of vertebrates. Intraindividual variability in the MHC-encoding genes is known to be adaptive and is maintained by balancing selection. We use the Eider duck as a model to investigate, how this adaptive genetic variation is impacted by repeated founding events. Our sequence analysis of the MHC IIB exon 2 indicates that large amounts of MHC variability are transmitted during the postglacial colonization such that the Icelandic Eider population is genetically as variable as the population in continental Europe. However, one of the intermediate colonization steps, ie, the Faroese Eider population, harbours apparently much less MHC variability. This contradicts the colonization history, but is well corroborated by population size estimates: The Faroese population counts only 5,000 pairs, about 100 to 500 times less than the other populations analyzed here. From a conservation point of view, long term effective population size has apparently a much more severe impact on MHC variability than a short bottleneck during a founding event.

We acknowledge financial support from the DFG (TI 267/1) and the Brachet Foundation, Brussels.

**P-9 Three-spined sticklebacks seen in a different light**  
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Recent studies evidenced that some fishes use ultraviolet light in social signalling. Using reflexion spectrophotometry we showed that reproductively active male sticklebacks also reflect in the UV-light (300–400 nm). Several body regions showed a reflectance peak in the UV-waveband. Silvery appearing regions reflected stronger than red-coloured and darker ones. Males within one population varied in UV-reflection. The UV-contrast of one particular region was positively correlated with physical condition.

**P-10 Diversity and evolution of optical designs found within the compound eyes of several infralittoral anomuran crustaceans from the Western Mediterranean Sea**

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It has generally been accepted that in terms of compound eye histological and fine structural designs, spectral sensitivity as well as optical capacity of individual ommatidia, the crustacean compound eye displays the highest degree of diversity amongst all recent euarthropods. However, most of what we know about compound eye diversity is essentially based on morphological and physiological research of large crustaceans like crabs, shrimps, lobsters, or stomatopods, whose ommatidial structures can be regarded as thoroughly understood. In contrast, the eyes of Anomura, especially those of the Paguroidea, have been rather neglected, even if they were expected to have developed the highest number of optical types amongst the Decapoda. The ommatidial organizations of the 17 examined paguroids and galatheoids, sampled in the infralittoral of Ibiza (Spain) and Sipan (Croatia) diverged from the decapodan ground pattern. Considerable deviations concerned distribution of distal accessory pigment cells, structure and function of corneogeneous cells, and arrangement of rhabdomeres. Furthermore, four classical and at least three intermediate types of apposition and superposition optics were found in connection with anomuran ommatidia. The occurrence of reflective superposition was limited to galatheoid taxa. Both morphological and molecular genetic data, which were obtained from mitochondrial 16S, indicate that a convergent evolution of parabolic superposition and apposition eyes might have occurred within the infralittoral Mediterranean Paguroidea, whereas the type of refractive superposition eye may have evolved only once in their ancestral lineage. It is believed that the Galatheoidea have retained reflective superposition optics, the latter assumed to be plesiomorphic to all decapod species.



**P-11      Hydraulic mechanisms in the development of echinoderm larvae –  
Implications for the evolutionary history of echinoderms?**  
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The early development of echinoderm larvae is characterized by the formation of fluid filled coelomic cavities. These coelomic cavities are maintained throughout the entire ontogenetic development, and they interact with each other in a characteristic way, determined by the principles of hydromechanics. From detailed analyses of subsequent stages of echinoderm larvae we can conclude that the shape of an adult echinoderm and the pentameric organisation is largely determined by the hydromechanical interaction of coelomic fluids and the developing skeletal elements.

Principles of ontogenetic development are usually assumed to provide implications for evolutionary reconstruction. However, ontogeny and phylogeny are quite different processes which have to be analysed in different ways. To investigate the phylogeny we can only reconstruct anagenetic relations, which means that we reconstruct the transitional steps which were necessary to transform one organic design into another. In contrast, ontogenetic development has to be understood as an economic process of shape preformation by hydraulic interaction, followed by tissue differentiations and stabilisation. Accordingly the hydraulic conceptualisation of the ontogeny of echinoderms tells us much about the individual development, but only few about echinoderm evolution.

**P-12      Evolution of dorsal chitin-cuticles within entoprocts & molluscs**  
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The body wall cuticles of adult molluscs and entoprocts were investigated by transmission electron microscopy. Lowicryl K4M sections were labelled with the Lectin *Wheat Germ Agglutinin* (WGA) conjugated to colloidal gold. The dorsal cuticle of the colonial entoprocts *Urnatella gracilis* and *Pedicellina cernua* exhibit a trilaminar cuticle. The stalk-cuticle consist of a homogenous surface-coating epicuticle, a fibrous exocuticle, and a basal amorphous layer which is strongly labelled by the Lectin conjugate. We could give a detailed description of the organisation of the cuticles and clarify whether the occurrence of chitin is restricted to a particular layer.

The monolayer-cuticle of the solitary entoproct *Loxosomella atkinsae* screened with the lectin WGA provides no evidence for the presence of chitin; whereas the homogenous cuticle of *Chaetoderma nitidulum* (Aplacophora) shows intense labelling. Ultrathin sections of embedded *Lepidochiton cinereus* (Polyplacophora) of periostracum and additionally its secreting perinotum were labelled intensively in distinct area by the immunogold conjugates. Chitinase treatment or competitive inhibition with N'-N'-N' Triacylchitotriose exclude labelling almost completely. The binding of WGA in connection with controlling experiments indicates the presence of chitin.

In conclusion with this studies, a dorsal chitin-cuticle might represent apomorphic condition in ground pattern within the taxon Lacunifera. To evaluate between the apomorphic or plesiomorphic state of the given feature, the probable sister group of the Mollusca, the entoprocts should be taken into closer consideration.



## SG3 Studiengruppe Morphologie

### V-S1.1 **Morphological and functional properties of a muscle tension receptor in an insect: A comparison with the Golgi tendon organ of vertebrates** M. Wanischek & Uwe Rose

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Vortrag verschoben in SG4: V-S2.4

### V-S1.2 **Crystalline structures in the midgut of the grape leafhopper** *Empoasca vitis*

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Translucent octahedral crystals were found in the midgut of grape leafhoppers. The chemical structure of the crystals was analysed by X-ray structure analysis as L(+)-calcium tartrate. This unique compound was found for the first time in insects. The size of the crystals varied strongly between and within individuals with a mean length of  $153 \pm 87 \mu\text{m}$  and a mean width of  $71 \pm 46 \mu\text{m}$ . Also, the no. of crystals/individual showed a broad variation and ranged from 1 to 150 crystals/individual.

Grape leafhoppers are polyphagous phloem sucker, that reproduce on vine. In Franconia, they produce one generation per year. Occurrence of calcium tartrate crystals as well as the no. of crystals per individual followed the seasonal pattern of tartrate concentrations in the vine leaves: only 7–10 weeks after immigration, while tartrate concentrations in the vine leaves start to increase, calcium tartrate crystals were observed in the midgut of nymphs as well as of adults. With further increase of tartrate concentrations in the leaves during continued vegetation growth and ripening of the vine the percentage of leafhoppers carrying crystals increased as well. This was accompanied by a continuous calcium tartrate accumulation in the gut of the leafhoppers. At the onset of the senescence of the vine leaves, when tartrate concentrations in the leaves drop, the presence of crystals as well as the no. of crystals per leafhopper declined accordingly. After emigration leafhoppers with calcium tartrate were only rarely observed. During overwintering and spring immigration no crystals were found in the midgut of grape leafhoppers.

The functional significance of calcium tartrate accumulation in the gut system of grape leafhoppers is discussed.

**V-S1.3 Fine structural aspects of the sperm storage organ in the female trapdoor spider *Antrodiaetus unicolor* (Araneae: Antrodiaetidae)**  
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The typical haplogyne genitalia of a female trapdoor spider *Antrodiaetus unicolor* are characterized by two pairs of spermathecae which are the site of sperm storage. Each single spermatheca is connected to the bursa copulatrix and divided into three main parts: stalk, bowl and bulb, which are surrounded by the spermathecal gland. The epithelium of the spermathecal gland is underlain by a muscle layer and consists of different types of cells partly belonging to glandular cell complexes (class 3 gland cells) which extend into pores in the cuticle of the stalk and bowl. Each glandular unit consists of usually one or two central secretory cells which are for the most part surrounded by a connecting cell that again is surrounded by a canal cell. The canal cell is separated from the other epithelial cells by several thin sheath cells that form the outer enveloping layer of the unit. The secretions are released through a cuticular duct that originates between the apical part of the connecting cell and the apical microvilli of the secretory cells and runs into a pore of the spermathecal cuticle. These glandular products of the class 3 gland cells likely are important for the conditions allowing long-term storage of the spermatozoa in this species. Remarkably, the bulb of the spermatheca possesses cuticle, which is hardly sclerotized and lacks glandular pores. This peculiarly structured bulb probably plays an important role in the discharge of the sperm mass and may allow postcopulatory female choice.

**V-S1.4 Morphology, histology and secretions of hind tibial glands of male orchid bees, *Euglossa cognata***  
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Male orchid bees collect volatile chemicals and store them in cavities in their hind tibiae. Although the purpose of these substances is still obscure, a signalling function in the context of courtship seems likely. The fragrance containers of *Euglossa* sp. are cuticular invaginations densely filled with hairs, which makes them effective for retaining volatile contents. In addition, the hind tibiae of some *Euglossa* are known to contain glandular structures with hitherto unknown secretions and function.

Here, we investigated a large accessory gland present in hind tibiae of *Euglossa cognata*. Scanning electron and light microscopy revealed a glandular epithelium composed of a single layer of large secretory cells lining invaginated and folded cuticle. The reservoir that is created by these folds is connected to but morphologically distinct from the fragrance container. For chemical analysis we separately extracted (a) accessory glands, (b) fragrance containers and (c) heads of four individual male *E. cognata*. In extracts of fragrance containers GC/MS revealed numerous terpenoid fragrance compounds as well as a variety of fatty acid derivatives. Most of these lipids were also present in cephalic extracts and represent the labial gland secretions which are used in the fragrance collection process. Accessory gland extracts were characterized by two clearly overrepresented components, the monounsaturated oleic acid (C-18), and 1-Hexadecanol (C-16). It seems likely that both are secreted by the glands in question, but their function has yet to be investigated in behavioural experiments. We speculate that they are true pheromones that enrich the males' cumulative bouquet of external odour components.

### V-S2.1 **Morphometric analysis of the larval branchial chamber in the dragonfly *Aeshna cyanea* (Insecta: Odonata: Anisoptera)**

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The aquatic larvae of the anisopteran dragonflies possess tracheal gills located in the rectum. In *Aeshna cyanea*, gills consist of longitudinally oriented curtain-like secondary folds that extend into the rectal lumen from six primary folds. Tracheae enter the base of the primary gill folds, ramify within the hemolymph space of the secondary folds and form tracheoles, which end blindly within the epithelium. Ventilatory activity of the hindgut increases under hypoxic conditions, indicating the importance of matching rectal gill ventilation with metabolic demand. Despite these indicators of the importance of rectal gills in gas exchange, quantitative studies are lacking that could test the hypothesis that these respiratory organs alone can satisfy the metabolic demand of this active, carnivorous insect.

Using stereological methods, we estimated the morphometric diffusing capacity for oxygen (DMO<sub>2</sub>) across the gill epithelium, i.e., from rectal water to the gill tracheoles, and developed and empirically compared various structural models for gas exchange. A 271 mg larva has a total branchial surface area of approximately 12 cm<sup>2</sup>. Tracheoles make up 6% of the epithelial volume of the gills; the harmonic mean thickness of the water-tracheolar diffusion barrier is 0.27 μm and consists mainly of cuticle. The calculated DMO<sub>2</sub> is 23.0 μl min<sup>-1</sup> g<sup>-1</sup> kPa<sup>-1</sup>, which, using published values for oxygen consumption in a similar species, would result in a mean driving pressure of 0.2 kPa at rest and 1.3 kPa during activity. Since these driving pressures are similar to those reported for other arthropods, we conclude that the DMO<sub>2</sub> of the gill is not rate limiting for aerobic metabolism in *A. cyanea* larvae.

### V-S.2.2 **About the fine structure and evolution of scolopendromorph eyes. Do they represent modified scutigermorph ommatidia or newly derived ocelli?**

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Based on previous light and electron microscopic examinations the occurrence of two main groups of chilopodan eyes was suggested: (a) notostigmophoran compound eyes with a bi-layered rhabdom and ommatidia containing a crystalline cone made up of four crystalline cone cells and (b) pleurostigmophoran ocelli with ommatidia equipped solely with a corneal lens. According to the recently confirmed Pleurostigmophora concept, it is still a matter of a discussion whether the pleurostigmophoran ocelli could have developed either by transforming and/or aggregating notostigmophoran ommatidia or by evolving a new, stemmata-like eye type. However, to date in Pleurostigmophora only the fine structure of the lithobiomorph eyes had been investigated; analogous studies on scolopendromorph or craterostigmomorph eyes were lacking. The lateral eyes of *Scolopendra cingulata* Latreille, 1789 were examined by electron microscopy. Each optical unit consists of a large, invaginated cornea (secreted by numerous corneogeneous cells) and a rudimentary, bi-layered retinula, made up of approximately 1000 retinula cells. The cup-shaped eye is surrounded by ramified and small protective cells, which lack pigment granules and whose narrow processes form membrane layers. Special pigment cells are only present outside the eye where they are surrounding the eye cup and running directly underneath the epidermis of the neighbouring head areas. The phylogenetic significance of the retinal cellular components of *S. cingulata* is discussed with regard to existing hypotheses of the pleurostigmophoran eye evolution.

**V-S2.3 Histological and immune histochemical investigations on the pyriform appendage of *Nautilus pompilius* (Mollusca, Cephalopoda)**  
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Nautiloid cephalopods possess an organ, that is situated close to the ventricle of the heart and to the unpaired gonad. This so-called pyriform appendage shows no communication with the heart, ends blindly, and opens into the mantle cavity by a narrow duct (Keferstein W 1866 Malacozool Blätter 13: 21). The aperture of this duct shows the same position on the left side like the genital aperture on the right side of the animal. This has given rise to the assumption that the pyriform appendage represents a rudimentary, blindly ending left oviduct (Lankester ER & Bourne AG 1883 Quart J Micro Sci: 340).

In order to clarify at first the morphology and histology of this organ, the pyriform appendage of *Nautilus pompilius* was investigated by histological, enzyme histochemical and immune histochemical methods.

The pyriform appendage is surrounded by an isoprismatic epithelium containing single alcian blue/PAS-positive goblet cells. A layer of connective tissue with mainly circular running muscle fibers and blood vessels borders on the outer epithelium. The organ is covered by a secretory cuboidal epithelium. The connective tissue forms longitudinal folds to enlarge the surface area. Catecholamine fluorescences, immune precipitates against the tetrapeptide FMRF-amide and the proof of the specific acetylcholine esterase demonstrated within the connective tissue layer indicate a finely balanced innervation of this organ.

These findings suggest that the pyriform appendage probably has still a putative function and represents no rudimentary organ.

**V-S2.4 Comparative immunohistochemical investigation on wounded, infected and parasitized 5<sup>th</sup> instar larvae of the tobacco-hornworm *Manduca sexta***  
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Insects are exposed to a constant attack of viruses, bacteria, fungi and parasites. In order to survive they had to develop an efficient immune system. This immune system is based on cellular and humoral mechanisms. The cellular part is carried by the cells of the hemolymph, the haemocytes. Subpopulations of these cells are able to ingest small pathogens such as bacteria by phagocytosis. Larger pathogens are enclosed and killed by forming multicellular nodules or capsules. The humoral part is composed of antibacterial and antifungal proteins, which are produced by different tissues and released to the haemolymph as well as coagulation and melanization reactions. These immune reactions e.g. the proteolytic prophenoloxidase activating cascade that leads to melanin formation are triggered by binding of pattern recognition proteins (PRPs) to pathogen structures. The PRPs recognize molecular patterns of microbial cell walls, e.g. bacterial lipopolysaccharide, lipoteichoic acid and peptidoglycan or fungal  $\beta$ -1,3-glucans. PRPs of insects are partly similar to other arthropod and even vertebrate PRPs, pointing out their important role in immune defence.

In order to understand functioning and interaction of PRPs, other immuno-regulatory relevant proteins e.g. proteases and protease inhibitors in relation to hemocyte defense reactions we analyzed the distribution of these proteins and hemocytes on cross sections of 5<sup>th</sup> instar *Manduca sexta* larvae by immuno-histochemical techniques with mono- and polyclonal antibodies and lectins. We compared sections and isolated haemocyte monolayers of *Manduca* larvae at different time points after wounding, bacterial infection and parasitization by the wasp *Cotesia congregata* with untreated larvae. (Financial support by the DFG TR254/2-3).

## V-S2.5 **Horse locomotion – a kinematic study of the limb and back motion in sound and lame horses**

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This study evaluates the characteristic movement pattern of the back and of each limb joint in 7 sound 10 and lame horses. The horses showed different degrees and origins of lameness. Recordings were taken on a treadmill using the three-dimensional, infrared-based analysis system Qualisys and a computer cinematography-based system (marquis). Projections of these three-dimensional data into the sagittal plane are used to examine the range of motion, the changes of the parameters with increasing speed and the individual variability. Additionally, the three-dimensional angle courses are calculated to analyze the actual joint movement. The entire motion is almost completely limited to the sagittal plane. Only the mid back (T18) shows not only flexion-extension movement but also lateral bending and axial rotation. This region is the most flexible part of the vertebral column and responsible for the tilting of the pelvis. The analysis of lame and sound horses reveals no characteristic changes of parameters correlated with the type of lameness. Every horse showed its individual movement pattern depending for instance on training, characteristics of individual muscles and skeletal anomalies. Even sound horses exhibit asymmetric locomotion patterns. Surprisingly, the most symmetric and regular angle-courses are observed in a horse suffering hind limb lameness. The contribution of the limb segments to the propulsion is also calculated. The scapula contribution is increasing from  $\pm 30\%$  to  $\pm 51\%$  comparing walk with trot.

## V-S2.6 **Dental adaptations in ruminants – Do they chew the way they eat?**

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Transverse mastication systems such as the selenodont molars of ruminants disintegrate plant tissues by shearing forces exerted from opposed edges, which slide on one another. Depending upon the angle of the edges this shearing system is more or less effective and the effect may range from separation through cutting to blunt separation with all transitional stages in between. In order to discern the function of enamel ridges, the occlusal ridge patterns are digitally reduced to their functional residuals in respect to functioning as a shearing system. Leading edges are discriminated from trailing edges. The functional residuals are investigated in respect to their alignment in relation to the chewing direction in 40 wild ranging ruminant species. These species represent three size classes and belong to three major feeding groups as browser, mixed feeder and grazer. Discriminant analysis enables separation of the three feeding classes based on shearing edge alignments. Discrimination was more distinct if size classes were analysed separately. Maintaining highly efficient slicing functionality is found to be the most critical adaptation in all species whose diet is to a certain extent made up of grass. The homogeneity of the forage is another critical factor for edge alignment optimization. In this respect, small grazers and large browsers have to cope with a lower degree of homogeneity in their diet than large grazers. This has driven evolution to introduce lower angled faces to small grazers and large browsers in order to smoothly cut veins and lignifications.

**V-S2.7 Arboreal locomotion of the chameleon (*Chamaeleo calytratus*: Sauria)**

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Chameleons are known as highly adapted to arboreal life. We study if there are adaptations to the arboreal mode of life in the metric and kinematic parameters. The locomotion of *Chamaeleo calytratus* is analysed using cineradiography and a 3D motion analysing system (Qualisys®). After knowing arboreal locomotor adaptations in mammals we are interested in studying non mammalian arboreal living amniotes.

The chameleon shows a hitherto unknown locomotory pattern. The footfall pattern does not really fit into the Hildebrand schema established for mammals. In his terminology, the chameleon pattern changes between moderate lateral sequence diagonal couplet walk, moderate walking trot and moderate diagonal sequence diagonal couplet walk. The increase of velocity in a speed range of 0.6 cm/s up to 10.0 cm/s is reached only by an increase of frequency. The step duration depends more on reduction of stance than of swing duration. Kinematic graphics of fore and hind limb segments are inverse. Also abduction angles of humerus and femur show a different kinematic pattern. The forelimb moves in a nearly parasagittal plane only during last third of stance and first third of swing phase. The movement of the hind limb is nearly parasagittal only at the beginning of stance and the end of swing phase. The differences between the abduction angles in humerus and femur seem to be in interrelation with the footfall pattern used by this animal.

In addition to the analysis of locomotory parameters, first results of muscle fibre type distribution in some selected, kinematic relevant muscles will be presented.

**P-1 A method for 3D mapping of cell nuclei in the vertebrate retina**

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The horizontal cell density distributions are complex morphological characters of the vertebrate retina and can be interpreted in the context of functional morphology, taxonomy, evolution and the ecology of vision. Density maps of ganglion cells indicate areas of potentially high spacial resolution and hence the directional foci of visual awareness, convergence maps can mirror the spacial light distribution in the process of structural adaptation to the photic habitat and the intra- or interspecific comparison of cell patterns allows conclusions about histogenesis or even about pathways of evolution.

The classical way to draw up density maps via paraffin histology, manual enumeration of nuclei and estimation of regional cell densities is time-consuming and occasionally incorrect. We try to benefit from the advantages of confocal microscopy and the options of digital imaging to comfortably acquire the positions, volumina and shape-parameters of cell nuclei in the entire retina. This also provides the opportunity for semi-automatic classification of cell types, mapping of cell densities and patterns as well as correlations of these complex characters between retinal cell strata – last but not least for the screening of species and developmental stages.

Presently we use 100µm vibratome-sections of the tissue of interest, stained with the near-infrared emitting fluorescence dye To-Pro-3 and make confocal optical section-series of 0.2µm to 1µm thickness. The raw data processing, the geometrical resp. numerical analysis and the 3D-rendering is accomplished via self-coded IDL-algorithms. This method is exemplified using the retina of the european anchovy.



## **P-2 The wingbase of Mecoptera**

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The wing base of the Neoptera and the associated areas of the notum and the pleura are composed of nearly twenty sclerites. Previous studies showed that these structures contain valuable information for phylogenetic analyses at different taxonomic levels.

In the present study we investigated the wing bases of species of Panorpididae, Panorpodidae, Choristidae, Eomeropidae, Bittacidae, Meropeidae, Boreidae and Nannochoristidae. Special emphasis was given to the border of the notum, the position and the form of the axillary sclerites, the bases of the wing veins and to the pleural elements of the wing joint. The wing bases of meso- and metathorax were investigated.

The wing base of Boreidae is highly derived and distinctly different from the wing bases of the other Mecoptera. These differences are correlated with a change of function of the wings of Boreidae. For the remaining taxa some potential synapomorphies could be identified. These include a third axillary that is composed of two parts and the hook-shaped fourth axillary of the hindwing base. A close relationship of Panorpididae, Panorpodidae and Choristidae is supported. The Meropeidae have a number of unique characters. Among these are a remarkably strong third axillary with a 90°-bend, and a corresponding slit in the mesothorax. These structures lock the wing in the resting position. The Bittacidae have a very narrow wing base with modified sclerites. The wing base of Nannochoristidae is very similar to the wing bases of Panorpididae, Panorpodidae and Choristidae. Thus, the placement of Nannochoristidae with Mecoptera is supported. It also was possible to identify characters in the forewing base that support a sister group relationship of Mecoptera and Diptera.

## **P-3 The sperm pump of male Strepsiptera (Hexapoda) and its phylogenetic implications**

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Recent studies on the systematic position of Strepsiptera suggest a sistergroup-relationship with Diptera. The clade comprising both orders is referred to as “Halteria”. The “Halteria” are supported by 18 S rDNA data, and several morphological characters suggest antliophoran affinities of Strepsiptera. Among other features, the presence of a sperm pump was considered as a shared character state of Diptera, Mecoptera and Strepsiptera. The present study is aiming at a critical evaluation of this coding strategy for the character.

For a detailed description of the terminal segments and the sperm pump cross sections and longitudinal sections of the abdomen of males of *Mengenilla* were examined. Internal structures were also studied with SEM and a three-dimensional computer reconstruction was derived from the cross sections.

The Strepsipteran sperm pump is formed by the modified proximal part of the ductus ejaculatorius. It is surrounded by a massive musculature with inner circular layers and outer longitudinal fibres, the latter probably originating partly from the M. abdominalis ventralis. The dorsal longitudinal fibers originate from the tergite of the 9th abdominal segment. Sclerotized elements are completely lacking in the sperm pump.

The sperm transmission apparatus of *Mengenilla* is structurally entirely different from the complex sperm pumps as they were described for males of Diptera and Mecoptera. Therefore, the presence should not be coded as the same character state in cladistic analyses.

**P-4 The ultrastructure of the protonephridia of *Chaetonotus maximus* (Gastrotricha: Paucitubulata)**

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The protonephridial terminal cell (TC) of members of the Paucitubulata contains two cilia surrounded by 16 circumciliar microvilli. Up to now it was unknown (1) if this indicates two monociliary TC and (2) how the nephridial duct and its accompanying cells are organized. A fusion was expected as monociliarity is regarded as plesiomorphic feature in gastrotrichs and both cilia were separated by a row of rod-like structures. In order to test this assumption, we studied the ultrastructure of the protonephridium in *Chaetonotus maximus*.

The TC of *C. maximus* is a biciliary cell. Both cilia neither own an accessory centriole nor ciliar rootlets. The cilia are surrounded by 16 microvilli forming a unit by being connected with a fibrillar extracellular matrix. Distally the TC forms a plasmatic hollow cylinder, closed by septate junctions. This small compartment houses cilia and microvilli. The wall of the cylinder is perforated by slits. Cylinder and adjacent cells are connected by septate junctions. The entire TC is embedded within an extracellular matrix which probably forms the filtration barrier in the area of the slits. The compartment is the proximal portion of the nephridial duct that is formed by the canal cell (CC) and the nephropore cell (NC). The duct runs anteriorly, forms a loop and returns posteriorly again. The connection of the duct to the outside is apparently done by the NC situated next to the CC. Only the TC is ciliated.

The described protonephridial structure corresponds to data of previously investigated species of Paucitubulata and therefore belongs to its ground pattern. Compared to basal macrodasyid gastrotrichs which show a plesiomorphic protonephridial structure (monociliated TC, CC and NC, 8 microvilli in the TC), the biciliary TC and the lack of cilia in the duct are apomorphic and probably an autapomorphy of Paucitubulata.

**P-5 Ultrastructural aspects of the male genital system and sperm of a mexican camelspider (Arachnida: Solifugae)**

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Camel spiders live in tropical regions preferably in arid environments. So far, only a few electron microscopic studies on this animal group have been done. According to literature the male genital system of Solifugae can be divided into three different parts: a) a common genital chamber with its accessory glands, b) the tubular vasa deferentia and c) the long thin testis. The epithelium of the testis consists mainly of a meshwork of somatic cells surrounded by a small layer of muscles. Within the testis the sperm cells can be discovered either as groups consisting of two or three sperm cells each or as individual cells floating in the lumen. The groups are surrounded by thin extensions of the somatic cells. Earlier stages of spermatogenesis could not be detected. In general, the sperm is rather simple representing a round or slightly elongated cell devoid of a flagellum. In contrast to species of the family Ammotrechidae or Karschiidae, for which sperm cells have already been described by other authors, the sperm cells of the mexican species, which belongs to the family Eremobatidae, show no tendency to form any piles or well ordered groups in the lumen of neither the testis nor the vasa deferentia.

**P-6      Cranium and cranial musculature in the larval caecilian, *Ichthyophis kohtaoensis* (Lissamphibia: Gymnophiona)**

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Due to their mainly subterrestrial lifestyle and pantropical distribution caecilians are a poorly known group of amphibians. Especially their larvae have been neglected in the past. In this study we examined caecilian larvae of *Ichthyophis kohtaoensis* in order to analyze the morphology and the musculo-skeletal integration of the head. We used histological serial sections, enzyme clearing and staining, dissections of larval specimen heads and computer-aided 3D reconstruction. We will homologize caecilian musculature with cranial muscles in other amphibians. In comparison to anuran tadpoles and caudate larvae the skull is already ossified at early larval stages in *I. kohtaoensis*. Most bones present in the adult are developed before metamorphosis. The nasal and premaxilla were not fused and the parasphenoid was not fused to the otic capsule and the occipital bones, i.e. an os basale was not yet formed, in the examined larval stages. The posterior part of the nasal overlapped the anterior part of the frontal, and the posterior part of the frontal overlapped the anterior parietal. On the palate there is overlap between the posterior premaxillae and anterior vomer. The lower jaw is already highly ossified in larvae. Dermal bones surround Meckel's cartilage almost completely. Also the articular was entirely ossified in the larval stages examined. The hyobranchial apparatus was completely developed in our larval specimens. Ceratobranchials III and IV, as well as basihyal and basibranchials I and II were fused. The m. interhyoideus posterior (accessory jaw levator) seemed to be stronger than the actual levator muscles.

**P-7      Nanometric silicon chips and the exo-skeleton of discinid brachiopods**  
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The first shell of pelagic juveniles of the recent brachiopod *Discinisca* cf. *tenuis* is covered with hundreds of nanometric tablets of about 0,7–2 µm in diameter. These tablets are partly arranged in highly ordered rhombic arrays on the shell surface. Six years ago, the siliceous nature of these tablets was shown. Before this, the sponge classes Hexactinellida and Demospongiae were thought to be the only marine invertebrate groups having a biomineralized skeleton with siliceous compounds. The investigation of a very young pelagic juvenile of *D.* cf. *tenuis* elucidates the so far enigmatic origin of the brachiopod's siliceous tablets. They are built in specialised cells of the mantle epithelium. A circumferential row of these specialised cells forms the innermost part of the so-called periostracal slot, which releases the periostracum, i.e. the organic outer layer of the brachiopod shell. Whilst the shell is growing periostracal material is transported towards the shell margin, thereby carrying the tablets in rather distinct intervalls like pieces of coal on a conveyor belt. A co-ordinated release of tablets from the circumferential row of uniform specialised cells accounts for the ordered appearance of the tablet arrangement on the shell surface.

**P-8 Determination of systematic error in stereological and non-stereological surface-area determination in the gills of the rainbow trout, *Oncorhynchus mykiss***

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Stereological methods recently developed in our laboratory yielded a surface area for trout gills that is approximately double that previously determined using non-stereological methods. Stereological analysis is carried out on sections of dehydrated and glycol methacrylate-embedded tissue, whereas the non-stereological estimates are based on planar projections of fixed but otherwise unprocessed tissue. Therefore, on six rainbow trout rainbow trout (*Oncorhynchus mykiss*), we tested the hypothesis that the stereological method yields a systematic overestimate of surface area due to significant expansion of methacrylate-embedded tissue after sectioning. On a second group of six trout, we tested the hypothesis that the non-stereological method results in significant underestimation of the surface area due to diversion of the secondary lamellae from the planar projection model. An index of actual area of the secondary lamellae was compared with one for the area of vertical projections of the same lamellae using intersection counting techniques and methacrylate-embedded tissue. In the first experiment, significant shrinkage occurred during acetone dehydration, but was compensated by expansion of the sections, such that no significant difference between the native and sectioned tissue was present. The non-stereological method, however, would underestimate the area by 42%. Considering that the base of the secondary lamellae could be masked by the gill filament and thus escape sampling in the non-stereological method, the systematic underestimate could be even greater. We therefore conclude that the observed error lies entirely with the non-stereological method. Supported by CAPES (Brasilien) to MNF.

**P-9 Ultrastructure of the caruncle and nuchal organ in the amphinomids *Eurythoe complanata* and *Paramphinome jeffreysii* (Annelida, "Polychaeta")**  
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Amphinomidae are one of the rare polychaete taxa possessing a caruncle, a bulging sensory area extending posteriorly from the prostomium onto the peristomium and up to a few chaetigerous segments. The caruncle or at least part of it is regarded to represent the nuchal organ, the most important sensory organ found in polychaetes. The present investigation was conducted on *Eurythoe complanata* (Pallas, 1776) and *Paramphinome jeffreysii* (McIntosh, 1868) differing in size and external appearance of the caruncle. In *E. complanata* a pair of u-shaped longitudinal ciliary bands follow the base of the large caruncle and there are several transverse ciliary bands. In *P. jeffreysii* there are considerably smaller longitudinal bands on the small and inconspicuous caruncle; transverse ciliary bands are lacking. The fine structure instead is almost identical. The longitudinal ciliary bands are formed by supportive cells making up so-called olfactory chambers into which sensory processes of primary sensory cells project. The supportive cells possess a dense layer of modified microvilli underneath the cuticle. The sensory cells are monociliated; their sensory processes, modified cilia and microvilli, occupy the olfactory chamber. Their dendrites form the nuchal nerve. The transverse ciliary bands are made up of non-sensory cells. Various other sensory elements have been found on the prostomium and caruncle. Because of structural similarities with typical nuchal organs and the caruncle of Spionida, only the longitudinal ciliary bands on the caruncle of the amphinomids can be interpreted as a nuchal organ. Results of previous investigations regarding the types of sensory cells and function of the caruncle can not be confirmed.

**P-10 Comparative morphology of the muscle system in different developmental stages of *Pycnophyes kielensis* (Kinorhyncha: Homalorhagida) by means of phalloidin labelling and CLSM**  
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In the context of the phylogenetic position within the Cycloneuralia the most interesting characteristics of the Kinorhyncha are the segmentation of the integument, nervous system, glands and the muscle system. The musculature of *Pycnophyes kielensis* (Homalorhagida) was studied by means of confocal laser scanning microscopy (CLSM) in different juvenile stages (J5, J6) and adult specimens. The f-actin subset was stained with FITC-labelled phalloidin and visualised with CLSM. This has previously been done only for one kinorhynch, adult specimens of *Antygomonas* sp., a representative of the taxon Cyclorhagida. In juvenile *P. kielensis* (J5), longitudinal musculature appears to be continuous while in adults it is clearly separated between adjoining segments. This is seemingly correlated with the development of the ridgelike extensions of the cuticle, the pachycycli, which are much weaker in juveniles than in adults. In the last juvenile stage (J6) the results showed intermediate specimens, on the one hand there are animals with the apparent continuous longitudinal muscles and on the other hand there are animals with a beginning segmentation of the longitudinal musculature. The comparison between juveniles and adults shows further, that the longitudinal muscles are present from segment III to XII in adults, whereas the longitudinal musculature in juveniles (J5) ends in segment XI. These results are a hint that segmentation in the musculature of kinorhynchs may develop relatively late during development, and it implicates the possibility, that the segmentation is derived from a continuous longitudinal musculature, like in the ground pattern of the Cycloneuralia.

**P-11 Homology modelling revisited – common obstacles and solutions**

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With the increasing number of sequences available through genome projects, the field of structural genomics is a fast-growing area. Where the high-throughput structure determination projects fail, bioinformatic methods take over, with homology modelling as the most prominent method. Modelling servers available on the internet offer the possibility to generate homology models by sending the sequence to the server and receiving the model by email or web-interface. The results obtained from these servers are often of good quality. However, there are some pitfalls which are not easily detected and might lead to a misinterpretation of the structure obtained by automated modelling.

Homology modelling programs or servers cannot predict the structure of parts of the sequence for which the corresponding structure in the template is missing. However, some programs and servers are able to extrapolate a structure based on empiric or statistic data derived from the PDB-Database. This will of course lead to less reliable structures, but the user may have no indication which parts of the structure are reliable enough to allow functional interpretation. The state of oligomerization influences the degree of flexibility at the putative interfaces. Although obvious, the user should make sure that a structural template in the same oligomerization state is used as it is necessary to constrain protein parts that might be less well-defined by homology. However, some modelling servers may not allow or may not be able to use oligomeric template structures, thereby returning non-optimal results. We will exemplify those problems by modelling a tyrosinase from *Pacifastacus leniusculus*, the signal crayfish.

**P-12 *Drosophila melanogaster* heart development: morphological studies using hand reporter constructs**

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The highly conserved bHLH transcription factor Hand was found in developing cardiac tissues in a variety of species. So far it is the only factor known that is expressed in all cell types (cardioblasts and pericardial cells) of the *Drosophila melanogaster* embryonic heart. In order to investigate the regulation of *hand* expression, we established a transgenic fly strain carrying a GFP reporter construct under control of the *hand* enhancer. It exhibits stable GFP expression in heart and pericardial cells throughout the whole life cycle of *Drosophila melanogaster*.

This fly strain turned out to be, aside from its purpose in the investigation of *hand* expression, a particularly powerful tool in studying heart morphology. Since GFP expression allows a direct observation in the living animal, we were able to follow heart differentiation and function throughout all stages of the *Drosophila* life cycle, for example by making movies of the heartbeat.

We were able to gain new insight into the complete sequence of events during heart differentiation, firstly revealing changes of shape, number and size of the pericardial cells in later stages like the three instar larvae, and throughout metamorphosis.

**P-13      Head structure of the female of *Eoxenos laboulbenei*  
(Insecta: Strepsiptera)  
Nadine Stecher**

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*Eoxenos* is the most plesiomorphic genus within extant Strepsiptera. The anatomy of the free-living female of *E. laboulbenei* has not been sufficiently examined yet. The present study deals with a detailed description of both internal and external structures of the head of the pharate female and a three-dimensional reconstruction of musculature, foregut, cerebrum, frontal ganglion and suboesophageal ganglion using a modelling software (Maya®, AliasWavefront).

**P-14      3D- Reconstruction and ultrastructure of exocrine glands in a solitary wasp, the European Beewolf, *Philanthus triangulum* (Hymenoptera: Sphecidae)  
Wolfgang Göttler & Erhard Strohm**

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Hymenoptera possess a large variety of exocrine glands. Whereas the morphology and functional significance of such glands has been extensively studied in social species, such as ants honeybees and vespine wasps, comparatively little is known about the solitary species. However, such knowledge would be important to find out whether glands in social species evolved in response to the larger demand for chemical communication and defence or some of the glands are already present in solitary predecessors. We investigated the mandibular gland in males (MG in the following) and the postpharyngeal gland in females (PPG) of a solitary sphecid wasp. To visualize the overall morphology of the glands, we reconstructed them based on histological sections using a computer program. Furthermore, we used SEM and TEM to reveal the ultrastructure of the glands. Both glands have unique features that differ from the respective glands in social species. The MG of male beewolves contains the sex pheromone. It is a complex gland with type III gland cells and it exhibits unique structures in its lumen. There are many branched setae and comb-like structures the function of which is not yet clear. The 3D-reconstruction helped to clarify how the content of this gland is secreted. The female PPG resembles the PPG of ants in its overall appearance. However, there are setae on the epithelium that range into the lumen and there is an additional lumen below the hypopharynx that does not occur in ants. In beewolves the gland has a function in the preservation of the prey (paralysed honeybees) whereas in ants it probably serves a function in generating the unique nest odour. We discuss these differences with regard to the evolution of these glands.

**P-15 First ultrastructural observations on tarsal sensilla of *Pseudocellus pearsei* (Arachnida: Ricinulei)**

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According to their relative rareness and limited distribution little is known about the ultrastructure of ricinuleids. In particular sense organs have not been subjects of electron microscopic research until now. Ricinuleids use their forelegs to explore their surroundings with tentative movements. The distal tarsomeres of legs I and II of the cave dwelling species *Pseudocellus pearsei* from Yucatan, México were investigated in this study. These tarsomeres show similarities in shape and surface structures which make them distinguishable from the distal tarsomeres of leg III and IV. Currently five different structures of the dorsal surface of the tarsomeres are examined with scanning and transmission electron microscopy: 1) Frequent setae with conspicuous longitudinal furrows show characteristics of chemoreceptive wall pore single-walled (wp-sw) sensilla. 2) A single treelike ramifying seta is considered to be a no pore single-walled (np-sw) sensilla. 3) Setae occurring in a small number and possessing a bipartite shaft seem to be np-sw sensilla. The surface of the proximal half of the shaft shows small branches, the distal half has a smooth surface. Presently it can not be excluded that these setae possess a terminal pore (tp). 4) Few short setae with smooth surface correspond to chemoreceptive wp-sw sensilla. 5) A single deep pit which opens on the dorsal surface with a circular pore contains a large number of setae. These setae show a complex inner structure and likely represent chemoreceptive wp-sw sensilla.

**P-16 Surface roughness parameters – a new approach to dental microwear in primates**

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Inferring on primate diet based on dental material opens museum collections of extant primates as well as fossil and subfossil specimens to the analysis of dietary regimes and tooth use. In primates, analysis of microscopic wear features (microwear) in molars based on facets involved in food shearing and crushing is well established. As a method involving SEM, traditional microwear analysis can not be employed to large series of specimens.

Any surfaces can be described as a topographic model with depressions and more or less prominent peaks. The resulting texture can be generally subdivided into three major classes of geometric information. 1 form, 2 waviness and 3 roughness, depending on the wavelength of surface undulations. In worn enamel surfaces roughness is represented by the wear features previously termed as microwear. In addition to these high frequency irregularities, wear in primate molars may expose low frequency irregularities representing areas of differential wear resistance in the tooth enamel. The frequencies of the later are within the magnitude of waviness in technical surfaces, and need to be separated from the signal using a filtering algorithm. The remaining surface roughness signal can be set in relation to diet.



**P-17 Ultrastructural distribution of carbohydrates, stored lipids and hydrolases in the nephrocytes of the harvestman, *Phalangium opilio***  
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Nephrocytes are cells enwrapped in basement membrane. Each cell is a podocyte with its plasma membrane folded to form invaginations. Nephrocytes are engaged in selectively sequestering colloids from the hemolymph by endocytosis, and releasing other molecules by exocytosis. They are known to be present in nearly all groups of the arthropods. Most of our knowledge is based upon the investigations in insects. Thus, aim of the present investigation is to study the functions of nephrocytes in an opilionid harvestman, *Phalangium opilio*.

Special ultrahistochemical methods were used to demonstrate the subcellular distribution of the different compounds by electronmicroscopy. Phosphatases were localized by means of cerulfide deposits. Triglyceride could specifically be seen with saponification followed by precipitation of lead; unsaturated fatty acids and smallest globules of fat in vesicles by means of imidazol-buffered osmiumtetroxid. The different distribution of carbohydrates was detected with *Thiery's* reaction.

As a result the distribution of the different compounds appears as follows: 1. abundant glycogen is uniformly distributed within the whole cytoplasm, 2. few small globules of fat is spread in the peripheral cytoplasm, whereas isolated major globules of fat are found in the central area of the nephrocytes. 3. triglyceride are found in small vesicles, unsaturated fatty acids in some globules of fat and in membranes. 4. abundant acid phosphatases occur in small peripheral and large central lysosomes, very little alkaline phosphatase could be detected in membranes of small vesicles.

The ultrastructural distribution of these substances might elucidate the functional role of the nephrocytes in storage and release of substances in harvestmen and its significance will be discussed.

**P-18 The dorsal circumesophageal roots: not a unique feature for Polychaeta!**  
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Presence of dorsal circumesophageal roots is one attribute of the polychaete cephalic ground pattern and, among other features, total absence of these roots characterizes the annelid subtaxon Clitellata and differentiates it from the Polychaeta. Coinage of the dorsal roots, however, varies considerably between polychaete species and in some taxa they are even missing. Recent investigations suggested that these differences simply reflect different degrees of fusion of originally paired connectives: they are partly fused in annelids possessing dorsal roots and completely fused in Clitellata, where dorsal roots are considered to be totally absent.

Because the paired nature of the polychaete connectives was most convincingly demonstrated in regeneration-studies, we traced the reestablishment of the anterior nervous system during regeneration in *Enchytraeus fragmentosus* and during stolonization in *Stylaria lacustris*. The tubulinergetic (acetylated  $\alpha$ -tubulin) and serotonergic nervous systems were analysed by cLSM. Especially in the developing head of *E. fragmentosus* a ventral and a dorsal connective could be demonstrated at each side of the mouth with both antibodies. Subsequently the two roots are transformed into a simple connective by fusion, proceeding from the ventral cord towards the brain. No sign of the dorsal root can be found in the differentiated oligochaete brain. Further studies have to examine, whether this transformation is also visible during embryological development. However, the present study demonstrates that the dorsal roots are not a unique feature for Polychaeta and supports the presence of paired circumesophageal connectives in Annelida.



## SG4 Studiengruppe Neurobiologie

### V-S1.1 **Transmitter receptors, modulation and learning. Synaptic currents within the olfactory pathway of the honeybee, *Apis mellifera*** Bernd Grünewald<sup>1</sup>, Anna Wersing<sup>1</sup> & Guillaume Barbara<sup>2</sup>

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What are the cellular and synaptic mechanisms of insect olfactory learning? We investigate the ionotropic receptors on neurons of the honeybee olfactory pathway using patch clamp techniques. Within the primary olfactory neuropile of the insect brain, the antennal lobe, spatio-temporal patterns of odor-induced activity are produced through complex interactions of excitatory, inhibitory and modulatory synaptic transmission. We identified functional ionotropic acetylcholine receptors on cultured antennal lobe neurons. Applications of GABA or glutamate induced picrotoxin-sensitive chloride currents. This indicates one excitatory cholinergic and two inhibitory networks within the honeybee antennal lobe. Bath applied histamine reversibly blocked about 50% of the glutamate-induced current, indicating a modulatory role of histamine.

Projection neurons connect the antennal lobes with the mushroom bodies, which are important neuropils for the formation of odor memories. These neurons are probably cholinergic and the mushroom body intrinsic Kenyon cells express a ionotropic acetylcholine receptor. This cation-selective receptor has a neuronal nicotinic profile and a high calcium permeability. Thus, activation of the conditioned stimulus (CS, odor) during classical conditioning of the proboscis extension reflex induces a depolarization and a calcium influx into mushroom body neurons. The reward (sucrose stimulation) is mediated by octopaminergic VUM neurons. It modulates the CS processing by modulating the ACh current of Kenyon cells through calcium-dependent signalling pathways. Our data are incorporated into a working model of the synaptic wiring of the olfactory pathway and the cellular mechanisms of honeybee olfactory learning.

### **V-S1.2 CSM14.1-cells transplanted into the striatum of parkinsonian neonatal rats lead to a preferential forelimb use**

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Cell replacement strategies for the treatment of Parkinson's disease are promising. We investigated the effect of a progenitor cell line (CSM14.1), which has the capability to differentiate into a dopaminergic fate in vitro, after transplantation in neonatal parkinsonian rats. On postnatal day one, rats were bilaterally lesioned by intraventricular 6-OHDA-injection (2 x 1µl, containing 12µg 6-OHDA, coordinates according to bregma: AP -0.6; L ±0.8; V (dura) -2.1). On P3, lesioned animals received 100.000 PKH26-labelled CSM14.1-cells into the right striatum (coordinates: AP +0.7; L -1.8; V -2.9). Five weeks after transplantation, forelimb preference was evaluated in age matched intact controls (n = 10), bilaterally lesioned (n = 17) and unilaterally transplanted animals (n = 6). No paw preference (right : left) was observed in intact (ratio 15 : 15 ±1.76) and bilaterally lesioned (ratio 14.8 : 15.2 ±2.1) animals, whereas lesioned animals, which received a unilateral cell graft in the right hemisphere showed a significant left paw preference (ratio 12.8 : 17.2 ±1.72, p = 0.042, U-test). Six weeks after birth, animals were perfused and brain sections were processed for immunohistochemistry to detect changes in tyrosine hydroxylase by densitometric measurement. Transplanted brains were treated as described earlier to investigate the differentiation of the PKH26-labelled transplanted cells. Preliminary results provide evidence, that this lesion leads to a nearly complete striatal dopaminergic deafferentation. It is conceivable that the preferential forelimb use could be due to a dopaminergic reinnervation by the grafted cells. This is the topic of our current investigation and morphological results will be presented.

### **V-S1.3 Temporal coding in the lower auditory pathway of crickets: a comparison between four cricket species**

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Crickets process acoustic signals within only two frequency channels already in their lower auditory pathway: a low-frequency channel for acoustic communication and a high-frequency channel predominantly for predator detection. The goal of the present study was to determine, whether two first-order ascending neurons (AN) which likely form a bottleneck for the respective processing pathways differ in their temporal coding capacities between species. We compared interneurons AN1 (most sensitive for low frequencies: 3–6 kHz) and AN2 (some low-, but mostly high-frequency input: >12 kHz) in 4 species of crickets (*Gryllus bimaculatus*, *Teleogryllus oceanicus*, *T. commodus*, *T. leo*). Both interneurons were reliably recorded by extracellular tungsten hook electrodes placed around the connectives and separated by their different spike amplitudes for further analysis. Sinusoidally amplitude modulated stimuli were employed to determine the temporal modulation transfer function (tMTF) and the rate-MTF from which measures for the accuracy of temporal resolution and coding capacity can be derived.

In the low-frequency channel, rate and temporal coding properties of the AN1 were similar across species. The AN2 revealed differences between some species in the low- and the high-frequency channel in both rate and temporal coding properties. In all species, both interneurons coded faithfully for a wide range of modulation frequencies (>100 Hz) that comfortably encompassed the periodicities of the species-specific communication signals. Nevertheless, these results show that significant differences in temporal coding can exist between cricket species already at the level of first-order interneurons.

**V-S1.4 Pupal and Adult Glomeruli in the Antennal Lobe of the Moth *Manduca sexta*: a volumetric Comparison based on 3D Reconstructions**  
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Although the antennal lobe of the sphinx moth *Manduca sexta* is an established model for neurodevelopmental processes there is no quantitative information present about the development of the glomerular neuropil.

The neuropil of the antennal lobe in *Manduca sexta* is organized into 63 glomeruli which are arranged in a sphere. Olfactory receptor neurons (ORN) in the antennae carry the odor information into the antennal lobe. This information is integrated in the glomeruli by local interneurons (LN) and sent to higher brain areas via projection neurons (PN). Pheromone information is processed in three male-specific glomeruli (cumulus, toroid 1 and horseshoe) summarized as macroglomerular complex (MGC).

The adult brain of *Manduca* is formed during 20 days of pupal development (P0 – P20). The interaction of ingrowing ORN, glial cells, PN and LN mainly between P8 and P12 lead to the formation of the glomeruli. After P12 the glomeruli increase in size, but the main wave of synaptogenesis seems to be finished.

Here we compare 3D reconstructed glomeruli of whole antennal lobes regarding to size and shape. Three stages were chosen: P13 males and adult males on their first and fourth day after eclosion. For glomerular labeling we used an antibody against synaptotagmin which reliably labels neuropilar structures. Wholemounds were imaged with a confocal laserscan microscope (Leica TCS SP2) and further processed with AMIRA 3.0 (TGS).

Comparison of the antennal lobe reconstructions show that all glomeruli examined retain their relative position while increasing in size, albeit in different ratios: the sex-specific cumulus and toroid show a higher growth rate than normal glomeruli and exhibit even post-eclosional growth.

DFG SCHA 678/3-3

## V-S2.1 **Regeneration of identified axons in the locust ventral nerve cord**

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Whereas regeneration of peripheral neurons after nerve injury is quite common throughout the animal kingdom, the central nervous system (CNS) appears to be less capable of regeneration, at least in vertebrates. However, neuronal regeneration is observed not only in the PNS but also in the CNS of a variety of invertebrate species.

In our experiments, we monitor regeneration of identified axons in the ventral nerve cord of the locust, *Locusta migratoria*, after crushing one cervical connective in the third larval instar. We use immunocytochemistry against less abundant transmitters like proctolin or serotonin which stain only small sets of identified neurons. The neck connective contains two prominent proctolin-immunoreactive axons that originate in the thoracic ganglia and project into the brain, arborising in the subesophageal ganglion.

Nervous systems were dissected and immunostained for proctolin on various days post crush. In the connective, severed axons had begun to grow into the lesion site within three days post crush. After six days, most neurons had grown past the lesion site and reached the subesophageal ganglion by nine days post crush, forming arborisations. Within the following week, target areas were reinnervated, however without completely reassuming original morphologies. This clearly characterised them as regenerated neurons, excluding the possibility of an incomplete crush in those preparations.

We conclude that postembryonic neuronal regeneration is possible in the Locust ventral nerve cord, which enables us now to study the underlying mechanisms and to compare them to the well described embryonic development in this animal.

We thank Manfred Eckert for providing the anti-proctolin antiserum.

## V-S2.2 **Effects of nitric oxide on adaptation of inhibitory inputs onto mechanosensory neurons**

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Presynaptic inhibition plays a major role in shaping sensory inputs, both in the spinal cord of vertebrates and in the crayfish nervous system. Here we investigate the dynamics of presynaptic inhibition and how they are controlled. In crayfish, presynaptic inhibition is involved in reducing information flow from mechanosensory hairs located on the tailfan when animals perform tail flips as part of their escape response. Stimulation of chordotonal afferents that monitor position and movement of the tailfan blades elicits inhibitory primary afferent depolarisations (PADs) in sensory hair neurons. To answer the question as to whether nitric oxide (NO) has an impact of the adaptation properties of PADs, groups of 6 mechanical stimuli were applied to the protopodite-endopodite chordotonal organ at a rate of one group per minute. Amplitudes of PADs elicited by the 1st and 6th stimulus of each group were compared to analyse adaptation. We found that lowering NO levels by bath application of the NO synthase inhibitor L-NAME decreased the adaptation of consecutive PADs, whereas application of the NO-precursor L-arginine had the opposite effect.

Chordotonal inputs onto mechanosensory hairs are indirect via inhibitory interneurons, very likely comprising ascending interneurons. Lowering NO levels by bath application of the NO scavenger PTIO decreased the adaptation of chordotonal inputs in a subset of ascending interneurons. Results show that NO exerts its effects within the central nervous system. Thus, the present results suggest that the effects of NO on depression of PADs are at least partially mediated by modulating proprioceptive inputs onto a group of interposed ascending interneurons.

### V-S2.3 **Tracking of biogenic hydrodynamic trails in Harbour seals** Nadia Schulte-Pelkum, Björn Mauck, Wolf Hanke & Guido Dehnhardt

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The wakes of fishes persist for several minutes, thus representing trackable hydrodynamic trails of considerable length. For Harbour seals it has been shown that they can use their mystacial vibrissae to detect and track hydrodynamic trails of considerable length generated by a miniature submarine. Here we show that this is also true for biogenic trails left by a swimming conspecific. Starting always from the same position, the trail generating seal was trained to dive one of nine different linear courses through an outdoor pool. After the trail generator had left the water, the blindfolded test animal (tracker) was allowed to start its search from a position close to that where the generator started. Particle image velocimetry (PIV) was used to investigate the flow in a seals's wake. Hydrodynamic trail tracking was successful in 90 % of the trials. The rate of successful trials was independent from the nine different courses. However, video analysis revealed that the tracking seal followed a trail using two different strategies: An almost linear course with a high degree of congruence to the trail, and an undulatory course, crossing the trail repeatedly in a sinuous pattern. The choice of strategy appears to depend mainly on the angle of the trail relative to the tracker's swimming path at the point of trail encounter. These results provide first proof that Harbour seals can detect and utilize natural hydrodynamic trails, and suggest that seals can use hydrodynamic trail following for finding conspecifics under the non-visual conditions they often encounter in their natural environment.

### V-S2.4 **Morphological and functional properties of a muscle tension receptor in an insect: A comparison with the Golgi tendon organ of vertebrates**

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Force generated by muscles is usually monitored by specialised receptors. Mammals have Golgi tendon organs and crustaceans have receptors located on the apodemes of their muscles. In insects however, receptors (campaniform sensilla) in the cuticle have been described that monitor force produced by muscles when they distort the cuticle. Campaniform sensilla thus function as indirect receptors of tension generated by their muscles. Only one individual receptor cell has so far been identified in the flexor tibiae muscle of the legs which is embedded in the muscles themselves and monitor the tension generated.

We have identified and characterised receptor cells on the dorsal valve muscle of the locust *Locusta migratoria*. These cells predominantly monitor muscle tension and not length and comprise approximately 120 to 140 receptor cells. The cells are found on the tendons of the valve muscle fibres near their attachment to the cuticle. Individual receptor cells are either monopolar or multipolar and project via the main motor nerve into the CNS. Their axons give off collaterals in the terminal ganglion but branch more intensively in the seventh and sixth abdominal ganglion.

The receptors respond best to force generated by active, isometric contractions of the valve muscle. Their response to ramp-like alterations of muscle tension characterises them as phasic-tonic receptors. One of the main goals of this study was to determine the effect of receptors activation on the activity of motoneurons innervating the valve muscle. Experimental activation of receptor cell leads to strong inhibition of motoneurons and is thus comparable with the autogenic inhibition revealed for mammals Golgi tendon organs.

The work presented here provides the first evidence that receptor cells exist on insect muscles with a similar function than the cells of the Golgi tendon organ in mammals.

**P-1            Excellent discrimination of the distance of two simultaneous water wave sources by the clawed frog, *Xenopus laevis laevis***  
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The purely aquatic clawed frog *Xenopus laevis laevis* detects and analyzes water surface waves with its lateral line system. These waves can have different sources (other frogs, enemies, prey or inanimate subjects such as leaves). Previous studies have revealed high capabilities of *Xenopus* to determine the direction and frequency of impinging water surface waves. In the present study we examined if and how precisely *Xenopus* can distinguish the distance of two simultaneous wave sources. We wondered whether the frog uses the radius of curvature of the circular propagating surface wave or its frequency dispersion for this task (the latter being used by the surface-feeding fish *Aplocheilichthys lineatus*).

We presented two simultaneous monofrequent 18 Hz stimuli and therefore ruled out the possibility to use the frequency dispersion. The stimuli arrived frontally at 45° left and right of the animal. The animals were trained by rewarding the turning response to the closer stimulus. We varied the intensity and time difference between the two stimuli to inhibit a response based on these factors. If a frog was able to differentiate between two distances the difference between these distances was decreased and the testing continued. Five frogs were used. The discrimination limen for waves presented at 10 cm distance was  $0,95 \pm 0,27$ . This indicates a precise discrimination, and a very similar discrimination acuity of the animals. Thus for determining the distance of the wave sources the radius of curvature of the two overlapping surface waves is used.

**P-2            Hydrodynamic reception in the California sea lion**  
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In the phocid seal *Phoca vitulina* the mystacial vibrissae have been characterized as a hydrodynamic receptor system, enabling these marine mammals to follow hydrodynamic trails of moving objects. However, as the structure of vibrissal hairs varies considerably across pinniped species, this sensory ability cannot simply be generalized to the entire suborder. While vibrissal hairs of *Phoca vitulina* and most other phocids are extremely flattened and have waved surfaces, all species of Otariidae and Odobenidae as well as those of the phocids *Erignathus barbatus* and *Monachus spec.* are oval in diameter and smooth in outline. Here we show that despite these differences in hair structure vibrissae of the California sea lion are well tuned to fish generated water movements. Using a go/no-go response paradigm, detection thresholds for hydrodynamic dipol stimuli of 20 and 30 Hz were determined for a male Harbour seal. Stimuli were generated by a sinusoidally oscillating sphere attached to a Ling vibrator. Electronic signals driving the vibrator were computer generated, DA converted and power amplified. The sea lion was trained to place its head in a hoop opposite to the sphere. Knowing the exact distance between the whiskers and the sphere the effective stimulus amplitude was calculated. The sea lion indicated the detection of a water movement by leaving the hoop station during the period of stimulus presentation. The sea lion responded to extremely weak hydrodynamic stimuli. In terms of water velocity, thresholds of the sea lion were 166 mm/s (20 Hz) and 218 mm/s (30 Hz) respectively. This sensitivity of the mystacial vibrissae of the California sea lion to hydrodynamic stimuli is similar to that of the Harbour seal.



- P-3 Tracking of complex hydrodynamic trails by harbour seals**  
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Harbour seals can follow hydrodynamic trails. A hydrodynamic trail is the sum of the water disturbances left behind by an object moving through the water. In harbour seals it has been shown that following these hydrodynamic trails to find a moving object – e.g. a prey fish – can be superior to locating it acoustically or visually. In this study, we presented hydrodynamic trails caused by a remote-controlled miniature submarine to two harbour seals. Contrary to earlier experiments, the submarine could be steered to produce trails with different curvatures. We tested to what degree the curvature affects the ability of seals to follow a hydrodynamic trail. Additionally we investigated the effect of aging of trails on the detection performance of seals. In the curvature experiments, 35 trials with animal A and 37 trials with animal B were performed. The swimming paths of both the submarine and the seal were filmed with a digital camcorder from about 8.5 m above the water surface and digitized for analysis. The trials were grouped in classes by the maximum angle between the legs of the submarine's swim path ( $0^\circ$  to  $20^\circ$ ,  $21^\circ$  to  $40^\circ$ , ...,  $181^\circ$  to  $200^\circ$ ), and the frequency with which trail following was aborted was determined for each class. We found no effect of the angle of curvature on the ability of the seals to follow the hydrodynamic trails. The maximum age of the hydrodynamic trails that were still detected was 45 s in animal A and 27 s in animal B. Particle image velocimetry performed separately from these experiments indicate that mean velocities in the 27-s-old trail were about 15 mm/s, but only 10 mm/s in the 45-s-old trail. These data show that seals can follow fish trails even if fish perform evasive manoeuvres.

- P-4 Localization of band-limited underwater sound in the clawed frog, *Xenopus laevis laevis***  
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According to physical theory, localization of underwater sound should be impossible by animals with pressure receivers at an interaural distance of only 1.5 cm, such as in the clawed frog, *Xenopus laevis laevis*. *Xenopus* can, however, localize underwater sound, which raises the question for the mechanism of localization. We tested this by presenting *Xenopus* band-limited mating calls from various directions and examining whether the frog responded by correctly oriented turns. The mating call consists of rapidly repeated pulses with a frequency range of 0.5–3.0 kHz, maximal intensity being around 2.0 kHz.

A conceivable mechanism for sound localization was involvement of the sacculus like in fish. Since the sacculus responds only up to 1000 Hz in amphibians, we presented calls whose frequencies below 1200 Hz were cut off. *Xenopus* localized these sounds, indicating that the sacculus is not essential for localization. *Xenopus* also localized sounds whose frequencies above 1800 Hz were eliminated. This indicates that the frequency range of the call's dominant frequency is not essential. Finally, we presented several mating calls limited to 100 Hz bandwidth (1.8–1.9 kHz; 1.9–2.0 kHz; 2.0–2.1 kHz). All these calls were localized with undiminished accuracy.

Though not directly revealing the mechanism for localization in *Xenopus*, these data allow for several conclusions. The sacculus is not essential; the frequency range of the call's dominant frequency is not essential. Localization of several narrow-band ranges suggests that no auditory notch detection mechanism is involved. Thus, sound localization in *Xenopus* seems to be independent of specific frequency ranges.

### **P-5 Detection of single and grouped targets by bumblebees**

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The detection of coloured objects is a major visual task in foraging bees. The behaviourally determined detection limit for coloured targets in honeybees implicates spatial summation over several ommatidia and depends on contrast distribution for the long wavelength photoreceptor within the target area. Here we tested whether colour detection in bumblebees is also dependent on the L-receptor and whether the detectability of grouped targets is determined by the detectability of single targets.

Individual bumblebees were trained to detect a disc coloured such that L-receptor contrast to the background was or was not presented (yellow and violet for humans). The observed detection limits differed for the two colours being 1.8° and 3.1° for yellow and violet discs, respectively. It parallels to the results obtained with honeybees indicating that detection of small sized targets is mediated by an achromatic visual system using the L-receptor. The higher resolution as compared to that of the honeybees (5° and 10°, respectively) can be attributed to the larger size of the bumblebee eye.

In the second experiment bumblebees were trained to detect a triplet of small discs. The yellow triplet's detection limit corresponded to the size of its single element subtending 0.75°. This indicates that the detection limit was improved through a grouping effect. Differently the detectability of the violet triplet lacking L-receptor contrast was limited by the detection limit of its elements. Our results indicate that processing of grouped targets by the achromatic system differs from that by the chromatic system and may be explained by a model of detector units with centre-surround receptive fields in the L-receptor mediated pathway.

### **P-6 Auditory brainstem responses of non-sedated harbour seals**

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Auditory brainstem response (ABR) measurements are a common tool to investigate the auditory abilities of vertebrates including humans. The sum potential of neurons in the brain stem is measured using electrodes attached to the skin or inserted subdermally. Acoustic stimuli are presented at a rate of typically 10 to 20 per second, and the responses to typically 1000 stimuli are averaged. The advantage of this method over behavioural tests is that it does not require training of the subject. While Wolski et al. (2003) already obtained auditory brainstem responses of a restrained, sedated harbour seal (electrodes placed subdermally, stimuli presented with a speaker), we measured the ABR of non-sedated animals by using surface electrodes and present the stimuli via headphones. In this way, a method is established that can be used to measure ABRs of animals caught in the wild for a short period of time. In our research facilities at Zoo Cologne, a nine-year-old male harbour seal was tested with tone bursts of 0.125 to 16 kHz. Responses were averaged over 1000 stimulus presentations. Thresholds were determined using a correlation technique. The resulting audiogram is in accordance with the shape of behavioural audiograms, although thresholds are shifted to higher values. In addition, the responses of this individual to broad-band click stimuli was measured. In the shallows of the North Sea, ABRs of a male harbour seal to broad-band click stimuli were measured. ABR waveforms and hearing thresholds were similar to those of the captive individual. We conclude that ABR measurement is an appropriate method to assess the auditory condition of wild animals in an ecological survey program.

**P-7 Two electrical foveae in the skin of the weakly electric fish,  
*Gnathonemus petersii* (Teleostei)**

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The “fovea” in the retina is a specialized region with high densities of photoreceptors. Visual foveae are used to focus objects for inspection. Similar to the bifoveal system in the retina of pigeons (one fovea for food detection, another for predator avoidance) we suggest that the weakly electric fish *Gnathonemus petersii* possesses two electrical foveae on its electro-sensitive skin. For object detection in darkness, *G. petersii* perceives self produced electric signals with electroreceptor organs distributed over almost their entire skin surface.

We counted Mormyromast electroreceptor organs, which are used exclusively for active electrolocation, at different regions on the fish’s skin. Two distinct regions on the head differed in several respects from all other electrosensory regions on the fish’s body: 1. the chin appendix (‘Schnauzenorgan’), and 2. a region between the mouth and the nasal openings (‘nasal region’). In both areas, we found a significant higher density of mormyromasts compared to the rest of the body. The morphology of these foveal receptor organs differed from those at other regions. In addition, the electrical field lines during an EOD were channeled onto these regions in a special way.

Behavioral observations, during which we determined the positioning of certain skin areas towards electrolocation targets while the fish was feeding, suggest that the ‘Schnauzenorgan’ is used for food detection and analysis, i.e. it focuses on close by (prey) objects. The ‘nasal region’, in contrast, focuses on more distant objects and therefore might be used simultaneously for the recognition and avoidance of obstacles.

**P-8 Mechanoreception by cuticular sensillae on the pectines of the scorpion  
*Pandinus cavimanus***

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Most studies on the function of the pectines so far focused on the role of the chemosensory peg sensillae, neglecting the mechanosensory properties. As behavioural experiments with walking scorpions indicated that the mechanoreceptive type I hairs distributed over the pectinal lamellae are probably engaged in reflectory body-height adjustment, it seemed necessary to study their mechanosensory properties in detail. Extracellular recordings from the main pecten-nerve in *in-vivo* preparations were used to measure the sensory activity of several hairs while single hairs were mechanically stimulated by computer-driven piezoelectric actuators.

The investigated hairs never showed spontaneous activity and always a strong phasic response to deflection. A single deflection (ramp-stimulus) elicited up to 5 spikes / second, depending on the stimulus parameters velocity, duration and amplitude. The deflection threshold which was necessary to elicit one action potential was approximately 1 degree; during the experiments deflection amplitudes up to 20 degrees were delivered. The minimum deflection velocity was 50 degrees / second, responses could be seen up to stimulus velocities of 3000 degrees / second. All analyzed hairs showed a specific directional sensitivity which could be approximated and described by a cardioid (cosine) function. The population of 35 investigated hairs together covered every relevant stimulus direction and showed an equal distribution of the individual preferred stimulus direction.

Therefore, the investigated hairs indeed qualify as ‘simple’ touch-receptors involved in the previously mentioned reflex. Ongoing studies have already shown that these hairs are involved in pectinal movements.

**P-9 Seals have a good nose for finding feeding grounds**  
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As food resources at the open sea are patchily distributed, it has been particularly unclear which environmental information seals may use to locate attractive feeding grounds. Elevated atmospheric concentrations of dimethyl sulfide (DMS), produced by phytoplankton in response to zooplankton grazing, have been demonstrated to be an indicator for productive areas. To find out whether seals can smell DMS we determined the detection threshold for DMS in two male harbour seals using a go/no-go response paradigm. Stimuli were presented using sealable glass syringes containing a piece of filter paper. Filter papers were moisturized inside the syringes with either 2 µl DMS-solution (dist. water) as the olfactory stimulus or 2 µl distilled water as the control stimulus and vaporized for one hour. Defined gaseous DMS-concentrations from 50 to  $1 \times 10^{-7}$  µg(DMS)/l(air) were obtained by total vapour saturation. Syringes were discharged at a constant flow (4 ml/sec) using an electronically controlled discharging apparatus. At the human threshold concentration of 1 µg/l seals detection performance was still 100% correct, while the DMS concentration typical for marine productive areas (0, 0005 µg/l) was detected with  $\geq 85\%$  correct decision. Compared to humans, interpolated detection thresholds of  $1,25 \times 10^{-6}$  µg/l and  $8,06 \times 10^{-7}$  µg/l (seal 1 & 2) indicate that the olfactory sensitivity to DMS in seals is several orders of magnitude higher. These results provide first evidence of a high olfactory sensitivity in seals. Well tuned to the DMS-concentration found in the marine habitat it provides the sensory basis for the identification of profitable feeding grounds.

**P-10 Ultrastructure of the pigmented photoreceptors in *Dactylopodola baltica* (Macrodasyida: Gastrotricha)**

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Since Remane described the Gastrotricha in the 20's of the former century, they are subdivided into the two groups Macrodasyida and Chaetonotida. The marine Macrodasyida are a small group of microscopic metazoa, inhabiting the interstitial system of sediments throughout the world.

With *Dactylopodola baltica*, one of the most basal species of the Macrodasyida was chosen to conduct an ultrastructural study of the photoreceptor cell in the anterior head region.

Ultrastructural details of the gastrotrich sensory system are known from a few investigations only. The eye of *D. baltica* is compared with the photoreceptor of *Turbanella cornuta* (Macrodasyida).

The eye of *D. baltica* consists of at least three cells: a sensory receptor cell, a sheath cell and a pigment cup. In the receptor cell, over two hundred microvilli project into a cup shaped lumen, each containing a single microfilament. They arise from a single socket. The sheath cell surrounds the ventro-lateral part of the receptor cell and contains only very few mitochondria and ribosomes. On the dorsal side of the receptor cell the pigment cell forms a cup and contains no other organelles but pigment granules of different size and shape. This is a modified epidermal cell which shields the eye from vertically downwelling light and only allows light to enter from an anterior position.

**P-11 Targeting at floral colour patterns of flower-naive bumblebees  
(*Bombus terrestris*: Apidae)**

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Bumblebees show distinct colour preferences. Using videographic techniques and artificial flowers we were analysed behavioural reactions of naive and non-trained bumblebees (*Bombus terrestris*): 1. the approach from some distance, 2. the antenna reaction which was the first contact with the artificial flower, and 3. the landing reaction. We tested, whether bumblebees spontaneously orient towards the centre or whether they are guided towards the centre part by floral guides by analysing the bumblebees' behaviour at single-coloured and two-coloured artificial flowers. In the dummy flowers a light blue colour was combined with a yellow centre part, which had 1 % of the size of the artificial flower (36 cm<sup>2</sup>), and consisted of two small, deep yellow circles simulating a frequent type of nectar guide often associated with the access to floral reward, both nectar and pollen.

At two-coloured artificial flowers 62.7 % of the approaching bumblebees made antennal contact with the dummy, and 34.9 % landed. Analysing the preferred site of behavioural reactions, centre part vs. border area, we found that 74.7 % of the bumblebees approached the centre part [vs. 25.3 % for the border area], (n = 166), 93.3 % antennated at the centre part (n = 104), and 96.6 % landed on the centre part (n = 58). At single-coloured artificial flowers only 35.6 % of the approaching bumblebees made antennal contact with the artificial flower, and 12.1 % landed. 1.3 % of the bumblebees approached the centre part (n = 149), no bumblebee antennated at the centre part (n = 53), and no bumblebee landed on the centre part (n = 18). In another set of experiments we found that the bumblebees' orientation towards the centre part was independent of the shape of the dummy flowers.

**P-12 Visual multiple-choice matching in a Harbour seal**

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The recognition of 'same or different' is a prerequisite for many cognitive tasks. Here, we tested concept formation during visual discrimination learning of a Harbour seal using a visual multiple-choice matching task. First, the seal was trained on a classic matching-to-sample paradigm using sets of two simultaneously presented visual stimuli (junk objects). The positions of comparison stimuli were balanced over trials and sequence of the respective sample was arranged according to pseudorandom schedules. The sample was presented in the middle position of a choice apparatus. When the comparison stimuli became visible the seal had to choose by pressing its snout against one of the comparison stimuli. The animal had to reach a learning criterion of >80% correct choices in two successive sessions before a new set of stimuli was introduced. After the criterion was reached for three sets of stimuli the experimental design was changed. Now stimulus sets were composed of six unknown stimuli, two of which were presented against each other in each trial. Here, the seal reached the learning criterion immediately when the fourth set of new stimuli was introduced. Finally, the apparatus was changed for multiple choice matching. Again, the sample stimulus was presented in the middle position, but there were four comparison stimuli. Here, the seal fulfilled the criterion in the first two sessions introducing the fifth set of stimuli. When completely new stimuli were used for two further sets of stimuli the seal reached the criterion in the first two sessions respectively. These data demonstrate that Harbours seals are able to process complex visual information on a conceptual level.

**P-13 Seals can see the stars**

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One possible mechanism for offshore orientation in marine mammals could be astronavigation. The knowledge how to navigate by the stars without the help of technical instruments has been used by ancient seafarers and is still in use in some Polynesian navigators. Of course, the first prerequisite for astronavigation is to see the stars. This has been particularly unclear for seals as it is assumed that due to adaptations of their dioptric apparatus to the optical properties of water, pinniped vision should be myopic and suffer from astigmatism when out of the water under low light conditions. Using a go/no-go response paradigm we therefore tested the capability of a Harbour seal (*Phoca vitulina vitulina*) to see real and artificial stars of various brightness. The dark-adapted seal was trained to place its head into the opening of a traversable tube and to retreat its head only when a small light appeared at the opposite aperture. Correct responses were rewarded by pieces of cut herring. During the first block of experimental sessions, qualitative evidence was obtained by showing that the seal responded to some bright real stars (e.g. Sirius) becoming suddenly visible when the tube was slowly moved across the night sky. During the second experimental stage, absolute thresholds were determined using artificial stars consisting of small spots of parallel light of pre-defined brightness generated by an optical system installed in front of the tube. The seal was able to detect artificial stars down to a brightness of 4.4 star magnitudes. This sensitivity should allow a seal to see enough stars of the night sky to reliably perform astronavigation.

**P-14 Spatial dimensions of receptive fields of ELL neurons in *Gnathonemus petersii* (Teleostei)**

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The weakly electric fish *Gnathonemus petersii* perceives its environment at night through its electrosensory system. With an electric organ in their tail they produce short electrical current pulses, which are perceived by epidermal electroreceptors distributed over almost their entire skin surface. Objects are detected because they alter the electrical input at certain skin regions, a process called active electrolocation.

Mormyromast electroreceptor organs are used for active electrolocation. Their afferent fibers project to the electrosensory lateral line lobe (ELL) in the brainstem, which contains a somatotopic map of mormyromast input. At least 18 different types of neurons are found in ELL, which can be divided into two main categories: E(xcitatory)- and I(nhibitory)-cells, according to their response patterns to peripheral electrosensory input.

In this study, we measured the spatial dimensions of the receptive fields of single E- and I-cells. Neuron responses were recorded extracellularly with NaCl-filled electrodes. Their responses to electric stimuli delivered to different skin areas were recorded. The strongest responses (highest number of spikes) of E-cells were found in the center of their receptive fields. Response strengths decreased when stimuli were moved out of the field center. The diameter of the receptive fields of different E-cell ranged from 3 to 7 mm. I-cells were most strongly inhibited in the center of their receptive fields, with inhibition decreasing towards the field periphery. Receptive field diameters ranged from 7 up to 10 mm in different I-cells. Some I-cells had an excitatory area surrounding the field's center, indicating that their receptive fields had a center-surround organization.

**P-15      Vibration characteristics of vibrissae of the California sea lion:  
A Multifunction-Sensor**

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The observation of blind but well nourished pinnipeds in the wild was one indication that besides vision other sensory information channels have to be considered for underwater orientation. Several investigations demonstrated the high sensitivity of seal vibrissae for minute water movements, enabling the animals to detect and track hydrodynamic trails. However, there is little information on the function vibrissae as single sensory units. While there are studies on the structure and innervation of vibrissal follicles, the biomechanics of vibrissal hairs has not been studied yet. We determined the vibration behaviour of single vibrissae in a water flow channel. Mechanical vibration induced by vortex abscission was detected with a piezo-electric force transducer and analysed via FFT-algorithm. The correlation between flow velocity and signal frequency was analyzed under various attack angles. For vibrissae a linear correlation between these parameters was found, suggesting that these hairs are suitable for measuring velocities. In contrast, an elastic, one-sided fixed, cylindrical body passing through its eigenfrequency shows a step function and thus would be inadequate for this purpose. Further measurements indicate that water flow disturbances can be measured using this kind of hair-sensor. This could enable a sea lion to detect the vorticity in the hydrodynamic trail of swimming prey. Thus, sea lion vibrissae represent multifunctional sensors not only for tactile stimulation, but also for the detection of flow velocity and hydrodynamic trails. These hair properties could be used in bionic applications for single component technical sensors.

**P-16      A neuroglobin-like gene from lower vertebrates expressed  
in non-neuronal tissues**

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Hemoglobin, myoglobin, neuroglobin and cytoglobin constitute four vertebrate globin types with distinct tissue-distribution and functions. By searching various sequence databases, we identified novel globin-like sequences that do not correspond to any of the known globins. The complete cDNA and partial genomic sequences of this globin were cloned from three fish species (*Danio rerio*, *Carassius auratus*, *Tetraodon nigroviridis*) and an amphibian (*Silurana tropicalis*). This novel globin displays the highest identity score with neuroglobin (~25 to 28%) and thus has been termed “neuroglobin-like” or Ngbl. The typical 8-alpha helical globin fold, as well as the distal and proximal histidines (E7 and F8) and the phenylalanine CD1 are conserved in neuroglobin-like proteins, but due to extensions at the N- and C-termini they comprise about 200 amino acids. The neuroglobin-like gene consists of 4 introns and 5 exons. In addition to the conserved globin-introns at positions B12.2 and G7.0, it contains two introns in E10.2 and H10.0. Phylogenetic analyses show an ancient relationship with the vertebrate neuroglobin, while database analyses suggest that the neuroglobin-like gene has been lost in the evolution of higher vertebrates. RT-PCR experiments on goldfish and frog RNA show that the neuroglobin-like gene is expressed in visceral organs, but likely not in neuronal tissues.

**P-17 Cloning and characterization of honeybee serotonin receptors**

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The indolalkylamine serotonin (5-HT) acts as a neurotransmitter, neuromodulator, and even as a circulating neurohormone in invertebrates. Serotonin affects a wide range of physiological and behavioural functions by activating G protein-coupled receptors. We have cloned a gene encoding a putative serotonin receptor from a brain-specific cDNA library of the honeybee, *Apis mellifera*. The longest open reading frame codes for a protein of 503 amino acid residues. Hydrophobicity analysis of this sequence reveals seven hydrophobic domains, a characteristic feature of G protein-coupled receptors. The deduced amino acid sequence of the honeybee receptor shows greatest sequence homology to 5-HT<sub>7</sub> receptors from *Drosophila melanogaster* and *Aedes aegypti* as well as to 5-HT<sub>1A</sub> receptors from various vertebrate species. We are currently generating a cell line stably expressing the receptor protein in order to investigate its intracellular signalling pathways as well as its pharmacological properties. Furthermore, the tissue distribution will be studied by RT-PCR and in situ-hybridization. Recently, we have isolated a partial cDNA of a second putative serotonin receptor from *Apis mellifera* by applying a PCR-based strategy. The amino acid sequence of this receptor is most closely related to the 5-HT<sub>2</sub> receptor of *Drosophila melanogaster*.

This work was supported by grants from the German Research Foundation (Ba 1541/4; Bl 469/4).

**P-18 Development of the peptidergic Va neurons of *Drosophila melanogaster***

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The Va neurons are a set of three pairs of secretory neurons in the ventral ganglion of *Drosophila melanogaster*. We found that these neurons are identical to the peptidergic neurons expressing *capa*. *capa* codes for periviscerokinins and a pyrokinin, neuropeptides with the C-terminal sequence PRXamide. In larvae, the axons of the Va neurons project into the transverse nerve (TVN). In adults, TVNs are absent, and the axons of the Va neurons form a network of fibers beneath the dorsal neural sheath of the ventral ganglion. It is unknown how this change in the projection pattern takes place during pupal metamorphosis.

We studied the development of the Va neurons by immunofluorescent double-stainings against PRXamides and Fasciclin2 (Fas2). Fas2-positive axonal tracts provide convenient landmarks for neurite mapping.

Until mid-stage 16, peptide immunoreactivity is absent in embryos. In all larval stages, the Va neurons showed a similar morphology as already described. In freshly hatched 1st instar larvae, however, only the Va somata were PRXamide-immunoreactive.

Pupal remodelling of axonal projections takes place during stage 7–11. In the stages 1–6, Va axons still project into the TVNs. In stage 12, the projections of the Va neurons closely resembles that in adults. The redifferentiating axon projections follow prominent Fas2-positive fiber tracts that newly emerge in the pupa. Moreover, Va neurons themselves become Fas2-immunoreactive early during pupal metamorphosis, while they are Fas2-immunonegative in all larval and adult stages.

We thank Manfred Eckert (Jena) and Stefan Thor (Harvard) for the gift of antibodies and flies, and Uwe Homberg (Marburg) for general support. Funded by the DFG (WE 2652/2-1).



**P-19 Effect of water turbidity on the visual acuity of Harbour seals  
(*Phoca vitulina*)**

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The pinniped eye is well adapted to the under water environment. Therefore, the visual system of pinnipeds is often considered to be the major source of sensory information for under water orientation and navigation. However, many pinniped species like the Harbour seal (*Phoca vitulina*) in the German Wadden Sea live in very turbid waters. The effect of turbidity on vision and how the animals might compensate for the loss of visual information under high levels of turbidity has not yet been considered. Using psychophysical techniques we determined the Minimum Angle of Resolution (MAR) of two male Harbour seals (Bill and Sam) at different levels of turbidity. Turbidity was measured in formazin nephelometric units (FNU) that compare the turbidity of a water sample to the standard formazin conforming to DIN EN 27027 and ISO 7027. During our experiments the turbidity in our experimental pool varied from 0.2 to 7.8 FNU. At a viewing distance of two meters and a turbidity of up to 1.5 FNU we found MARs being almost unaffected in both experimental animals (Bill ~ 5', Sam ~9', respectively). With increasing turbidity visual acuity decreased rapidly in both animals, resulting in MARs of >40' at a turbidity exceeding 4 FNU. As MARs >20' (eg in bats and rodents) are considered to represent poor visual capabilities, our results demonstrate a dramatic loss of visual performance in seals even at the moderate levels of turbidity used in this study. In areas in the North Sea, where seals are known to orientate and forage, our measurements revealed turbidity levels exceeding 40 FNU. Therefore, our results indicate that visual information alone cannot explain underwater prey detection and orientation.

**P-20 Is aprin involved in proliferation control of rat olfactory epithelium?**

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Aprin (androgen-induced prostate proliferative shutoff associated protein AS3) inhibits cell proliferation in the prostate and protects against carcinogenesis. Although proliferation in the olfactory epithelium (OE) continues during adulthood OE doesn't develop tumors. We asked whether aprin is expressed in the rat OE. We report here the sequence of rat aprin (Accession # AY388627) and the expression of aprin mRNA in the olfactory epithelium of postnatal rats using RT-PCR and (competitive) duplex PCR. Semiquantitative estimates reveal that aprin mRNA expression level in the OE is lower (~8x) compared to that in testis. Although proliferation dramatically decreases in rat OE postnatally, the expression level of aprin does not change much. Besides the OE, aprin mRNA is also expressed in other neuronal (olfactory bulb, visual cortex, cerebellum, eye, adrenal gland) and non-neuronal tissues (testis, kidney, heart, lung, and very weak expression in muscle, intestine, liver) with highest expression in testis. No differences between males and females were observed in aprin expression in OE. Aprin function is discussed in relation to cell turnover and neuronal survival. Supported by NIH Grants # DC04637, DFG Grant SFB509 TPC4, FORUM F108/00 M122/13.

**P-21 Seals use vortices of hydrodynamic trails to determine the swimming direction of moving objects**

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When foraging in dark or muddy waters, marine mammals cannot rely on their visual system. Consequently, a high selection pressure can be expected for marine mammals on the development of sensory systems suitable to substitute vision. While odontocetes possess a sonar system, corresponding sensory abilities are not known in other marine mammals. In this respect it has been shown for blindfolded Harbour seals that they can use their vibrissal system to detect and follow the hydrodynamic trails left by moving objects. It's crucial for successful trail following that a seal is able to recognize the swimming direction of a fish at any given point of the trail. In this study we determined the maximum period of time after trail generation as well as hydrodynamic parameters allowing a seal the recognition of the swimming direction of the trail-generating object. Hydrodynamic trails were generated by means of a fin-like paddle moving from left to right  $v_v$  (~1.5 m/s) in an experimental box (2.5x2.5x1.70 m) with silent water. During trail generation the blindfolded seal stationed in front of the box and was supplied with headphones for acoustical masking. After delays of 5-60 s the animal was asked to enter the box for trail detection and decided about trail direction by choosing a left or right target at the front side of the box. The Harbour seal was still able to recognize the correct direction of the paddle movement when the hydrodynamic trail was 35 s old. Particle image velocimetry (PIV) revealed that especially the vortices turning in defined directions are the hydrodynamic parameters in a trail used for the recognition of the swimming direction.

**P-22 Hydrodynamic reception in sea snakes?**

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The spine bellied sea snake (*Lapemis curtus*) is a piscivorous predator that feeds mainly at night. Due to morphological studies it has been hypothesized that sea snakes can detect weak water motions and/or weakly electric fields. We investigated by means of electrophysiological techniques whether *L. curtus* has sensory systems capable of detecting weakly electric fields and/or low-amplitude hydrodynamic stimuli.

Evoked field potentials were recorded from the midbrain of *L. curtus* with tungsten electrodes (resistance <3 Mohm). Although visual evoked responses were readily obtained, electric field stimuli of amplitudes as high as 1 mV/cm never caused neural responses. Water motions were generated with a sphere (diameter 1 cm) that was vibrated with various amplitudes and frequencies close (2-5 mm) to the snakes head. In two animals vibrating sphere stimuli (test range 50 Hz 200 Hz) caused evoked potentials provided sphere vibration amplitudes were at least 20  $\mu$ m. The lack of any responses to electric field stimuli and the high displacement thresholds to water motions indicate that spine bellied sea snakes most likely have neither electro- nor hydrodynamic reception. The responses to high-amplitude water motions may have been mediated by the mechanoreceptive scale sensillae, found also in land snakes. Our results challenge the hypothesis that sea snakes have a special hydrodynamic sense and/or electroreception.

**P-23      Tuning curves of infrared sensitive neurons in the Tectum opticum of the rattlesnake *Crotalus atrox***

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Pit vipers (Crotalinae) possess infrared sensitive receptors within their facial pits which are innervated by fibers of the trigeminal nerve. In pit vipers infrared information is processed in the hindbrain, midbrain (Tectum opticum) and forebrain. Many tectal neurons of pit vipers are sensitive to infrared stimulation. Infrared sensitive tectal neurons may receive additional visual input.

We investigated the functional properties of infrared sensitive neurons, recorded in the stratum griseum centrale of the contralateral Tectum opticum of anaesthetized western diamondback rattlesnakes (*Crotalus atrox*). To obtain tuning curves (frequency of action potentials as function of stimulus intensity) we stimulated the pit organs with a red (650 nm) laser beam. We found that unimodal infrared sensitive tectal neurons responded in a similar way to an infrared stimulus as bimodal infrared- and visual sensitive neurons. The threshold of unimodal and bimodal tectal neurons for infrared stimuli was 0.2 mW. At the stimulus intensity of 1.0 mW (test range 0.1–1.4 mW) neuronal response showed saturation.

**P-24      Selective octopaminergic modulation of giant descending interneurons in the cricket**

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Octopamine is generally considered to function in the mechanism underlying arousal in arthropods. However, accumulating evidence suggests a more selective role for this amine in behaviour. We report that octopamine selectively modulates specific members of a well known group of giant descending interneurons with extensive arborisations in antennal mechanosensory neuropiles of the cricket *Gryllus bimaculatus* De Geer.

Retrograde staining, and extracellular recording of a cervical connective identified two of these neurons with contralateral descending axons. Both cells produce one action potential in response to a single touch of the flagellum with a fine bristle. The response latencies indicates that both connections are monosynaptic. The comparatively fast spike-conduction velocities ( $\approx 4$  m/s) qualify them as giant interneurons in insects. Only one of these cells, however, spikes in response to electrical stimulation of the sensory nerve in the flagellum. This, and other findings, suggests that the one interneurone receives inputs from the flagellum, and the other from the pedicellus. Interestingly, systemic application of the octopamine agonist chlordimeform (CDM) enhances the responsiveness of the interneurone having flagellar inputs in a dose dependant and reversible fashion, but leaves the responsiveness of the other interneurone unaffected. Since CDM enhances the response to mechanical and electrical stimulation equally, CDM must act on octopaminergic receptors located in the central nervous system, rather than on peripheral sensory cells. To our knowledge, this is the first evidence suggesting that octopamine can selectively modulate specific members of a neurone pool receiving synaptic inputs of related modalities.



# SG5 Studiengruppe Ökologie

## V-S1.1 **Community composition of phytophagous insects and parasitic fungi on trees** Martin Brändle & Roland Brandl

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Historical and contemporary processes influence diversity and structure of communities. The relative importance of these two classes of processes are still a matter of debate. We analysed the similarity of phytophagous insects and parasitic fungi communities associated with 23 tree genera native to Germany using a modified Simpson-index which is independent of gradients in species richness (insects 6164 host records; fungi 860 host records). Similarities of phytophagous insect communities were on average higher than those of the parasitic fungi. For insects and fungi, phylogenetic closely related trees and trees with large overlap in distributional ranges across Germany share more species than distantly related trees and trees with low range overlap. Habitat (niche) overlap between host trees were of only minor importance. Genetic (phylogenetic) distance between hosts (measured by the Kimura-distance between tree genera; rbcL gene) explained a large part of species turn-over of insects between trees (squared matrix correlation  $rm = 0.82$ ). The importance of genetic distance was lower for parasitic fungi ( $rm = 0.58$ ). Nevertheless, community similarities of phytophagous insects were closely related to those of parasitic fungi, even when we controlled for genetic distance, range as well as habitat overlap between host trees. The patterns of species turn-over between host trees are not random. Phylogenetic (historic) and ecological factors are of about equal (?) importance for community composition. The robust correlation between similarities calculated across insects and fungi, however, calls for additional factors. Candidates are secondary metabolites as well as the transfer of fungi by insects between host trees.

**V-S1.2 Population ecology of the afro-tropical pig-nosed frog, *Hemissus marmoratus*: effects of climate and predation on survival and recruitment**

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We studied the population ecology of the West African pig-nosed frog, *Hemissus marmoratus* to understand the relative contributions of adult survival and recruitment to population growth rate in savannah frogs using mark-recapture modelling. Between years adult survival was sex-specific and varied between 0.03–0.64 for males and 0.08–0.33 for females. Adult survival was significantly associated with annual rainfall and is cause for concern if rainfall declines further in the study region as predicted by changes in global climate. There was a significant interaction between rainfall and sex with dry weather having a stronger negative effect on males than females. Pig-nosed frogs experienced boom and bust years. Recruitment (*in situ* and immigration) was substantially more important than adult survival in determining realised population growth. *In situ* recruitment was highly variable between years with 1–36% of eggs and tadpoles released by females into the pond surviving to metamorphosis. Years of low tadpole survival were associated with high numbers of predatory tortoises. The pig-nosed frog can serve as a model for other pond breeding anurans from savannah habitats since they share many life-history traits: highly variable juvenile recruitment, density independent regulation by predators and weather, short generation time, low adult survival and density independent regulation by predators and weather. Our demographic data should be useful, not only in reversing population declines, but also in efforts to proactively prevent declines from occurring in the first place.

**V-S1.3 The effects of local and regional factors at different scales on herbivore-parasitoid communities**

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The relative importance of local and large-scale landscape effects on species diversity and species interactions were studied on herbivore-parasitoid insect communities. The studies were carried out in 15 landscape sectors. Landscape sectors differed in landscape structure and complexity, so as to build up a gradient from simple to richly structured landscapes. These factors were quantified within scales from 1.0–6.0 km diameter. Within the sectors thistle abundance and distribution were estimated in 1998 and 2000. Local insect species diversity and species interactions were analyzed by dissections of thistle shoots and galls sampled in each landscape sector.

The results showed that both local and landscape factors affected local insect communities and species interactions. For instance, insect abundance was influenced by habitat type and host abundance, but also by landscape factors. The infestation rate caused by an agromyzid fly was positively related to percent non-crop area, whereas the parasitism rate of this fly increased with increasing habitat diversity in the landscapes. Thereby, the responses of species to landscape characteristics depended on the considered spatial scale. The results gave also evidence, that temporal dynamics in landscape composition was likely to influence species diversity and interactions.

The results indicate that large-scale factors are important for local species diversity and interactions between the species. Further, the great differences in the spatial scale experienced by each species emphasize the need to take local as well as landscape management into account. This may help to better explain the complexity of plant-enemy interactions and species population dynamics.

#### V-S1.4 **Searching for enemy free space – how two leaf beetles differing in plant specificity might escape egg parasitism**

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Herbivorous insects should choose places for oviposition that enhance the chance to avoid egg parasitism. Here it was shown how two galerucine leaf beetles differing in host plant specificity use different strategies to gain possible “enemy free space” for their egg batches. In the tritrophic system *Ulmus minor* – *Xanthogaleruca luteola* – *Oomyzus gallerucae* egg deposition of the monophagous elm leaf beetle induces the emission of plant volatiles that are attractive to naive egg parasitoids of *O. gallerucae*. When elm leaves are heavily infested with eggs and feeding beetles, gravid beetle females prefer volatiles from undamaged leaves. However, when the infestation level is low, the beetles prefer volatiles from leaves carrying eggs of conspecifics.

In the other tritrophic system investigated field studies had revealed that the polyphagous tansy leaf beetle *Galeruca tanacetii* can use structural vegetation complexity to reduce parasitism of the specialist egg parasitoid *Oomyzus galerucivorus*. Further laboratory bioassays showed that the egg parasitoid can learn different host plant volatiles. Here it was investigated if also an enhanced odour complexity (resulting from a high vegetation diversity) can negatively affect learning and orientation of *O. galerucivorus*. The results are discussed in respect to the possible existence of a partial refuge for beetle eggs in complex odour environments.

#### V-S1.5 **Who bears the costs of interspecific competition in an age-structured bank vole population?**

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Social and density-dependent life-history processes may differ according to age and the reproductive history of individuals. We studied effects of interspecific competition from field voles on various fitness components of female bank voles *Clethrionomys glareolus* in an age-structured breeding population in large (0.25 ha) outdoor enclosures. We monitored survival, reproduction and space use of experimental bank vole populations. Within enclosures we manipulated the presence and absence of field voles. When coexisting with field voles, the year-born bank vole females had lower survival rates than the over-wintered ones. Characteristics of litters of breeding females were not affected by the competition treatment. Inter- and intraspecific competition seemed to work additively on the year-born females through direct interference. Because old, over-wintered females are not surviving to the next non-breeding season, the lower survival of young breeders through interspecific competition might alter the structure of the breeding population at the start of the next breeding season, thus altering population growth patterns.

**P-1 Forensic Entomology and Neglect of Elderly Persons**

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Wounds of living persons are a potential target for the same flies that live, or feed early on corpses. This can lead both to complications in estimation of colonization time (“post mortem interval”, PMI), or to additional information that might be valuable in a trial, or during the investigations. With forensic entomology, and forensic entomologists being more and more present, even lower profile cases like the neglect of elderly people (without violence being used against them; i.e., natural death) comes to our attention. Furthermore, much more people grow older than in the past years which leads to increased awareness of malpractice of caregivers in the professional, and personal environment (in German: “Pflege-Vernachlässigung”). We briefly sketch three cases in which forensic entomology helped to better understand the circumstances of death, and especially before death.

*Case 1:* Elderly women found dead in October 2002 in her 3rd floor apartment in urban Cologne, Germany. Apartment was very clean except of the bath room in which a bath tub had been filled with water, and clothing. Exclusively dead adult flies of the species *Muscina stabulans* FALLÉN were found spread on the floor; no blow flies in the zoological sense of the meaning were present in any live stage. Calculation of PMI led to an interval of around three to four weeks. This would have been a misconduct of the paid professional care giver who was supposed to check for the women every week. The caregiver claimed that she had called the women ca. two weeks ago to check on her; the now dead woman allegedly rejected a visit. This possibility could not be ruled out since the old woman was known to be healthy, yet mentally unstable and behaving “difficult” against everybody. In clear contrast to the entomological findings, it was assumed that the care giver tried her best; no prosecution followed.

*Case 2:* In September 2002, an old woman was found dead in her apartment in an urbanized town in western Germany. Her foot was wrapped in a plastic bag; inside, numerous larvae of *Lucilia sericata* were found. The care giver openly stated that “it was well possible that the foot of the person was wrapped in a plastic bag, and that maggots may have been present inside during the lifetime of the woman”. The age of the maggots was estimated as four days. However, judging from the deep tissue loss at the foot, it was discussed that most likely, the maggots had been feeding on the living woman for at least a week whilst she was still alive but then left the bag to pupate elsewhere. The apartment could not be checked for pupae, however.

*Case 3:* In March 2002, the corpse of an old woman found in her apartment in an urban apartment in a western German town. The apartment was not cleaned up, and on the actual corpse, the following insects were found: Larval *Fannia canicularis* flies, larval *Muscina stabulans* flies, and adult *Dermestes lardarius* beetles. These insects are known to build up populations inside of human housings but *Fannia* frequently hints towards the presence of feces, and urine in cases of neglect. In this case, further evidence for this possibility was found in the fact that the skin of the corpse was not fed on by the larvae. Pupae (of an unknown species) were reported but not collected.

*Conclusion:* From the actual case work, we get the impression that misconduct of elderly people currently becomes a severe problem in aging societies like Germany. From a juridical standpoint, it is – and will be – very difficult to judge if the care giver is guilty of misconduct, or not. Forensic entomology can give important insights into the dynamics, the amount, and the final state of bodily care that was given to the neglected person. At the same time, forensic entomology helps to excuse care givers who did actually do their duty whilst maggot infestation of a person’s wounds occurred during a normal interval of non-visits.

*Acknowledgements:* The criminal police forces, and the D.A.’s offices of the cities of Dortmund, Cologne, and Bonn, as well as the members of the Institute for Legal Medicine of the city of Dortmund contributed significantly to the cases. Especially, I wish to thank Dr. Josephi, Dr. Ralf Zuehloff, KHK in Doro Christmann (Case 2), and the departments KK 11 (homicide detective’s bureaus) of the PP’s (Police HQ’s) of Köln, Dortmund, and Bonn.



**P-2 Welcomed or Condemned? The public opinion on invasive species**

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The global change of biodiversity and the impact of neobiotic species as an important part of these changes are becoming more aware in public interest. Increasing numbers of media reports on that topic represent the direct result of this interest, as the media try to satisfy their recipients. However, there are different views of how invasive species are perceived by the public and how they are presented in media reports. The media represent public opinion but also influence or even control it. It is very important to understand medial techniques of gaining, transforming and giving information. Therefore, reports of different media types (newspapers, magazines, broadcasting services and television) on biological invasions were analysed to show the present status of information given to the public and especially how it is presented. Results show a very controverse view of invasive species and a great insecurity how to deal with them. It will be shown by especially developed “case studies” how the perception of neobiotic species is based on their impact on human life.

**P-3 Sediment-linked occurrence of ophiuroids off Helgoland, German Bight (North Sea)**

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In the past decades there have been a number of inventories of the benthic macrofauna of the German Bight, setting up species check lists and discussing faunal associations in the North Sea. Far back established monitoring programmes and analogous studies on longterm trends and possible changes in the species diversity, is a main constituent part of the research work of the Biologische Anstalt Helgoland (BAH).

Comparing earlier observations, the aim of the present study is to give an overview of the current spectrum of ophiuroids off Helgoland, as well as of their abundances and distribution to appropriate substrata.

Furthermore, the sediment preferences of the ophiuroids will be evaluated and a possible role of interspecific competition and active habitat selection will be examined (in progress). Van-Veen and dredge samples were taken from diverse sediment types occurring off Helgoland, and examined with respect to both ophiuroids and sediment characteristics in order to allow for a precise correlation between species occurrence and preferred substrate.

**P-4 Hypoxic regulation of oxygen transport – comparative analysis of two coexisting water flea species (*Daphnia pulex* and *Daphnia rosea*)**  
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The acclimation process to hypoxia includes changes at the systemic level (ventilation, perfusion) during acute oxygen shortage as well as regulation on the biochemical level regarding the oxygen transport protein hemoglobin during chronic exposure to low-oxygen conditions. In the present study, oxygen transport variables of *D. pulex* and *D. rosea* were examined as reaction to hypoxia. For *D. pulex*, Hb subunit composition was analyzed using 2D gel electrophoresis. As a long-term incubation of *D. rosea* was only possible at normoxia, the physiological reactions of this species were observed at short-term hypoxia. *D. rosea* showed an increase of the heart beating rate that was maintained on an increased level down to an oxygen partial pressure of 1.5 kPa. The appendage beating rate already decreased below 8 kPa. Half-maximal saturation of Hb (*P50*) *in vivo* was achieved at 1.2 kPa ambient oxygen partial pressure in *D. rosea*. Under long-term exposure *D. pulex* showed an exponential increase of the Hb-concentration as a function of oxygen partial pressure. Altogether, an approximately twentyfold increase of the Hb-concentration from normoxia to hypoxia (2.1 kPa) was observed. The *in vitro P50* of *D. pulex* Hb was reduced linearly from 0.8 to 0.3 kPa with decreasing ambient oxygen partial pressure. *D. pulex* Hb subunit structure was changed under hypoxic conditions. Some Hb subunits were expressed with increasing oxygen partial pressure, others were expressed only under hypoxic conditions. From this state we conclude that the increase of Hb oxygen affinity under hypoxic conditions is due to the expression of subunits with increased oxygen affinity.

**P-5 Pre- and post-zygotic selection in a hermaphrodite – does *Schmidtea polychroa* avoid the cost of inbreeding?**  
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“It is a truth universally acknowledged that” inbreeding depression can lead to great fitness costs. Various forms of inbreeding avoidance have evolved on behavioural and gamete level. The sexual biotype of the freshwater planarian *Schmidtea polychroa* is simultaneously hermaphroditic, but non-selfing. Offspring mortality is high, which might result from inbreeding depression, as neither mate choice nor kin recognition seem to occur. The selection arena hypothesis predicts that maternal individuals reduce wasting of resources, and thus the cost of inbreeding, when several embryos compete against each other for food. Less fit animals die during development, but their share of food is not wasted, because siblings can feed upon the remnants, and – perhaps – even on their dead sibs. *S. polychroa* produces cocoons with several zygotes embedded in a common yolk source. This species is highly promiscuous, and multiple paternity is the general state among cocoon mates. To see the consequences of inbreeding, and whether *S. polychroa* avoids costs via promiscuity, I let groups of worms undergo different mating regimes. These treatments include (i) monogamous inbreeding, (ii) in- and outbreeding, (iii) monogamous outbreeding, and (iv) polygamous outbreeding. Clarification about the existence of mate choice will be given by behavioural data from the mating sessions. Comparison of offspring viability among treatments shall elucidate the strength of inbreeding depression in *S. polychroa*, and the planarian’s potential ways of diminishing such.

**P-6 Influence of inbreeding on kin recognition in three-spined sticklebacks**Joachim G. Frommen<sup>1</sup> & Theo C. M. Bakker<sup>2</sup><sup>1</sup>Institut für Evolutionsbiologie und Ökologie, An der Immenburg 1, Bonn, Germany [jfrommen@evolution.uni-bonn.de]; <sup>2</sup>Institut für Evolutionsbiologie und Ökologie, An der Immenburg 1, Bonn, Germany [tbakker@evolution.uni-bonn.de]

We tested kin recognition in an experimental design in which in- or outbred sticklebacks were given the choice to shoal with either a familiar group of full sibs or an unfamiliar group of unrelated animals. The time that testfish joined each group indicated that subadult, non-reproductive sticklebacks preferred to shoal with familiar relatives. Analysing in- and outbred trials separately indicated that there exists an influence of inbreeding on the testfishes' ability to recognise kin.

**P-7 Beggars can't be choosers: nest-site selection of the Honey Buzzard (*Pernis apivorus*)**

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The Honey Buzzard (*Pernis apivorus*) is a hymenoptera feeding specialist and long distant migrant, which winters in Africa south of the Sahara. This forest dependant species arrives in its West Palearctic breeding range late in spring (May), when species of similar size (e.g., Common Buzzard *B. buteo*, Goshawk *Accipiter gentilis*, Black Kite *Milvus migrans*), with similar nest-site habitat requirements, have already chosen the "best" forest patches for breeding.

In two different study areas in east Austria nest-site choice of Honey Buzzard was studied. In the one area, hilly and well forested (>40 % forest) with a breeding density of 8-9 pairs /100 km<sup>2</sup>, 33 nest sites and 50 random plots were analysed. The second area (85 % forest) was located in the riverine forests along the Danube, where it has an extremely high density with 26 pairs / 100 km<sup>2</sup>. Here 24 nest sites plus 50 random plots were measured.

At the macro habitat level the nest-site is characterised by a high proportion of forest, mature forest-stands, and grassland. Typical for this species is its high degree of tolerance for anthropogenic features, such as settlements and roads. The micro habitat was well structured, had a high canopy and a high proportion of deciduous trees. The number of the nest-tree species as well as the variation in their diameter was very high. Comparing the 57 nest-sites as a whole, in both areas there were almost no significant differences with the 100 random sites. Whereas all the other sympatric raptor species (5 and 8 species, respectively) were much more distinct. Its late arriving time combined with the time pressure for reproduction (<5 months) could be the reason for its plasticity and the high degree of similarity between habitat supply and demand.

**P-8            Where have all the brown bears gone? Genetic monitoring of the brown bear *Ursus arctos* population in central Austria**

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The small population of brown bears in central Austria goes back to the release of 3 bears in the range of a single migrant bear that had settled in the area in 1972. Two females and one male were introduced in the years 1989–1993. The population has been monitored by radio-tracking and collecting data on bear signs and observations. In 2000 we started a genetic analysis using microsatellites and sex specific PCR markers to characterise the brown bear population in central Austria. The aim of the study was to improve our knowledge of population size and sex ratio, and to reveal the relationships between individuals.

Hair and feces samples were gathered from a 650 km<sup>2</sup> area. Furthermore we analysed blood samples from captured individuals, among them the three introduced bears and three of their offspring. Seven different microsatellite loci were used for genetic characterisation. Sex was determined with two different primer sets, one for the sdf locus and one for the amelogenin gene.

We present results from three years of genetic monitoring, which were combined with the field observations. During this time only one male and two females (mother and daughter) of the population took part in the reproduction. Despite the fact that 26 bears were born in this region since 1993, the number of individuals remains surprisingly low (ranging from 7–8). Our results suggest that subadult bears migrate from the investigation area. Nevertheless, indices for bear occurrence in the neighbouring regions are rare.

**P-9            “Should I stay or should I go” the genetics of parasite-avoidance in *Caenorhabditis elegans***

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The free-living soil nematode *Caenorhabditis elegans* is one of the main model species in biological research. However, there is not much known about its natural ecology, including possible interactions with parasites such as physiological or behavioural responses. In this study, we employ *C. elegans* as a model host to investigate the genetics of parasite-avoidance. The Gram-positive soil bacterium *Bacillus thuringiensis* is used as a model parasite. In a previous study, where different natural worm isolates were compared, a significant positive correlation between resistance and avoidance behaviour was found. Here, we test whether there is a genetic basis for this correlation by examining different components of the insulin-like receptor pathway. This pathway is well known for its pivotal role in longevity. It was recently also shown to mediate parasite resistance, especially towards Gram-positive bacteria. We will now elucidate to what extent it is also involved in the behavioural response towards parasites.

**P-10 Habitat selection of *Eptesicus nilssonii* (Chiroptera: Vespertilionidae) in a diverse environment**

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*Eptesicus nilssonii* has been described as forest-dwelling as well as using habitats in urban areas. Here, we study the habitat preference in a diverse environment by radio-tracking. Home ranges of 10 female and 3 male *E. nilssonii* captured at a maternity roost in Bad Grund / Germany, were determined during two breeding seasons (2002/03). Habitat composition of the bats' main foraging area was calculated using Arc View GIS (Ver. 3.3). We discriminated between forest (46 % of total area), grassland (26 %), agricultural areas (12 %), urban areas (15 %) and lakes (<1 %). The occurrence of the five habitat types within each bat's home range was compared to the observed habitat use. Forest habitats were preferred by far, followed by grassland, urban areas, lakes and agricultural areas. The latter were avoided significantly ( $\chi^2$ ,  $p < 0,05$ ) by most bats. Preferences varied significantly for bats tagged before and after the birth of the young. Forest use matched the expectation before the birth of the young, but was significantly lower than expected afterwards. After birth, the females spent significantly more time than expected in urban habitats ( $p < 0,05$ ). Moreover, they spent a significantly higher percentage of activity time hunting in urban areas, particularly around streetlamps, than did bats before (U-Test,  $n=10$ ,  $p < 0,01$ ). Females hunted in 27 % of their foraging time with conspecifics, with the degree of competition being significantly higher after birth ( $n=10$ ,  $p < 0,01$ ). These data provide first quantitative evidence that urban habitats can be very important to female *E. nilssonii*. However, preference of urban and avoidance of forest habitats is restricted to the time after the birth of the young.

**P-11 Blood parasites in nightingales and their relation to mating status, song and day of arrival**

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Blood parasites can have detrimental effects on their hosts. If they affect male sexually selected traits, then these could provide information on male resistance to parasites. In this study we analyzed the relationship between blood parasites and male singing behaviour and other phenotypic traits in nightingales, *Luscinia megarhynchos*. A positive relationship was found between parasitism and day of arrival. Unexpectedly however, more mated than unmated males were parasitized. Parasitism did not effect biometry, nor song rate at dawn or during the day. During nocturnal song, parasitized males sang less than unparasitized males and parasitized birds sang fewer whistle songs than unparasitized subjects, which is a category of song that is thought to be important in female choice. The finding that more mated than unmated males were parasitized may suggest the hypothesis that being mated to such males may provide a heritable immune benefit to offspring's.

**P-12 Genetic analysis of the stone crayfish (*Austropotamobius torrentium*) in Germany, with emphasis on the local distribution around Regensburg and the impact of alien crayfish species**

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Since the second half of the 19th century, native crayfishes in European freshwaters have declined as a response to pollution, habitat alteration and diseases – especially the crayfish plague transmitted by alien species. *Austropotamobius torrentium*, the smallest of four native species in Germany, is confined to headwaters and adapted to cold water with high flow through and rocky environments. It has never been of economical interest and is therefore likely to show its original pattern of distribution. In this study, autochthonous populations of this species were collected from 18 localities in southern Germany. These, and additional samples from museum collections were analysed with mitochondrial 16S rRNA and cytochrome oxidase subunit I (COI) gene fragments for phylogeographic studies on a regional scale in southern Germany. Our results reveal a very low level of genetic variability in *A. torrentium* indicating a recent postglacial invasion to central European waters or recent gene flow between populations, which could also be triggered by culturing activity of prehistoric man. Phylogeographic structure is much more pronounced near the southern glacial refugial zones and may reflect different subspecies as suggested for populations from the Balkan. A case study in a brook in the Bavarian Forest inhabited by both the native *A. torrentium* and the introduced signal crayfish *Pacifastacus leniusculus* demonstrates the invasive potential of the latter. This larger, faster growing invader shows reproductive superiority (more eggs & faster juvenile growth) under laboratory conditions. This could play an important role in species replacement. A concept for management and conservation for all existing populations of *A. torrentium* is discussed.

**P-13 Does earthworm coelomic fluid induce apoptosis in certain tumor cells?**

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The cytolytic action of *Eisenia fetida* coelomic fluid (ECF) is known for a long time and caused by several well described molecules known as fetidins, lysenin, CCF-1, H1-3 and Eiseniapore. The toxic action is directed against different targets like microorganisms, Trypanosomes and different eucaryotic cells including tumor cells.

In our current study we analyzed the killing effect of ECF and coelomocyte lysate (CL) against cells of the following tumor cell lines DU 145 (prostate carcinoma), IGR-1 (malignant melanoma), Cak-1 and Caki-2 (kidney clear cell carcinoma) and RCC-EW (polymorph cellular adenocarcinoma) in vitro using the MTT assay. A significant decrease in cell viability was shown for all cell lines tested, in a doses dependent manner after 30 min incubation with ECF as well as coelomocyte lysate. Prostate carcinoma cells DU 145 were shown to be most sensitive in that assay.

We were applying sub-lethal doses of ECF in cell cultures of the named tumor cells in order to investigate whether cytotoxic molecules are able to induce apoptosis of these cells. A hypothesis based on the fact that some lytic molecules of ECF specifically bind to sphingomyelin. Sphingomyelin hydrolysis on the other hand is involved in signal transduction that leads to apoptosis. So far we obtained a clear indication for apoptosis induction by ECF using the Annexin-V-Fluos Staining Kit. An assay most suitable to demonstrate early stages of apoptosis and moreover, in combination with propidium iodide apoptotic cells can be distinguished clearly from necrotic cells. High numbers of apoptotic cells were identified for IGR-1 and Caki-2 cells after incubation with ECF. We like to verify these results by PARP-Western blotting and RT-PCR in ongoing experiments.

**P-14 Ecological genetics of endangered Cloud rats: conservation basics for an endemic murine rodent taxon**

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Cloud rats of the genera *Phloeomys* and *Crateromys* are endemic to the Philippines. Six species have been identified: the Northern and Southern Luzon slender-tailed cloud rats (*Phloeomys pallidus* and *P. cumingi*) are found on Luzon in primary and secondary forest. Also on Luzon, but restricted to pine-oak areas of the Cordillera Central, the Giant bushy-tailed cloud rat is found, *Crateromys schadenbergi*. Populations of the Panay bushy-tailed Cloud rat, *C. heaneyi*, remain in the forested areas of central Panay Island. The remaining two species, *C. paulus* and *C. australis*, are represented merely by their holotypes from Ilen Island and Dinagat Island, resp. Hence, two species are possibly extinct, and the other species are threatened by ongoing habitat destruction and poaching. Very little scientific information on the biology of Cloud rats has been published. Anecdotal evidence indicates that Cloud rats are strictly nocturnal, live in tree nests, most probably in territorial monogamous pairs, and feed primarily herbivorously. The scarcity of reliable information on the biology of Cloud rats is alarming! Both for conservation issues as well as basic behavioural, evolutionary, and ecological research, fundamental information on population structure and dynamics and behavioural biology are of paramount importance! Here we show, in arboreal rodents with such a remote and nocturnal live style, application of capture/recapture techniques in combination with microsatellite typing is the most promising approach to achieve urgently needed basic information. Given the murine descendancy of the taxa, microsatellite primers can be accessed from well-accessible house mouse sources.

**P-15 Reactions of oribatid mites (Acari, Oribatida) to changing forestry methods in the lowlands of north-eastern Germany**

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In the research project "future-oriented forestry management" (BMBF) the ecological consequences of changing forestry methods by introducing common beech to pine forests to create mixed deciduous and coniferous woodlands were investigated. The main research was focussed on ecofaunistical and soil ecological investigations and on the recording of the reaction of selected animal groups in different strata to the alteration of forest composition. Natural beech forests were chosen as a reference. To explore the soil fauna, samples were taken in the Müritzer National Park and in a forest near Eberswalde three times a year in 2000 and 2001 and once in the year 2002. The results of the oribatid mites were evaluated quantitatively and qualitatively for the sampling periods 2000 and 2001.

Species numbers and species densities are clearly lower in the beech forests than in the mixed and pine forests. The abundance of oribatids obviously decreases with increasing age of beech understorey, while their number grows with an increase of coniferous trees. Species with a preference for pine forests appear in all sampling spots, but their number increases significantly with the increase of pine trees. Species with a preference for beech forests appear first when the beech undergrowth reaches an age of about 40 years.

**P-16 Population differentiation in the common earthworm *Lumbricus terrestris***  
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The common earthworm *Lumbricus terrestris* plays an important role in the ecology of the soil, because it contributes to the decomposition of dead organic matter, the maintenance of soil structure, and it also represents a central component of terrestrial food webs. Due to these reasons, *L. terrestris* is of high economic interest, especially in agriculture and as an indicator of soil quality. Thus, it came as a surprise that to date only little is known about its population dynamics. In this study, we explore the genetic diversity, migration rates and evolutionary history of *L. terrestris* populations. For this purpose, we compared seven population pairs, of which one was always obtained from a small fragmented and isolated location (small population) and the other from an open, wide area (large population). From these populations, we collected a total of 198 individuals. Population dynamics were reconstructed from two mitochondrial genes (NADH 2 and NADH 4), which we characterized using single-strand conformation polymorphism (SSCP) analysis in combination with DNA sequencing. The results of this study will help to understand the importance of different selective forces on the maintenance of genetic diversity and the differentiation of populations within a fragmented environment as in industrialized countries.

**P-17 The carabid fauna of the forest stands in the north-eastern lowland of Germany with the focus of the forest conversion**  
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The objective of the project “Soil-biological and ecofaunistical investigations to estimate the effects of the forest conversion in the north-eastern lowland of Germany” (Fö.-Kz.: 0339757) is to analyse the reactions of selected animal groups with regard to the conversion of the forest stands. This project is part of a network investigation with the title “future-oriented silviculture” throughout Germany to study the effects of the forest conversion with the aim to extend the ratio of the naturally existing tree species. This means for example in the north-eastern part of Germany a decrease of the surface area covered with pine (*Pinus silvestris*) in favour of the red beech (*Fagus sylvatica*), which characterizes the Baltic beech forest. In this project the carabid fauna (Coleoptera: Carabidae) was sampled using pitfall traps in mixed and pure stands of pine and beech of different age stages, altogether on 11 investigation sites, for three years (2001–2003).

Additionally, using other types of traps (crown and slot traps, stem eclectors) for the special proof of lignicole beetles and butterflies a lot of carabid species could be detected. It turned out that the number of the carabid species occurring in the strata “soil surface” and “stem/crown” is nearly equivalent. The carabid coenosis of the examined forest stands consists primarily of common or non-specific forest species. The carabid coenosis of the investigation sites shows altogether a high measure of concordance. Thus the species identity (Jaccard-Index) for 22 of the 25 annual series of investigations amounts to at least 50%. Within this range the diversity values of the nature forest stand (Naturwaldparzelle) achieve the highest degree of quality of all investigation sites. Beside the nature forest especially the young forests attract attention. In the young forest stands higher values (species and individual numbers) were measured. As afforestations they came out from eradication surfaces. Thus they are subject to modified conditions in structural regard (small space resistance at the soil surface) and in view to the species composition (arise from non-forest species in comparison with older forest stands).



**P-18 Effects of urbanisation on major histocompatibility complex (MHC) variability and parasite load in the yellow necked mouse (*Apodemus flavicollis*)**

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Negative consequences of urbanisation are based on an increase of environmental stress as well as on fragmentation and isolation of natural habitats. Stress in mammals induces an immune debilitation and might increase susceptibility to pathogens. Habitat fragmentation leads to restricted migration and increases the probability of genetic drift, inbreeding and thus loss of genetic variation in the remaining populations. The highly polymorphic MHC-molecules are essential in the vertebrate immune reaction. Their variability is correlated with the diversity of the T-lymphocyte receptors which in turn determines the disease and parasite resistance of an organism. Polymorphism is thought to be maintained by balancing selection either through heterozygosity advantage, driven by the ability of heterozygous hosts to detect a wider range of antigens, or by frequency-dependent selection (= rare-allele-advantage), which describes the temporary selective advantage of some rare alleles over common ones. Four populations of *Apodemus flavicollis* in the city of Hamburg were chosen to investigate the effects of urbanisation on MHC polymorphism and parasite load. MHC variation of the functional highly important DRB gene was assessed by SSCP and sequencing. The susceptibility to diseases was examined by measuring intestinal parasite load (fecal egg counts) using a modification of the McMaster technique.

On the population level we found a low extend of genetic variability at the MHC associated with a high intensity of nematode infections and vice versa. Considering the individual MHC constitution, certain alleles were linked with either very high or very low intensity of infections. This study provides strong evidence for an association of MHC variation and parasite burden in a free-ranging rodent and supports the rare-allele-advantage hypothesis in maintaining MHC polymorphism.

**P-19 Tit for tat – sperm trading in a hermaphroditic sea slug**

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In simultaneous hermaphrodites, differences in fitness pay-off for the male and female function can result in a preference for one particular sex role. This leads to a conflict over mating roles during copulation. In some hermaphrodites, mating partners alternate sperm exchange repeatedly during a single mating sequence. This process is well documented and often referred to as sperm trading. It is considered a possible solution for the conflict over mating roles. However, the implicit assumption of sperm trading that sperm donation is conditional upon sperm receipt has never been proven. Recent studies suggest that this conditionality lacks in some hermaphrodites with a sperm trading pattern. In this study we tested sperm trading in the sea slug *Chelidonura hirundinina* (Opisthobranchia: Aglajidae). Here, a mating sequence typically starts with one simultaneous, reciprocal intromission, followed by several overlapping simultaneous or alternating unilateral intromissions. To test whether sperm donation depends upon sperm receipt ('tit-for-tat'-like strategy), we manipulated animals in such a way that they were not able to donate sperm, while mating behaviour remained unaffected. If sperm are traded, the partner of a treated animal should detect the cheating and refuse to reciprocate. We show that animals with a manipulated partner had fewer intromissions than individuals mated with a non-manipulated partner, and that matings were usually terminated by the cheated partner. This is the first evidence that reciprocity is indeed conditional in an apparent sperm trading system.

**P-20 Paternity in parthenogenetic planarians**

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Several theories predict that asexual reproduction should be disadvantageous compared to sexual reproduction (e.g. Deterministic mutation hypothesis, Muller's ratchet, Red Queen). But why are asexual species still persistent? One possibility is that a little bit of sex (occasional sex) occurs could compensate for the disadvantages of asex.

We examine the importance of occasional sex in sperm-dependent parthenogens of the freshwater planarian *Schmidtea polychroa*. Here, sperm is only necessary to trigger development of parthenogenetic eggs. As parthenogens are hermaphrodites, they produce sperm, which is fertile.

Previous studies revealed that field mated parthenogens produce genetically differing offspring. We now want to confirm with paternity analysis that this genetic diversity is caused by introgression of paternal chromosomes into the progeny-genome.

We determine the genotype of each adult using five highly polymorphic microsatellite loci and perform controlled crossing experiments. By comparing parental with filial genotype we are able to detect paternal alleles incorporated into the offspring's genome. This allows us to estimate the degree of sex in asexual forms of *Schmidtea polychroa* and to explain the success of asexual forms in this species.

**P-21 Morphological plasticity: winner strategies of a Mediterranean sponge**

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Porifera are simple-organised Metazoans with a non-specialized body structure. They are considered as sessile organisms but locomotion occurs in some species. Some sponges preserve a high degree of adaptability to the environmental conditions through a surprisingly high morphological plasticity. In particular, the demosponge *Chondrilla nucula* Schmidt, 1862 shows peculiar life strategies thanks to its high morphological dynamic. The sponge is able to move actively on the substrate showing in some cases even a negative geotaxis. Specimens can fuse with each other or they can fragment to disperse and colonise new substrate. Attachment on the substrate is rapid because of the high reorganisation capability at the cellular level. *C. nucula* is also able to exploit other benthic organisms as available substrate being a non-destructive and occasional epibiont. In spite of its semi-encrusting shape it can live also in high sedimented area, developing a peculiar mechanism of elimination of the sediment that involve the production of a mucous layer over its body. For these characteristics *C. nucula* finds in unstable but good enlightened areas its favourite environment, being a pioneer species among the sponge fauna of the Mediterranean Sea.

**P-22 Association between MHC genes and parasite load in two rodent species, the hairy-footed gerbil (*Gerbillurus paeba*) and the striped mouse (*Rhabdomys pumilio*) in the Kalahari Desert**  
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Approximately 70% of all the world's drylands are endangered by desertification. Particularly in the savannas of Southern Africa anthropogenic impacts have led to severe habitat degradation. Here primarily overgrazing has caused encroachment of bush scrubs. Plant structures in dry savannas (e.g. the Kalahari) strongly affect faunal diversity. In particular small mammals depend on vegetation patterns. Due to relatively short generation times environmental changes can affect their population structure and genetic constitution rapidly. These genetic shifts in turn may have an influence on the population's immune competence and therefore its ability to face pathogens. We used two rodent species that are widely distributed in Southern Africa (*Gerbillurus paeba*, *Rhabdomys pumilio*) as models to investigate potential effects of different land use on population structure, parasite load and genetic constitution. The individual parasite burden was determined through fecal egg count analyses. Genetically we focused on the major histocompatibility complex (MHC) which plays a crucial role in the vertebrate's immune system. The MHC is the prime example for resistance genes with extensive polymorphism attributed to balancing selection. Thus MHC-genes are placed among the best candidates for molecular adaptation processes. To explain potential selection mechanisms in this context, a few strongly debated, pathogen-based models have been developed.

In our study we aimed (1) to examine both MHC constitution and parasite burden in the investigated populations with regard to different land use, (2) to analyse the importance of MHC constitution for resistance to parasites and (3) to take the acquired data into consideration with respect to selective mechanisms acting on the MHC in the presence of parasites. Our results indicate effects of different land use on both population structure and genetic constitution. Furthermore we found correlations between the MHC and individual parasite load supporting the hypotheses that MHC polymorphism is maintained by pathogen driven selection.

**P-23 Kin recognition in *Pelvicachromis taeniatus* (Teleostei: Cichlidae)**  
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Theoretical considerations and several case studies show that mating between close relatives can result in severe inbreeding depression. This leads to a selective pressure on the evolution of mechanisms for inbreeding avoidance. One possibility is the evolution of kin recognition mechanisms. We tested experimentally, whether females of *Pelvicachromis taeniatus*, a West African stream-dwelling cichlid, react differentially to males of different degrees of kin relationship. We offered mature females a choice between an unfamiliar brother and an unfamiliar non-brother. During the experiments, both optical and olfactorial information about the potential mates was available to the females. Contrary to our predictions, females spent significantly more time with their brothers. On the one hand this result shows the ability of female *P. taeniatus* to discriminate between males of different degrees of relatedness. On the other hand further investigations are necessary to clarify whether this behaviour has to be interpreted as mate choice or shoaling behaviour.

**P-24 Reactions of the gamasid fauna (Acari, Arachnida) to changing forestry methods in northeastern Germany**  
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In the research project “future-oriented forestry management” (BMBF) the ecological consequences of changing forestry methods by introducing common beech to pine forests to create mixed deciduous and coniferous woodlands were investigated (duration of the project: April 2000 – April 2002). The main research was focussed on ecofaunistical and soil ecological investigations and on the recording of the reaction of selected animal groups in different strata (soil, soil surface, dead wood, cabbage layer, bush layer and tree layer) to the alteration of forest composition. Natural beech forests were chosen as a reference. To explore the soil fauna, samples were taken in the Müritz National Park and in a forest near Eberswalde three times a year in 2000 and 2001 and once in the year 2002. The results of the gamasid mites were evaluated quantitatively and qualitatively for the sampling periods 2000 and 2001. The individual numbers and species richness rise with an increase of deciduous trees and with rising age of the pine forests. The highest species numbers and densities indicate the natural beech forests and an old unmanaged pine forest, which is 160 years of age. It was stated that the structures of communities of predatory mites differ very much between managed pine forests and the natural beech forests. But the differences are alleviated clearly on the mixed deciduous and coniferous woodlands.

It seems that the Gamasida show clear reactions to different stages of forest reorganisation.

**P-25 Life history plasticity and social conflict in a primitively eusocial bee**  
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All organisms face the problem of allocation of resources between growth and reproduction as a part of their life strategy. In eusocial species individual growth is to some extent substituted by the production of workers that take over foraging and defence. This generates an additional level of complexity since the number and production pattern of the workers has to be optimised. Additionally, conflicts between the queen and workers might arise that do not exist among clonal cells of an unitarian organism. Our study population of the halictid bee *Lasioglossum malachurum* exhibits a remarkable variability in the nesting cycle. We hypothesise that these differences in life strategy of the primitively eusocial species are caused by exogenous, endogenous or social factors. Several unique characteristics make this species and, in particular, our study population an ideal model system to investigate these questions by a combination of empirical field studies and theoretical modelling. Further more microsatellite and gas chromatographic methods are used to analyze the complex sociogenetic structure.

**P-26 Colony density, distribution and intercolonial relationship of the army ant *Dorylus (Dichthadia) laevigatus* (Dorylinae: Formicidae: Hymenoptera) in Borneo**

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Most army ants are predominantly subterranean (hypogaeic) but the majority of army ant studies concerning distribution, behavior etc. were conducted on epigaeic species. Due to the hypogaeic lifestyle direct observations are very restricted. We developed a method to study hypogaeic army ants using oil baits.

In Tawau-Hills-Park (Sabah, Malaysia) we established a grid system with 56 regularly placed baits to screen for the 2 known hypogaeic army ants *D. laevigatus* and *D. vishnui*. The baits were checked in 3-day-intervals. During these checks we also sampled approximately 30 individuals if army ants were present. With this method it was possible to estimate the density of the two *Dorylus*-species in the sampling area. During the observation period of 2 months we found *D. laevigatus* at 57% of the baits and *D. vishnui* at 43% of the baits. We will present data on the temporal-spatial distribution of the two army ant species.

We are currently developing genetic markers (microsatellites, mitochondrial DNA sequences) for *D. laevigatus* to precisely define the colony borders in this army ant species. If we have determined the colony borders we can then identify the homorange of single colonies.

Due to their reproductive system (colony fission) we would expect to see differences in the genetic relationship and geographic distance between mtDNA and chromosomal DNA markers. Therefore, we have developed markers for the mtDNA and will also present preliminary results of a mtDNA analysis.

We also present estimates of the mating frequency of 4 *D. laevigatus*-colonies. All 4 colonies were multiply mated.

These sociogenetic analyses will complement our field data and help us to better understand the ecological impact and life history of the common Malaysian army ant *D. laevigatus*.

**P-27 Defence waving in the Giant honeybee (*Apis dorsata*)**

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The nest of the Asian Giant honeybee *Apis dorsata* consists of a single comb covered by several layers of bees forming a curtain. Abdomen flipping is a behavioural component shown by bees of the roofing layer. It may happen either seemingly uncoordinated and stochastic (forming the so-called *flickering* behaviour), or highly coordinated and cascadic-like as a domino-effect, resulting in wavings on the nest surface (known as *shimmering behaviour* or abdominal shaking, or more interpretative, as *alarming* or *defence waves*; see Kastberger G & Biswas S 1998 *Zoology* 101, 48). Defence waving is evoked by approaching wasps, hornets, moths or birds, or even by wasp-like dummies. It occurs strikingly fast, spreading over the whole nest within a fraction of a second (Kastberger G et al 2001 Proc. DZG Osnabrück 94, 7). The coordination of such kind of colony response to predatory signals is sensed visually, but assumingly also mechanically due to movements of the bee curtain generated by the synchronised mechanical pulses.

The present paper analysed the spatial and temporal structure of defence waves and measures its key parameters. A wave is formed by only 2–3% of the total number of surface bees per image (40 ms), its duration ranges from 600 to 2500 ms. We also investigated whether defence waving informs the participants of the nest curtain, actively or passively involved, about the predatory signal. Lastly, we use the defence waving as a multiagent model to provide appropriate algorithms for controlling robot swarms under selected scenarios.

**P-28 Foraminifers at the autecological limit: A marine group of protists in low salinity brackish water of the north-eastern coast of Germany**  
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Foraminifers (Granuloreticulosea) are an important, abundant and highly diverse taxon distributed from the abyss of the world oceans up to the supralittoral of the sea coasts. Information on their distribution in the Baltic Sea is very scarce because of weak research interest caused by low abundance and low diversity of foraminifers in the Baltic Sea. Published knowledge is mainly based on deep water association described by Lutze (1965) and a salt marsh locality at Kiel described by Lehmann (2000). Now, we have got data on taxonomic composition, distribution and ecology of shallow water associations (<2 m) by collecting sediment samples from more than 30 stations along the German Baltic Sea coast. It shows a much wider distribution and more complex community structure of foraminifers in the study area.

The salinity gradient running from the west to the east in the southern Baltic Sea causes a similar diversity trend within the foraminiferal fauna. There live 85 species in shallow and deeper water along the coast of Schleswig-Holstein, 28 species in Mecklenburg-Vorpommern whereas only 4 species are reported from the Polish coast so far.

Main taxa in the oligohaline to lower mesohaline salinity range of the German coast are *Miliammina fusca*, *Criboelphidium williamsoni* and trochamminids. Principal factor for their distribution is the character of the substrate. Trochamminids are typical for phytal habitats and sediment with plant detritus cover, *M. fusca* lives on sediment stations and is the most abundant foraminiferal species in general. The lowermost documented salinity limit for the foraminifers is about 5 psu in the study area – we found living trochamminids in the Barther Bodden in a reed fringe.

The study of foraminiferal live at its lower salinity limit in brackish water of the southern Baltic Sea is still in progress and will draw a more detailed picture of it in the future.

**P-29 Importance of *Platorchestia platensis* (Kröyer) (Amphipoda) for the decomposition process of stranded *Zostera marina* L.**  
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It is estimated that around 350 000 m<sup>3</sup> *Zostera marina* strand on the shores of the German Baltic coast every year. This organic material is subject to different processes of degradation (leaching, microbial decay, mechanical fragmentation) in which also the infauna of the beach wrack is involved. One of the most abundant representatives of the German wrack-fauna, the amphipod *Platorchestia platensis*, can be found under and in accumulations of stranded *Zostera marina* (see Dürkop 1934).

Experiments show that these animals are able to ingest directly the mechanically and microbial hardly vulnerable material. The present study examines in two different methodical approaches how these species affect the dynamic of degradation and the rate of turnover of stranded *Zostera marina*.

The first approach measures energy release, assimilation efficiency and the abundance as well as size distribution of the animals in the habitat to calculate food requirement. The second approach experiments with microcosms were undertaken to investigate the indirect effects through enhanced fragmentation and possible higher microbial activity in addition to the direct influence of the animals to the eelgrass.

The results show that the influence of *Platorchestia platensis* to the decomposition process of stranded *Zostera marina* is low. Turnover-rates between 450 and 5900 days were calculated on the basis of food requirement and abundance of *Platorchestia platensis* in relation to the amount of stranded eelgrass. This calculation does not consider the much lower abundances and metabolic rates in winter. Therefore the natural turnover-rates are much lower than calculated rates. Also the results of the microcosm experiments show only a slight increase of decomposition of *Zostera marina* in presence of the animals. Although no higher bacterial biomasses were found in microcosms with animals the amount of decayed *Zostera marina* detritus was occasionally 3 to 5 times higher compared to the calculated assimilated amount. It is concluded that *Platorchestia* seems not to play such important role in decomposition process of stranded eelgrass like for example *Talorchestia carpensis* in the decomposition of *Ecklonia maxima* on the beaches of South Africa (Griffiths & Stenton-Dozey) or *Orchestia bottae* in the decomposition of *Cystoseira barbata* in the supralittoral of the Black Sea (Sushchenja 1967).

**P-30      Activity patterns of raccoon dogs in Mecklenburg-Western Pomerania  
(Germany)**  
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Activity patterns of the raccoon dog *Nyctereutes procyonoides* (Gray, 1834) (Canidae) in Mecklenburg-Western Pomerania were recorded with the help of radio-tracking data in 1999–2003. The present study based on 13.229 radio-locations from 66 individuals.

Raccoon dogs show an outstanding day-night rhythm: whilst breeding and months with shorter nights, raccoon dogs were active up to 10 hours (June), in the winter only one hour (February) in bright daylight. To identify differences in circadian activity, the year was divided in five parts. All activity patterns are clearly influenced by sun rise and sun set as well as by breeding (May-June), prolonged daytime (March – April, July – August, September – October) and short daytime (November – December).

The activity of females and males during pup rearing proved to be detected. Males did more rest at night and were longer active in the daytime than females. Also the circadian activity rhythm whilst breeding was different too.

Hibernation of several days couldn't be detected in four winters. Nevertheless, a strong correlation of temperature and inactivity was identified. Low temperatures led to a significant by longer inactivity.

**P-31      Changes of the microbiocommunity associated with the marine sponge  
*Pachymatisma johnstonia* after cultivation**  
Steffen Kuppardt

Rostock



## SG6 Studiengruppe Physiologie

### V-S1.1 Molecular analysis of the tobacco hornworm chitin synthase

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Chitin, a linear polymer of N-acetyl- $\beta$ -D-glucosamine, is the most abundant amino polysaccharide in nature and is found predominantly in arthropod exoskeletons and fungal cell walls. Chitin is produced by the enzyme chitin synthase, an integral membrane protein that utilizes UDP-N-acetyl- $\beta$ -D-glucosamine to form the polymer. In insects chitin is synthesized by ectodermal cells that form chitinous cuticles but also by entodermal cells of the midgut that secrete a chitinous peritrophic matrix. In order to analyze for the first time chitin synthase of entodermal cells, we modified previously published assays based on incorporation of N-acetyl- $\beta$ -D-[14C]-glucosamine to characterize enzyme activity of larval midgut cells from the tobacco hornworm, *Manduca sexta*. To investigate chitin synthase in the course of development, we monitored enzyme amounts and activities in midgut extracts of different larval stages and found them both to be significantly reduced during molt and in the wandering stage. Since maximal values were observed for 5th instar larvae aged three days, we used midguts from this particular stage as starting material for biochemical isolation of the chitin synthase. Purification steps involved differential centrifugation of midgut membrane vesicles and subsequent affinity chromatography using immobilized anti-chitin synthase antibodies. This procedure led to a fraction containing only four remaining proteins, three of them were identified to be actin, aminopeptidase N and chitin synthase. Native-PAGE revealed that the isolated chitin synthase exhibits a molecular mass of 525 kDa suggesting that not the monomer, which has a deduced molecular mass of 175 kDa, but a homo- or heteromeric trimer was obtained.

### V-S1.2 CyclicAMP-dependent activation of vacuolar-type H<sup>+</sup>-ATPase (vATPase) in blowfly salivary glands

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Secretion in blowfly salivary glands is stimulated by the hormone serotonin (5-HT) that activates an ATP-dependent transport of K<sup>+</sup> into the lumen of the gland. We have previously shown that a vacuolar-type proton pump (vATPase) in the apical membrane of the secretory cells provides the primary driving force for K<sup>+</sup> extrusion. The intracellular second messenger that carries the information from the activated receptor to the vATPase is unidentified hitherto. Here, we have examined whether cAMP, known to be produced within the secretory cells in response to serotonin application, activates the vATPase.

Electrophysiological measurements of the transepithelial potential indicated an increase in cation extrusion upon superfusion of isolated glands with cAMP and IBMX, a phosphodiesterase inhibitor. Similar results were observed with cAMPS-Sp, a hydrolysis-resistant cAMP analogue, or with forskolin, an activator of adenylyl cyclase. ATPase assays confirmed that these substances led to an increase in vATPase activity. Biochemical assays showed further that forskolin, cAMPS-Sp or cAMP/IBMX caused a recruitment of peripheral V1 subunits from the cytosol to the plasma membrane, indicative of an assembly of V0V1 holoenzymes. Since Fura-2 measurements did not show an increase in cytosolic [Ca<sup>2+</sup>] under these conditions, we conclude that a rise in intracellular cAMP is sufficient to induce an assembly of vATPase holoenzymes and an activation of pump activity in this system. (Supported by Deutsche Forschungsgemeinschaft: Wa463/9-3)

### V-S1.3 **Does calreticulin exist in earthworms?**

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Coelomic fluid of annelids exhibits numerous biological activities. Cytolytic components secreted into the coelomic cavity by coelomocytes are of particular interest with regard to their potential medical applications. Secreted lytic molecules often require molecular chaperons to prevent autolysis and to increase the yield of correctly folded proteins. Calreticulin was described as one of the most important lectin-like chaperons necessary for glycoprotein maturation. It was isolated first from the sarcoplasmic reticulum of rabbit muscle as a 60-kDa calcium-binding protein by Ostwald and MacLennan in 1974 and cloned in 1989. Calreticulin is encoded by a single gene, which has been identified in both vertebrate and invertebrate species as well as in some higher plants but not in prokaryotes and yeast. Here we report a partial sequence characterization of a calreticulin-coding cDNA in *Eisenia fetida* earthworms (*Oligochaeta*, *Annelida*), isolated by RT-PCR using degenerated primers. The neighbor-joining phylogeny tree strongly supports a common origin of the *E. fetida* calreticulin-like molecule and calreticulin-like molecules of nematodes. Furthermore, the binding of rabbit anti-human calreticulin antibodies was detected in free coelomocytes and in the mesenchymal lining of the coelomic cavity by immunocytochemistry and immunohistochemistry.

### V-S1.4 **The effect of peptide hormones on Na<sup>+</sup>-absorption across earthworm integument**

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Many hormones are known to play a major role in the regulation of Na<sup>+</sup>-absorption in various vertebrate tissues. Invertebrates use ion channels, transporters and pumps comparable to those of vertebrates for the regulation of their electrolyte homeostasis. The fact that earthworms (*Annelida*, *Oligochaeta*) generate an amiloride-sensitive short-circuit current across their skin epithelium, suggests the presence of an epithelial sodium channel (ENaC) in the apical membrane of this tissue.

ENaCs are mainly regulated by aldosterone in mammalian tissues and to a lower degree by vasopressin-like peptide hormones. As annelids lack steroid hormones such as aldosterone, they offer an interesting quasi knock-out model to study the effect of those phylogenetically old peptides on Na<sup>+</sup>-transport without being superposed by an aldosterone effect.

In this study, Ussing chamber experiments in current-clamp-mode were performed to investigate the effect of oxytocin, vasopressin, vasotocin, isotocin, annetocin, conopressin and a newly synthesized peptide (2-tyr-8-lys-conopressin) on the amiloride-sensitive short-circuit current (I<sub>amilo</sub>) across earthworm skin. Only the conopressin-derivates led to an increase in I<sub>amilo</sub> whereas all the other tested peptides led to a decrease.

The observed reactions seem to be related to the chemical structure of the peptides. An also revealed dose-dependency of the hormone effect on I<sub>amilo</sub> can explain why oxytocin is being described in the literature either as a natriuretic or an anti-natriuretic peptide by different authors.

Supported by the DFG.

**V-S2.1 Thermoregulation during pupal development affects synaptic organization in the adult honey-bee brain**  
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In honey-bee colonies, brood temperature is controlled precisely close to 35°C. Bees raised at lower temperatures (in the natural range of temperatures) were shown to perform less well in dance communication and olfactory learning than bees raised at higher temperatures. Here we explored whether there are temperature-mediated influences on the synaptic organization in the adult brain and compared effects on workers and queens. Pupae were raised in incubators at 29–37°C. Adult brains were immunofluorescently labeled and examined with a confocal microscope. Analyses focused on sensory input regions in the mushroom bodies (MBs), brain areas associated with higher order processing. Pre- and postsynaptic structures of synaptic complexes (microglomeruli, MG) in the MB calyces, and selected glomeruli in the antennal lobes were analyzed using phalloidin and an antibody to synapsin. In the MB calyx, MG numbers differed in bees raised at different temperatures and persisted after the first week of adult life. In the olfactory input region (lip), MG numbers were highest in bees raised at the temperature normally maintained in brood cells (34.5°C) and significantly decreased at 1°C below and above. In the visual input region (collar) MG numbers were less affected. Interestingly, in queens the maximal MG numbers were shifted towards lower temperatures, and developmental time and emergence rates were much less affected compared to workers. We conclude that thermoregulation of brood generates area- and modality-specific effects on synaptic neuropils in the adult brain, and resulting differences may underlie temperature-mediated effects on adult behavior.

**V-S2.2 Transepithelial fluid reabsorption in ducts of salivary glands in the cockroach *Periplaneta americana* (Blattodea: Blattidae)**  
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Poster, Abstract s. P–23

### V-S2.3 Glycosylation of yolk proteins (vitellins) in nereidid polychaetes

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N-Glycosylation is a feature of most secretory proteins and necessary for correct transport through cellular compartments and secretion from the cell. In this study, the carbohydrate structure and composition of the yolk proteins (Vitellins) of two polychaetes, *Platynereis dumerilii* and *Nereis virens* was investigated with respect to their species specificity. In nereidids, the yolk protein is secreted by specialized coelomic cells (eleocytes) and incorporated by the growing oocyte, where it constitutes about 50% of the total soluble oocyte protein.

The monosaccharide composition of the vitellin-bound carbohydrates was determined by reversed phase high-pressure liquid chromatography (HPLC) after trifluoroacetic acid hydrolysis. Intact glycans were obtained after N-Glycosidase F deglycosylation and size separation by normal phase HPLC. The glycan fractions were sequentially digested with linkage specific exoglycosidases to get information about their structure.

In the vitellin of *P. dumerilii*, N-linked glycans were of the high mannose type. The results suggest an uniform glycan structure consisting of a linear chain of 10 alpha-linked mannose residues attached to the vitellin via a single N-acetyl glucosamine (NAGA) residue. In *N. virens*, the size of the N-glycan fraction was more heterogeneous consisting mainly of tri- and tetrasaccharides and the terminal alpha-mannose residues were linked to two NAGA residues via a beta-mannosidic linkage.

The glycosylation pattern was consistent in several vitellin preparations of either species suggesting high species specificity. Supported by the German Research Foundation (DFG Ho 889/5-1).

### V-S 2.4 Chemical camouflage in castles of clay: *Macrotermes herus* and its termitophilous beetle

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The integrity of termite colonies is guaranteed by recognition cues denying non-nestmates access to the colony. Nevertheless, members from several insect orders succeed in invading termite colonies. An important group of such termitophiles is the tribe Termitopaediini (Staphylinidae), which are host specific at the termite species level (mainly species of the subfamily Macrotermitinae). In social insects, cuticular hydrocarbons (CHC) are supposed to play the key role in species and nestmate recognition. We compared CHC profiles across colonies of the termite *Macrotermes herus* with those of the termitophilous *Termitobia herus* found in *M. herus* colonies:

(1) CHC profiles varied considerably between termite colonies (chemical phenotypes). (2) Profiles of the termitophilous *T. herus* matched with those of its host colony. (3) Profiles showed caste specific differences within termite colonies. However, such differences were significantly smaller than between colonies. (4) Profiles of the termitophiles were more similar with those of sexuals and nymphs than of steriles.

The match of profiles suggests that CHCs are the recognition cues in termites. The beetles camouflage by these recognition cues to get access to a specific colony. According to Kistner (2001, Sociobiology 38, 5-278) *Termitobia* chooses the proximity of nymphs. Having the profiles of sexuals and nymphs guarantees them a full integration into the colony and even being fed the same food as queens and/or nymphs. Kistner (2001) further speculated that such food passes hormones from termites to the beetles causing postimaginal growth leading to physogastry in the beetles as in the termite queens.

**V-S2.5 Inhibition of egg production by adipokinetic hormone in *Gryllus bimaculatus* (Ensifera: Gryllidae)**  
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Energy-mobilization by neuropeptides of the adipokinetic hormone (AKH) family is among the best-studied processes in insect physiology. In addition, these peptides also inhibit lipid synthesis in the fat body, a feature that has attracted much less attention. Besides flight, one of the most energy-demanding events in the adult life of a female insect is the production of eggs, where huge amounts of energy-rich substrates for deposition in the growing oocytes have to be provided by the fat body. We investigated the age-dependent changes in fat body lipid, protein, glycogen and free carbohydrate content in 0–30 d old females. In addition, the egg-production and the content of energy-rich substrates in the eggs was measured to calculate the amount of substrates transferred to the eggs during vitellogenic growth. Lipid (21%) and protein (15%) are the principal contributors to the ripe egg. We hypothesized that the inhibition of lipid and/or protein synthesis in the fat body would interfere with egg production. To test this assumption, AKH was injected twice daily into 0–3 d old adult females. On day 4 the fat bodies and ovaries were analyzed. In AKH-injected females, the fat body contained significantly less lipid and protein compared to Ringer-injected controls, indicating that AKH inhibited lipid and protein synthesis. As a consequence, the number and size of terminal oocytes in the ovaries of AKH-injected females was lower. Our results suggest that AKH interferes with the production of eggs at least in part via the inhibition of lipid and protein synthesis. Therefore, in migrating insects, AKH might play a central role in the regulation of the trade-off between flight and reproduction.

Funded by the DFG, Lo 697/4-1 and 4-2

**V-S2.6 Rhythm and coordination of contractions in the sponge *Tethya wilhelma* (Porifera: Demospongiae)**  
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Slow but rhythmic body contractions occur in many sponge species. Its importance for the filter feeding sponges by means of increasing water exchange inside the aquiferous system has been underestimated so far, mainly due to difficulties to observe and to quantify contraction. We used digital time-lapse photography in conjunction with semi-automated image analysis based on the ImageJ software package to quantify the contraction behavior of the globular sponge *Tethya wilhelma*. Under nature-like conditions in the aquarium photographs were taken every 200 seconds for a period of 8 days, resulting in 3,185 images. 44 contraction cycles were observed, with an average period of 236 min  $\pm$  112 min and an average reduction of the projected area of the sponge body by 44.2%  $\pm$  6%. The sponge is able to contract upon mechanical stress, e.g. feeding amphipods. Though there is a tendency for reduced contraction during night, no significant difference by means of period or strength between day and night could be shown. Based on these results we used *T. wilhelma* as a model to investigate coordination mechanisms in sponges. A semi-closed micro observation chamber was used under stable temperature and oxygen level. We tested a variety of substances, including neuroactive signal molecules like acetylcholine, GABA, serotonin, NO and others, and its antagonists and/or inhibitors. Our results indicate that coordination of contraction in sponges is based on the same signal molecules found in higher Metazoa. On the other hand the relatively slow reactions on transmitter substances indicate that they might act as long range signals throughout the whole sponge body and not only local like in the nervous system of higher Metazoa.

### V-S3.1 **Oxygen binding and its allosteric control in haemoglobin of the branchiopod crustacean *Triops cancriformis***

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While structural and functional aspects of the haemoglobins of various branchiopod crustaceans such as those of the genera *Daphnia* and *Artemia* have been studied in detail, much less is known concerning allosteric characteristics of oxygen binding. This study elucidates oxygen binding characteristics of haemoglobin (Hb) of a primitive branchiopod, the tadpole shrimp *Triops cancriformis*. Two pooled haemolymph samples of 500 µl each were collected from 25 and 35 animals, respectively, and dialyzed using a molecular weight cutoff of 30000. The haem concentration was 0.96 and 0.85 mM, respectively. O<sub>2</sub> binding measurements were made in 0.1 M Tris buffer at different pH values and Mg<sup>2+</sup> and Ca<sup>2+</sup> concentrations. The dialyzed Hb displayed a moderate O<sub>2</sub> affinity of 9.2–16.5 mmHg (pH 6.7–9.2, 20 °C) and a moderate pH dependency (Bohr factor = -0.16). Hill's cooperativity coefficient increased linearly from 1.91 to 2.91 at pH 6.7–9.2. Divalent cations increased the O<sub>2</sub> affinity with Mg<sup>2+</sup> exerting a greater effect than Ca<sup>2+</sup>. Analyses of extended Hill plots according to the Monod-Wyman-Changeux model indicates an O<sub>2</sub> affinity control mechanism that is similar to that of extracellular annelid Hbs. In *T. cancriformis* Hb, protons lower the affinity by decreasing the O<sub>2</sub> association equilibrium constant of Hb in the high-affinity state (KR), which is in contrast to vertebrate Hb, where protons and organic phosphates modulate the O<sub>2</sub> association equilibrium constant of Hb in the low-affinity state (KT). Changes in KR show a preferential, oxygenation-linked proton binding to the oxygenated Hb which seems to optimize the O<sub>2</sub> loading at the respiratory surfaces in hyperventilating animals facing environmental hypoxia.

### V-S3.2 **Epithelial immune response in the fruitfly**

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The fruitfly *Drosophila melanogaster* employs two major principles to combat invading microorganisms, a systemic and a local immune response. In contrast to the systemic immune response which is characterized by a massive release of antimicrobial peptides into the hemolymph, a number of different organs is able to launch a local immune response that is restricted to the area of infection. Among these organs are those associated with the intestinal tract (salivary glands, intestine, Malpighian tubules), the trachea and the reproductive organs. All these tissues may express numerous antimicrobial peptides at the site of infection. To learn more about the basic design of the epithelial immune response and its essential molecular repertoire (the molecules that are of major importance for this response,) we combined transcriptomal studies with the analysis of a new novel type of transgenic lines that allow gene-silencing of any gene of interest in a spatiotemporally defined way. A major difference between the local, epithelial response and the systemic response observed here is the apparent lack of specificity in the local response. Regardless the type of infection, the same response is launched in these epithelial cells. This difference points to divergent recognition and signalling pathways in the local and systemic immune response. By using DNA-microarray analysis, we identified the complete set of genes/proteins involved in the signalling cascades that are expressed in the corresponding epithelial organs. Based on this information, we currently produce and analyze transgenic lines defective in the expression of one or more of the most interesting candidate genes to elucidate their physiological role in the epithelial immune response.

### V-S3.3 Association between the MHC constitution and parasite burden in the mouse lemur, *Microcebus murinus*

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We have investigated the importance of major histocompatibility complex (MHC)-constitution on the parasite burden of free ranging mouse lemurs (*Microcebus murinus*) in the littoral rain forest in southeastern Madagascar. The MHC class II DRB exon 2 variability, encoding the major part of the peptide binding region, was investigated in more than 220 mouse lemurs using SSCP and sequencing. The four investigated forest fragments differed significantly in the number of nematode infections (NNI) as well as in the fecal egg count (FEC) rates which may be explained by the genetic constitution of individuals. Whereas homozygous and heterozygous individuals did not differ in the number of nematode infection, heterozygotes revealed significant lower fecal egg counts compared to homozygotes. A positive relationship was found between parasite load and specific alleles. Whereas Mimu-DRB\*1 was significantly associated with high parasite burden, the alleles Mimu-DRB\*6 and 10 were more prevalent in low-infected individuals. An odds-ratio test showed that individuals Mimu-DRB\*1 had a 1.8-fold higher chance of having a high parasite burden than individuals without this allele. All these three alleles associated with parasite resistance had unique amino acid motifs in the antigen binding sites that distinguished them from the remaining 11 identified Mimu-DRB alleles. Our results support the hypotheses that MHC polymorphism in *M. murinus* is maintained through pathogen-driven selection acting by means of both, heterozygosity advantage and frequency-dependent selection. This is the first study on the association of MHC variation and parasite burden in a free-ranging primate.

### V-S3.4 Characterization of a lipoprotein in the polychaete annelid *Nereis virens*

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A lipoprotein, recently found in the coelomic fluid of the polychaete *Nereis virens* was characterized biochemically and by electron microscopy. After staining of the coelomic fluid with the lipophilic dye Sudan Black B, native agarose gel electrophoresis revealed the lipoprotein fraction as a single band. The lipoprotein was present in either sex in contrast to vitellogenin, a female specific lipoprotein. The lipid accumulating coelomocytes were considered as a potential site for lipoprotein synthesis. In cell culture experiments however, no release of lipoprotein into the medium could be detected.

The lipoprotein was isolated from the coelomic fluid by ultracentrifugation in a self generating gradient of iodixanol. Denaturing electrophoresis (SDS-PAGE) of the isolated lipoprotein revealed two apoproteins with molecular weights of  $247 \pm 9$  and  $99 \pm 9$  kDa, respectively. In feeding experiments, the presence of the smaller subunit was shown to be more dependent on the nutritional state than the larger one. The apparent molecular mass of the native lipoprotein complex was 1,8 MD as determined by size exclusion chromatography.

The lipids transported by the lipoprotein were extracted with chloroform/methanol and analyzed by thin layer chromatography. Phospholipids were the main lipids, while other lipid classes were only present in traces.

By electron microscopy, the lipoprotein was shown to be of discoidal shape, with a diameter of about 55 nm and a thickness of 13 nm.

Due to its high phospholipid content, it is likely that the *Nereis virens* lipoprotein serves similar function as crustacean lipoproteins. With respect to its large size however, it differs significantly from these.

### **V-S3.5 Characteristics of paravertebral muscles in small mammals**

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According to anatomical position and their superficial muscle fibre direction different functional roles were supposed for the paravertebral muscles in mammals. These hypotheses can be supported by the metabolic profile of the muscles. Fibre type distribution was mapped in serial sections of the back muscles of four different small mammalian species. All species showed congruent patterns of fibre type distributions in the muscle examined. The M. sacrospinalis and the M. psoas major possessed the highest proportion of glycolytic fibres. The Mm. rotatores, multifidi, intertransversarii et interspinales contained the highest proportion of oxidative fibres. Regionalisations of oxidative fibres were found near to the vertebral column and around intramuscular tendons in the M. quadratus lumborum and the M. spinalis. The results suggest clear functional differentiation between the various paravertebral muscles and even intramuscular regions. Number and position of muscle spindles are important in order to understand the functional role of a muscle. In comparison to the M. spinalis, the M. quadratus lumborum contained nearly three times more receptors, but proportion of the different morphological spindle types was comparable. Direction and length of fascicles of back muscles were determined and 3D reconstructed to show the intramuscular fibre architecture. All these data of intramuscular architecture of the back muscles were examined as prerequisite to understand their functional role during motion.

The study was supported by the Deutsche Forschungsgemeinschaft (DFG) (“Innovationskolleg Bewegungssysteme”) and the Berufsgenossenschaft Gaststätten und Nahrungsmittel (BGN).

### **V-S3.6 Shoulder movement, locomotor dynamics and fibre type distribution of shoulder muscles in small primates and non-primate mammals**

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Primates are said to be unique in their great extent of forelimb protraction during quadrupedal walking. Unlike most other mammals, primates place their hands far in front of the head. The protracted forelimb posture of primates at the beginning of a step cycle is very sensible to vertical load because gravity acts with long moment arms at proximal limb joints and creates a large extensor torque about the shoulder. Most primates utilise a specific dynamic strategy to minimise the torque about forelimb joints. Torque transfer between trunk and support by prehensile hindlimbs allows a posterior weight shift from forelimbs onto the hindlimbs. However, prehensile abilities of the hind feet are necessary for the weight shift. Callitrichid monkeys have large claws instead of nails and the grasping abilities of their hind feet are very limited. Like other mammals, callitrichid monkeys shift most of their weight to the forelimbs.

The amplitude of shoulder movements and the peak vertical load on the forelimbs are related to the percentage of a special type of muscle fibres in the rotator cuff muscles of the shoulder. Fatigue-resistant Type 1 muscle fibres are assembled in deep regions of joint-stabilising muscles and are mainly responsible for maintain posture. The comparison of fibre type percentage in shoulder muscles between primates and non-primate mammals shows a substantial increase of type 1-fibres in the infraspinatus muscle in primates. This muscle acts against the torque at the shoulder joint and prevents a hyperextension of the joint. Compared to other primates, shoulder muscles of the tamarin (Callitrichidae) with its considerable forelimb loading have the highest percentage of type-1 fibres to stabilise the shoulder.



### V-S3.7 **Cytoglobin is a connective tissue and neuron-specific protein that is induced by hypoxia: a function in collagen synthesis?**

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Recently, cytoglobin has been identified as the fourth member of the vertebrate globin family. Cytoglobin has a molecular mass of 21 kDa and displays 35 % amino acid sequence identity with myoglobin, but its function is still unknown. Using Northern and Western blot methods, cytoglobin was found to be expressed in a broad range of mouse and human tissues. Under hypoxic conditions, cytoglobin mRNA levels are significantly elevated in rat. Immunofluorescence studies show the presence of cytoglobin in the cytoplasm of connective tissue fibroblasts, hepatic stellate cells, chondroblasts and osteoblasts. Cytoglobin expression decreases upon differentiation to chondrocytes and osteocytes. The differential expression argues against a general respiratory function, but indicates a connective tissue-specific role of cytoglobin. We suggest that cytoglobin may provide oxygen to the hydroxylation reaction of procollagen. Cytoglobin expression was also observed in some neuronal subpopulations of the central and the peripheral nervous systems. Surprisingly, cytoglobin is localized in both the cytoplasm and nucleus of neurons, indicating an additional role of this protein in neuronal tissues, e.g. the delivery of oxygen to NO synthases.

### V-S3.8 **Organization of the septal organ: olfactory receptor expression and nerve fiber projection**

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The septal organ (SO) is a small patch of olfactory epithelium located as an island in the respiratory epithelium on the nasal septum. Although discovered decades ago, its functional relevance remains enigmatic. Here, we have identified a repertoire of chemosensory receptors expressed in the SO. The results demonstrate that SO neurons express receptor genes belonging to class-II olfactory receptors that are also expressed in the main olfactory epithelium. In the SO, no topography analogous to the receptor expression zones of the main olfactory epithelium was evident. The majority of identified receptors correspond to genes with restricted expression in the medial and lateral zones of the main olfactory epithelium. Most of the receptor types were found to be expressed in only few SO neurons, except for mOR244-3 which was observed in a very high proportion of cells. Although a high fraction of SO neurons expressed mOR244-3, we found no evidence for the co-expression of different receptors in individual cells. Analyzing the projection pattern of SO neurons using the OMP-GFP transgenic mouse line revealed that axons navigate in highly variable fiber tracks across the main olfactory epithelium towards the main olfactory bulb. All SO axons cross through the cribriforme plate at a spatially defined site and terminate exclusively in the posterior, ventro-medial aspect of the bulb. Here, one portion of axons forms a dense network on the medial side where they apparently enter glomeruli which are mainly innervated by axons of olfactory sensory neurons from the main olfactory epithelium. Another significant portion of the axons targets a few glomeruli which appear to receive input exclusively from the septal organ neurons.

#### **V-S4.1 Response of oxidative stress parameters and activation of hypoxia inducible factor to changing environmental temperature in polar and temperate zoarcid fish**

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We are interested in the cellular mechanisms that support wide ranging latitudinal distribution of marine eurythermal fish and have studied a new facet of thermal tolerance in zoarcids from different climatic regions. The common eelpout, *Zoarces viviparus*, from the North Sea was compared to the Antarctic eelpout, *Pachycara brachycephalum*, with respect to cellular oxidative stress parameters and the potential to induce metabolic reorganization during functional hypoxic stress. Functional hypoxia sets on at the limits of thermal tolerance and we hypothesize that survival of thermal stress in ectotherms involves hypoxic signalling to induce metabolic reorganisation.

It turned out very clearly that polar eelpout maintain a stronger antioxidant defence system (antioxidant enzyme activities and 3 fold higher levels of liver glutathione) to protect their susceptible membranes from oxidative damage and in so doing decreased the levels of lipid peroxidation damage and the formation of lipid radical chain reactions.

EMSA-binding activity of the hypoxia inducible transcription factor (HIF-alpha) was found above habitat temperature at 5°C in polar eelpout and at low temperature of 6°C in North Sea eelpout. In both cases, accumulation of ROS mediated damage correlated with HIF stabilization and a decrease in enzymatic antioxidant defence. We see here that metabolic ROS production becomes unbalanced at the thermal limit of the tolerance range of an ectotherm and in some way or other this is involved in metabolic reorganization during onset of functional hypoxia.

#### **V-S4.2 The heat-shock response and patterns of vertical zonation in the common mediterranean sponge *Aplysina aerophoba* Schmidt, 1862: Stressgen sequences and quantitative expression**

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Species of Porifera comprise a major portion of marine benthic communities. Zonation patterns of sublittoral communities are relatively poorly known due to problems of accessibility and lack of wide-scale applicability. Many biological and physical factors are involved in the distribution of sponges, including sedimentation, substrate, light and oxygen availability, water flow and nutrient levels. These factors and consequently the habitats, change with increasing depth of water. One well-known strategy of organisms to cope with proteotoxic stressors is to react by the induction of stress proteins, particularly the stress protein family with a molecular weight of 66-78 kDa. This family is highly conserved, and perhaps the largest of all the Hsp families and the best documented one. Hsp70 induction is regarded as a biomarker and allows assessment of the stress condition of a single specimen. In this study the focus is on the common Mediterranean sponge *Aplysina aerophoba* undergoing stress in nature, and on the roles of stress proteins in the stress physiology of ADD the whole organism. We investigated genes of the hsp70 family coding for Hsp70 and genes for beta-tubulin in *A. aerophoba* in the Limski channel, near Rovinj, Croatia, to assess the physiological response that enables ADD S them to survive in different depths. The levels of expression of hsp70 mRNA in different depths of water have been studied by real-time polymerase chain reaction.

**V-S4.3 Plasticity of the thermal tolerance window of *Daphnia magna* (Crustacea: Cladocera) – an integrative approach**  
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Exposure to different temperatures induces acclimation processes optimizing physiological performance at the respective conditions. As limitations of thermal tolerance seem to be correlated to restrictions in oxygen supply, temperature acclimation is likely to affect oxygen transport mechanisms.

Studies on *Daphnia magna* cultured at 10, 20 and 30 °C for many generations utilized variables from the biochemical, physiological and behavioural level to characterize the thermal tolerance window of each acclimation group. The preference position within a temperature gradient was correlated to the animals' acclimation temperature; cold-acclimated animals showed stenotherm behaviour, while animals from 20 and 30 °C distributed more widely within the gradient. Although maximal swimming activity was observed at the respective acclimation temperature, minimal lactate concentrations indicated that energy was provided by aerobic metabolism at these conditions. At lowered and especially at elevated temperatures, lactate concentrations were raised despite of considerably reduced motility. In the warm, enhanced ventilation and perfusion rates could not meet the increasing energy demand.

The analysis of structural and functional properties of the respiratory protein revealed that with rising temperature, the oxygen transport capacity was enhanced by increased amounts of high-affinity hemoglobin. Two-dimensional gelelectrophoresis showed a differential expression of Hb subunits as a function of water temperature.

The results indicate that acclimation-induced changes of the size, form and position of the thermal tolerance window are closely related to a misfit of oxygen supply and energy demand.

**P-1 Distinct distribution of neuroglobin in vascular and avascular mammalian retinae**

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Neuroglobin is a heme-containing respiratory protein implied to play an essential role in oxygen homeostasis of neuronal cells. Recently, neuroglobin was found to be highly expressed in the mouse retina. Like humans and most other mammalian species, mice possess a so-called vascular retina in which oxygen is supplied by the outer choroidal capillaries, the deep retinal capillaries and the inner capillaries. Some mammals such as rabbits and guinea pigs have an avascular retina in which the deep retinal and inner capillaries are absent. Here we compare the distribution of neuroglobin in vascular (mouse, rat) and avascular (rabbit, guinea pig) retinae. In mouse and rat, neuroglobin is essentially present in the inner segments of the photoreceptor cells, both plexiform layers and the ganglion cells. By contrast, in rabbits and guinea pig, neuroglobin is restricted to the inner segments of the photoreceptor cells. In the vascular retina, oxygen consumption takes places mainly in the inner segments of the photoreceptor cells, the plexiform layers and the ganglion cells. In the avascular retina, only the inner segments located close to chorioidal capillaries show oxidative metabolism, whereas the non-vascularized layers of the retina rely on fermentation. Thus our results support the hypothesis that neuroglobin expression correlates with oxygen consumption, and that neuroglobin supplies oxygen to the respiratory chain of mitochondria.

**P-2 Psychosocial stress during pregnancy increases fear-related behaviour and serum-corticosterone concentration in male Long-Evans rats in the open field paradigm**

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There is increasing evidence that prenatal stress affects the behavioural and hormonal development of offspring in rodents. In most studies relatively artificial stressors such as restraining were used. Thus, we investigated whether psychosocial stress during pregnancy influences fear-related behaviour and glucocorticoid-secretion in the adult rat offspring.

Pregnant Long-Evans rats were stressed daily for 2h throughout pregnancy by confrontation with a female conspecific. At the age of 100 days male offspring were tested in an open-field arena for 90 minutes and their behaviour was video-taped. After 10 minutes a blood sample was taken within 3 minutes. Immediately after sampling the animals were returned to the arena. At the end of the 90 minutes a second blood sample was taken.

During the first 10 minutes, adult prenatally stressed (PS) male rats spent significantly less time within the inner squares of the open-field than adult control (CON) male rats from undisturbed pregnancies, although the number of entries did not differ between CON and PS. No differences were found between the exploratory behaviour of CON and PS (time spent moving, passed distance). Although all males had increased corticosterone concentrations after the open-field test (in comparison to base values taken two weeks before the test-session) the concentrations of PS were higher than those of CON.

In conclusion, these results demonstrate that prenatal stress in laboratory rats is associated with increased fear-related behaviour in a novel environment. Furthermore, the results show a stronger activation of the HPA-axis in PS, although exploratory behaviour of the two groups in a novel situation did not differ.

**P-3            *In vivo* activity of proprioceptive afferents in the main motor nerve of the stomatogastric nervous system of crabs (*Cancer pagurus*)**  
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There are numerous *in vitro* studies of the crustacean stomatogastric networks, but only few *in vivo* analysis of motor activity. *In vivo* studies of sensory-motor interaction are rare because it is difficult to record from small sensory nerves. Using chronic double recordings from the dorsal ventricular nerve (dvn) it is now possible to separate two afferent ascending units from the descending rhythmic motor activity of the pyloric and gastric network in freely moving crabs or under simultaneous endoscopic inspection of stomach movements in restrained animals. Both units show bursting activity during gastric mill movements. Unit I does so during weak and strong gastric activity, whereas unit II can switch from phase coupling to the gastric mill during strong gastric activity to phase coupling to the pyloric rhythm during weak or absent gastric activity.

Specific mechanical stimulation of the stomach teeth causes afferent responses of up to 30 Hz. These afferent bursts are followed by changes of the pyloric pattern. The pyloric periods are shortened, i.e. the period duration of the pyloric pacemaker neurons (pyloric dilators = PD) is shortened though their burst duration and spike frequency remain constant. This is accompanied by a decrease in the spike frequency of the pyloric constrictor motor neurons (PY) and an increase in the lateral pyloric motor neuron (LP). This motor response corresponds to the reaction of isolated stomach preparations after stimulation of the gastro-pyloric receptor (GPR) cells under open loop conditions found by Katz and Harris-Warrick.

Therefore our new approach provides additional support for the theory that the GPR-cells are engaged in monitoring and shaping the gastro-pyloric activity.

**P-4            *Locomotion of Trichosurus vulpecula – analysis of metric parameters of walking gait on a pole at different inclinations***  
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The walking gait of two individuals of brushtail possums (*Trichosurus vulpecula*, Marsupialia: Phalangeridae) was recorded using a video camera (50 frames/s). In contrast to other studies of *Trichosurus vulpecula*, a wooden pole was used as substrate to meet the requirement of arborealism. Metric parameters such as duty factor, stride length, stride frequency for hind- and forelimb, as well as footfall patterns and the diagonality factor were assessed for different experimental setups: a horizontal setup, and different inclinations (only the steepest inclination of 30 degrees will be shown). *Trichosurus vulpecula* is an arboreal animal walking on relatively thin branches and possessing hindlimbs with grasping ability. Like arboreal primates they rely on diagonal sequence walking gaits but with a diagonal coupling. As in many other mammals the species showed a dual mechanism for acceleration. It increases the stride frequency as well as the stride length to gain speed. This was observed on the horizontal substrate as well as in walking upslope and downslope on a 30 degree inclination. Differences in metric parameters between the horizontal setup and inclination setup are presented. It is assumed that with increasing inclination there will be a caudal shifting of the stride of fore- and hindlimb in relation to the eye and the hip joint, respectively. In contrary to that there will occur a cranial shifting of the stride with decreasing inclination.

**P-5 Circadian rhythms in the rats' hippocampus: Expression of MT1- and MT2-Melatonin receptors are time- and light-controlled**

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The aim of the present experiments was to investigate time-dependent effects of melatonin on the synaptic transmission within the hippocampus.

Rats were entrained to a 12/12 hrs LD cycle (ZT0=lights on). Hippocampal slices were prepared at different points of time and evoked field potentials (FP) were recorded from the CA1 region. To analyse the expression of transcripts for the MT receptors, single cell PCR experiments with CA1 neurons were performed.

Electrophysiological experiments: Melatonin (10 nmol/l) increased the slope of FP in slices prepared at ZT 3 (early day) and ZT 10 (late day) more than 2 times of the initial level. In contrast, melatonin had no effect in slices of the early night group (ZT 13) and decreased the slope of FP in slices of the late night group (ZT 20) to approximately 50% of the initial level. To determine whether the different reactions to melatonin are mediated by different melatonin receptors, we used the MT2 receptor antagonist 4-PPDOT (10 nmol/l). The antagonist suppressed the melatonin effects at ZT 3, but had no effect at ZT 20. The melatonin effects were light-dependent: with prolongation of the dark phase to ZT3, the enhancing effects of melatonin at ZT 3 were abolished; a 3-hour light exposition prior to ZT 20 caused an enhancement of the slope of FP at ZT 20.

Molecularbiological experiments: The single cell experiments with CA1 neurons revealed a gene expression for both melatonin receptors, however at different points of time: the rhythmic gene expression for MT1 peaks at late night (ZT 20), whereas the expression for MT2-mRNA was restricted to the day (ZT 8).

The results showed that the time-dependent and opposite effects of melatonin on the synaptic transmission are mediated by the light-controlled expression of MT1 and MT2 receptors.

**P-6 Molecular cloning of Na<sup>+</sup>/K<sup>+</sup> ATPase a-subunit from leech**

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The Na<sup>+</sup>/K<sup>+</sup> ATPase is an ouabain-sensitive, electrogenic ion pump responsible for maintaining the balance of sodium and potassium ions in almost all living cells. The electrochemical gradients for Na<sup>+</sup> and K<sup>+</sup> are required for maintaining membrane potentials, cell volume, and secondary active transport of other solutes, e.g., the transcellular transport processes in intestine, glands, and kidney. It belongs to the P-type family of active cation transport proteins. P-type ATPases are found in almost all eukaryotic organisms from protozoa to vertebrates and they all share remarkable similarities in their molecular structures. The protein is a heterodimer composed of a- and b-subunits with molecular masses of 100 or 36 kDa, respectively.

Here we report the molecular cloning and sequencing of the a-subunit of the Na<sup>+</sup>/K<sup>+</sup> ATPase from the medical leech *Hirudo medicinalis*. We screened a cDNA library with a specific probe generated by PCR using degenerated primers. The amino acid sequence shows significant similarities to vertebrate- as well as invertebrate a-subunits. The identity scores at the amino acid level are in the range of 64 (vertebrates) – 77 % (arthropods). Phylogenetic analysis revealed that the leech Na<sup>+</sup>/K<sup>+</sup> ATPase fits well into the group of invertebrate Na<sup>+</sup>/K<sup>+</sup> ATPases, which is related to, but clearly different from other groups of P-type ATPases (vertebrate Na<sup>+</sup>/K<sup>+</sup> ATPases and, even more, H<sup>+</sup>/K<sup>+</sup> ATPases and SERCA Ca<sup>2+</sup> ATPases) indicating an early origin of Na<sup>+</sup>/K<sup>+</sup> ATPases in the evolution of multicellular organisms.

**P-7 Physico-chemical and immunological analysis of Per a 3 allergen from the American cockroach**

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Cockroach allergens are part of house-dust and a major cause of asthma-related health problems of inner city children. Three important allergenic fractions of the American cockroach *Periplaneta americana* were found in the crude-extract of the cockroach. The Per a 3 allergen-fraction is the most potent one and exhibits no cross-reactivity to other allergens. By sequence Per a 3 belongs to the family of insect storage hexamerins and thus is also related to arthropod hemocyanins. However only little was known about the physico-chemical properties of Per a 3.

We physico-chemically characterized the Per a 3 fraction. Two isoallergens, Per a 3.1 and Per a 3.2 are present and can be separated by their polarity. Both isoallergens are hexamers with a molecular mass of 512kDa for Per a 3.1 and 465kDa for Per a 3.2. The molecular masses for the monomers are 79kDa and 74kDa respectively.

Due to their function as insect storage proteins they are rich in aromatic amino acids, which is in accordance with their high molar absorption coefficients Per a 3.1:  $\epsilon(280\text{nm})=1,65$  [ $l/(g \cdot \text{cm})$ ]; Per a 3.2  $\epsilon(280\text{nm})=1,44$  [ $l/(g \cdot \text{cm})$ ].

With regard to the immunochemical properties, we found a significant cross-reaction between the two isoallergens with specific antibodies to Per a 3.1 in western-blotting. No cross-reactivity to the hemocyanin of *Palinurus elephas* was detected.

Based on the structure of hexameric hemocyanin of *Panulirus interruptus* we computed a model of the quaternary-structure of the hexamerin. In this model we located linear allergenic IgE-epitopes of a clone of Per a 3.1 (C12). Their location on the protein surface allows a recognition by the immune system in the native or denatured state. Further experiments are targeted to identify the allergenic state of the Per a 3 isoallergens.

This work was granted by NMFZ Mainz.



**P-8 Cloning of a partial nitric oxide synthase (NOS) cDNA from the cockroach *Periplaneta americana* and possible involvement of NO in the regulation of saliva secretion**

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We have cloned a ~800 bp NOS fragment from a brain-specific cDNA library of the cockroach *Periplaneta americana* by using a PCR based strategy. The PeaNOS sequence shows highest similarity with NOS sequences of *Manduca sexta* and other insects. With RT-PCR experiments we were able to identify PeaNOS mRNA expression in several cockroach tissues including brain, salivary glands, Malpighian tubules, midgut, and skeletal muscle. To localize NOS at the cellular level, NADPH diaphorase staining was performed on cryostat sections of the brain and the salivary glands. We confirmed the staining pattern in the brain, which was described earlier, and we found that only one cell type of the salivary glands, the central cells, were specifically stained. To test whether NO is involved in the regulation of saliva secretion in *Periplaneta americana*, secretion measurements on isolated salivary glands were performed. It has been shown earlier, that the secretory rate of these glands is stimulated by the biogenic amines dopamine and serotonin. We could show in this study that the dopamine-induced secretion is reduced by the NO donors sodium nitroprusside (SNP) and DEA-NONOate. The effects of both substances were dose-dependent and reversible. After inhibition of endogenous NO production by treatment with the NOS inhibitor L-NAME, a small but statistically significant increase in saliva secretion was observed.

This work was supported by a grant from the German Research Foundation (Bl 469/4).

**P-9 Comparative histophysiological aspects of the esophageal epithelium in vertebrates, with special reference to the general nutrition type**

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Independent of its structure, i.e. a mucous monolayer in fishes, a glandular lining in reptiles and carnivorous birds, or a stratified cornifying system in plantivorous birds and mammals, the vertebrate esophageal epithelium tolerates chemical and mechanical strain exerted by normal nutrition. Regarding this ability, our study presents first comparative information on the specific histophysiology of the esophageal inner cellular lining.

Bouin-fixed, paraffin embedded esophagus material of plantiv. (red-eye, marg. tortoise, black grouse, horse) and carniv. (trout, sump turtle, buzzard, cat) species was processed to demonstrate SH-/S-S- groups with IC3-PE-maleimide and DCCI, as well as PCNA, cytokeratins (6, 13, pan), connexins (26, 30, 43), and defense cells (MAC387, pan T) immunohistochemically using sensitive visualization.

The esophagus epithelium of plantiv. birds and mammals, esp., reacted strongly for PCNA (in all cell nuclei), panCK, CK6, and Cx 26/43 (Cx 26 in tortoise) in the str. basale, PCNA (some cell nuclei), panCK, CK6, and Cx 26/30/43 (Cx 26 in tortoise) in the str. spinosum, SH-/S-S- groups, panCK, CK6, and Cx 30/43 in the str. granulosum, and SH-/S-S- groups and panCK (bird) in the str. corneum. In the plantiv. fish and the carniv. species, these reactions were clearly weaker, whereas PCNA staining in the mucous epithelium or the str. basale, resp., appeared regularly but in lower numbers of cell nuclei. Macrophages and T cells were not conspicuous in both nutrition groups studied.

The results emphasize a specific need of epithelial regeneration and stabilization, including intraepithelial communication for differentiation, in plantivorous vertebrates with a high mechanical load of the esophagus epithelium.

**P-10 Shoaling preferences under ultraviolet light condition in three-spined sticklebacks**

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We investigated the use of UV vision on shoaling decisions in three-spined sticklebacks. Although humans are blind to wavelengths between 300–400nm many animals additionally perceive UV wavelengths in this range.

It appears that UV vision is costly as it is known that short wavelengths were destructive to cell tissue. On that score the extension of visual sensitivity into UV must have some advantages over UV-blindness.

**P-11 Magnesium-dependence of tyrosinase- and catecholoxidase-activity of hemocyanin from the spider *Eurypelma californicum* and the scorpion *Pandinus imperator***

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The type 3 copper proteins tyrosinase, catecholoxidase and hemocyanins share similar active sites although their physiological functions differ. Whereas hemocyanins serve as oxygen carrier proteins, tyrosinases catalyze the hydroxylation of mono- to ortho-diphenols as well as the subsequent oxidation to ortho-quinones, and catecholoxidases catalyze only the latter reaction. All these three proteins are found in crustaceans, and with exception of the hemocyanin also in insects. In the latter case they participate in the sclerotisation of the exoskeleton, in wound healing, and are an important part in the innate immune system of the arthropods.

Tyrosinases, often referred to as phenoloxidases, are absent in the phylum chelicerata. But the 4x6-meric hemocyanins from the tarantula *Eurypelma californicum* and the scorpion *Pandinus imperator* exhibit ortho-diphenolase-activity as well as monophenolhydroxylase- / tyrosinase-activity in response to the detergent SDS. These activities can be verified by the use of native PAGE and spectroscopic assays.

We present here a detailed characterization of the activation and the enzymatic properties of the hemocyanin.

**P-12 ABC-Transporters in *Caenorhabditis elegans* and their role in the transport of toxic substances**

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Multidrug Resistance Proteins (MRPs), members of the ABC transporter family, mediate the transport of various substrates across biological membranes at the expense of ATP hydrolysis. They play a general role in the elimination of endogenous and toxic substances. Up to now, eight putative *C. elegans* MRP homologues were identified by sequence comparison. The *C. elegans* gene *mrp-1* has further been characterised by determination of the expression pattern via lacZ and GFP reporter constructs. Deletion mutants concerning *mrp-1* have been reported to show an increased sensitivity to the heavy metal ions cadmium and arsenite.

We have started to investigate the role of *mrp-2* by applying a *mrp-2* dsRed promoter construct. Expression was observed in the pharynx and the rectal gland. At present, we analyse *mrp-2* expression patterns and levels at different environmental conditions, e.g. heavy metal exposure, in wild type as well as in a *mrp-1* deletion strain. In a complementary approach, quantitative RT-PCR on whole worms will give us additional information about expression at different food supply, heavy metal exposure and other environmental conditions.

Physiological properties, i.e. the transport rates of membrane proteins, are investigated by microinjecting specific fluorescent substrates (Fluo-3, Rhodamine123) into intestinal cells or pseudocoel followed by recording the fluorescence increase in the intestinal lumen ("fluorescence shift assay"). A simultaneously injected 3 kDa TexasRed dextran serves as a co-marker and control to visualise cell integrity after the injection process. The substrates Fluo-3 and Rhodamine123 were found to be secreted into the intestinal lumen, whereas the TexasRed labeled co-marker remained within the injected compartment.

**P-13 An ecofaunistic investigation on the effects of a windfall event in the np "Vorpommersche Boddenlandschaft"**

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In December 1999 a storm caused several windfalls on the Darss peninsula (ca. 9.000 scm wood). The effects of this windfall were documented by ecofaunistic investigations by the Zoological Institute & Museum of the University in Greifswald. In the years 2000 to 2003 the windfall, a neighbouring pine and fir wood for comparison as well as a beech wood were sampled with standardised beetle traps. Altogether 11.108 specimen from 298 species of beetles were included in the analysis.

On the pine windfall the number of individuals grew by a factor of more than seven. Especially for saproxylic beetles the windfall was very attractive, therefore the activity species numbers increased. More than 175 species (almost 60 %) were detected only in low abundances. They were opposed by flagship species of the windfall, exclusively saproxylic beetles, which were followed by the predators of those species. On the windfall on the Darss the Scolytidae like *Ips typographus* and its accompanying species as *Crypturgus cinereus* und *Hylurgops palliatus* showed a rapid development. In the fourth year of the investigation period the bark beetle community noticeably decreased.

The natural predators of the bark beetles profited from the higher abundances of these species. Between the Scolytidae as prey and their antagonists (especially predatory coleoptera) existed tight delayed interactions in the population dynamics.

During these investigations numerable remarkable finding were noted.

**P-14 Cysteine proteinases vs. serine proteinases: traits of protein utilization in crustaceans**

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The utilization of dietary proteins is facilitated by a set of digestive peptide hydrolases. In crustaceans these are often dominated by “trypsin-like” serine proteinases. In addition, highly active cysteine- and metallo- proteinases were identified. However, the distribution of proteinases classes is diverse between species.

In order to reveal possible traits in the preferences of digestive proteinases between crustaceans we investigated by inhibitor assays the distribution of serine- and cysteine proteinases in the midgut glands of a set of ecologically important crustaceans. The species belonged to the Caridea (*Crangon crangon*, *Crangon allmani*, *Pandalus montagui*), Anomura (*Pagurus bernhardus*), Brachyura (*Cancer pagurus*), and Euphausiacea (*Euphausia superba*).

All investigated crustaceans showed high total proteolytic activities which did not differ between species. Trypsin, however, varied significantly between species showing lowest activities in Caridea and the highest activity in *Euphausia superba*. E64, a specific inhibitor of cysteine proteinase suppressed total proteinase activity by more than 70 % in *Crangon*-species but not in *C. pagurus* and *E. superba*. In contrast, the serine proteinase inhibitor AEBSF had only little effect in Caridea but was most effective in *P. bernhardus*, *C. pagurus* and *E. superba*.

Two preliminarily conclusions may be drawn. 1. The expression of proteinase classes is related to the life style and feeding habits 2. Proteinases classes reflect phylogenetic patterns: Caridea express predominantly cystein-proteinase, while Anomura, Brachyura and Euphausiacea prefer serine proteinases.

**P-15 Digestive enzymes in the brown shrimp *Crangon crangon*: activities and intraspecific variability of endopeptidases**  
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Endopeptidases, such as trypsin-like serine proteinases belong to the most important digestive enzymes in crustaceans. However, screening of brown shrimps (*C. crangon*) showed that most animals had very low trypsin activities while, conversely, about 10 percent of the population had very high trypsin activities. In order to investigate the causes of this extraordinary high intraspecific variability we compared trypsin activities with that of other important digestive enzymes and related the results to nutritional and somatic factors. Furthermore, we compared the endopeptidases expression patterns of *C. crangon* with that of the Northern krill *M. norvegica*.

In *C. crangon* amylase and cellulase always showed distinct activities. Accordingly, trypsin was probably not co-expressed with these digestive enzymes. Furthermore, trypsin activities were not correlated with the midgut-gland-index and thus with the nutritive state of the shrimps. Size had also not effect.

Electrophoretic separation of proteins and zymograms of endopeptidases revealed an extraordinary high variability between individuals of *C. crangon*. In contrast, *M. norvegica* showed significantly higher trypsin activities and expressed uniform patterns of protein and protease.

High trypsin activities occurred predominantly in females. Since *C. crangon* is a partially protandric hermaphrodite with primary females it seems possible that high variability of endopeptidases may be related to physiological changes due to sex conversion. Future research will focus on the relation between sexual development and ontogenetic variation of *C. crangon*. Additional factors such as the effect of parasites will also be considered.

**P-16 Spatiotemporal calcium signalling in blowfly salivary glands: differences after serotonin and histamine stimulation**  
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Salivary glands of the blowfly, *Calliphora vicina*, secrete a KCl-rich saliva. Salivation is stimulated by the biogenic amine serotonin (5-hydroxytryptamine, 5-HT). 5-HT binds to two different G-protein coupled receptors and causes (1) an increase in intracellular [cAMP] that stimulates transepithelial K<sup>+</sup> transport, and, (2) activation of the phosphoinositide signalling cascade culminating in intracellular Ca<sup>2+</sup>-oscillations and propagating intercellular Ca<sup>2+</sup>-waves that activate transepithelial Cl<sup>-</sup> transport. Histamine was suggested to activate only the cAMP pathway, because (1) it produces changes in transepithelial potential (TEP) indicative of cAMP-mediated transepithelial K<sup>+</sup> transport, and, (2) TEP-oscillations without PIP<sub>2</sub> breakdown.

Here we show by microfluorometric Ca<sup>2+</sup>-imaging using Fura-2 that histamine does cause an increase in intracellular [Ca<sup>2+</sup>], often exhibiting oscillations with concentration-dependent frequencies. Ca<sup>2+</sup> elevations are caused by Ca<sup>2+</sup> release from intracellular stores, abolished when PLC is blocked by U73122 or by yohimbine, an antagonist of the 5-HT receptor coupled to the phosphoinositide pathway. In addition, we show that 5-HT- and histamine-induced Ca<sup>2+</sup> signals have different spatiotemporal patterns: 5-HT produces Ca<sup>2+</sup> oscillations and propagating intercellular Ca<sup>2+</sup> waves, while histamine produces local Ca<sup>2+</sup> oscillations in single cells or synchronous Ca<sup>2+</sup> “beating” in the whole gland but never propagating Ca<sup>2+</sup> waves. (Supported by DFG Wa 463/9-3)

**P-17 Multiparametric analysis of haemoglobin function in normoxically and hypoxically acclimated *Daphnia magna***  
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The aim of the present study was to characterize the contribution of systemic and molecular adjustments to the improvement of hypoxia tolerance during long-term acclimation to environmental oxygen deficiency in the water flea *Daphnia magna*. Therefore several parameters were measured in single individuals of a clonal population over a period of three generations, immediately after transferring the parental generation (P) from normoxic to hypoxic conditions (15 % air sat.). Every three days haemoglobin-concentration ([Hb]), Hb oxygen affinity, specific oxygen consumption rate were measured. Additionally, heart rate, limb beating rate, tissue oxygenation state and *in-vivo* Hb-saturation were simultaneously determined.

In comparison to a control group kept under normoxic conditions, the main effects already occurred within the first three days of hypoxic exposure. [Hb] and Hb affinity increased by 270 % and 30 %, respectively. The specific oxygen consumption at normoxia decreased by 20 %. Moreover, we found a significant decrease in the critical ambient oxygen partial pressures (P<sub>c</sub>), below which the limb beating rate (factor 2.3) and tissue oxygenation state (factor 2.4) started to become impeded. In contrast, the P<sub>c</sub> for heart rate showed only a slight decrease from 1.4 to 1.1 kPa. Overall the P<sub>c</sub> of oxygen consumption rate shifted from 4.2 to 2.0 kPa.

The improved hypoxic tolerance of hypoxia-acclimated animals was first and foremost related to the increase of [Hb] and the related oxygen transport capacity of the haemolymph. No additional adjustments of systemic parameters were found. Hence main regulatory contribution in *D. magna* results primary from adjustments at the molecular level.

**P-18 A novel hemoglobin from *Drosophila melanogaster***

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Gas exchange in terrestrial insects is based on diffusion of oxygen from the atmosphere to the inner organs through the tracheal system. Nevertheless, a hemoglobin (Hb1) had been characterized in the fruitfly *Drosophila melanogaster*, which is mainly expressed in the fat body and the trachea. Recently, we found a second hemoglobin (Hb2) in this species, which comprises 222 amino acids and has a calculated molecular mass of about 25 kDa. In contrast to Hb1, the Hb2 mRNA is expressed at apparently low levels. The Hb2 cDNA has been recombinantly expressed in the pET3a system. Using specific anti-Hb2 antibodies, a polypeptide of about 30 kDa was detected in protein extracts from the fly and the recombinant system. The difference of about 5 kDa compared to the expected mass could be explained by the high pI (9.18) of Hb2. At the moment, the function of Hb2 is largely unknown, and further biochemical and histological characterizations are underway.

**P-19      Development and regulation of A-type allatostatin immunoreactivity in the metamorphosing antennal lobe of the sphinx moth *Manduca sexta***  
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The antennal lobe (AL) of *M. sexta*, which contains many peptidergic neurons, is newly built during metamorphosis. All neurons comprising the AL are born until two days after pupal ecdysis (P2). Among the neuropeptides found in antennal lobes of various insects, some are members of the family of A-type allatostatins (AST-A; cockroach type or *Diploptera* type of allatostatins). They share the c-terminal amino acid sequence Y/FXFGLamide. To learn about time course and regulation, we started to study the developmental pattern of A-type allatostatin immunoreactivity, located in antennal lobe neurons of the sphinx moth *Manduca sexta*.

Most AL-neurons labeled with the anti allatostatin (Dip-Allatostatin I) antiserum belong to the local interneuron type and are described as type Ia neurons in addition to other types of AST-ir neurons. The labeled cell numbers of type Ia neurons increase in a typical pattern from the larva to the adult. The rapid second increase of AST immunoreactive (AST-ir) cell numbers between stage P4 and P8 parallels the increasing 20-hydroxyecdysone (20E) hemolymph titer. To investigate the relationship between the 20E titer and the number of AST-ir type Ia neurons, we mimicked the increase of the hormone early in development by injecting an equivalent amount of 20E into the hemolymph of stage P1 pupa. Dissecting animals 2 to 6 days after 20E injection showed a developmental advancement of 2 to 3 days regarding to the number of AST-ir cell bodies, when compared with control injections with the vehicle alone. This result strongly indicates that peptide expression in the developing AL is regulated via 20E.

Supported by DFG grant SCHA 678/3-3

**P-20      Digestion and excretion in a flower visiting bat (*Glossophaga soricina*)**  
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Some phyllostomid bats feed on nectar and pollen. This demands adaptations of the digestion system and the renal function. Nectar is composed mainly of water and diverse saccharides, consequently the absorption of sugar during digestion as well as the excretion of water should be high and also the renal reabsorption of ions and other molecules. We studied the composition of urin and feces of the flower visiting bat *Glossophaga soricina* by feeding a solution of honey in water ad libitum (mean sugar concentration: glucose 90,2 mg/ml, fructose 105,6 mg/ml, saccharose 0,6 mg/ml). The results of this study indicated a water content of the feces samples of about 65% of the fresh weight. The fraction of sugar in dried feces was about 11% and consisted mainly of glucose, fructose, sucrose, lactose and few other saccharids. The fraction of aminoacids was negligibly low (<1,0 %). The samples of urin were composed of diverse saccharids, urea, sodium- and kaliumions and creatinine. The fraction of aminoacids in urin was very low (<0,3 µg/µl). Finally we measured the osmolality which also was very low (<300 mosmol/kg).

Since nectar contains a low amount of aminoacids in nature the bats eat pollen to meet their requirements of proteines. Pollen is hard to digest, thus a lot of it is excreted indigested. To measure the efficiency of pollen digestion we fed pollen for a short time and collected the feces samples afterwards for some days. The samples were dried and the ratio of undigested to digested pollen was calculated. Pollen (digested and undigested) appeared in the feces shortly (<45 min) after feeding. The level of digested pollen in the feces remained high, while the undigested decreased quickly, after a few hours.

**P-21 Characterization of a cuticle protein of the sphinx moth, *Manduca sexta***

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Cuticular proteins of insects play an important role in defining mechanical and biological functions of their integument. These proteins may constitute more than 50% of the total cuticular weight, comprising several members such as arthropodin, sclerotin, and resilin. The different arrangement of the embedded chitin fibers, in association with the local protein secretion and the disposition of the layers, can change widely the mechanical properties of the integument in a way that confer optimal local plasticity and elasticity to the integument. In the present study, a protein of the larval endocuticular layer of *Manduca sexta*, is recognised by a monoclonal antibody (MS#77), previously raised against *Manduca sexta* haemocyte. In an effort to understand the specific property of this protein, a combined histological and biochemical study has been made. Firstly, immunohistological investigation of larval semi-thin transversal sections were performed with the original MS#77 hybridoma and a series of lectin labelling assays. An overlapping binding pattern to of the cuticular layers was found with the *Vicia villosa* lectin, which recognise preferentially  $\alpha$ - or  $\beta$ -linked terminal N-acetylgalactosamine, linked to serine or threonine in a glycopeptide. Western blot analyses were made after extraction of cuticular proteins with different buffers. A strong band of approximately 48 kDa appeared only when cuticle is extracted with high concentration of SDS and the yield increased when EDTA was added. Moreover, biotinylated V.v. lectin bind to the same protein, showing that the MS#77 antigen is likely to be a glycoprotein. Therefore, a large preparation of cuticular proteins were made under optimal buffer condition and the extracted proteins were subjected to gelfiltration, mono-Q and preparative electrophoresis purification, allowing us to fully purify the antigen. Finally, enzymatic and chemical deglycosylation techniques were performed. Results will be shown in the present communication.

This research was supported by the EU network Insect Chemical Ecology (INCHECO) – Contract n. HPRN-CT-1999-00054.



**P-22      Glutamate, GABA and serotonin induce contractions in the sponge  
*Tethya wilhelma* (Porifera: Demospongiae)**  
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Sponges have been shown to possess characteristic metazoan signalling molecules. Nevertheless it is still unclear whether their function and organization is comparable to that of higher metazoa. For our examinations we used the spherical sponge *Tethya wilhelma*. Like some other sponge species *T. wilhelma* shows slow but rhythmic body contractions. Therefore it is a suitable model organism to investigate the physiology and coordination mechanisms of sponges.

*T. wilhelma* specimens were kept under constant temperature and oxygen levels in a 200 ml experimental reactor. After several hours of adaptation various neurotransmitters were added to the seawater and their effects on the contraction behaviour of the sponges were recorded. To analyze and to quantify contraction digital timelapse photography was used. Image analysis was performed to calculate size changes of the sponge body.

Glutamate, GABA and serotonin induce contractions in *T. wilhelma*. The minimal effective doses of these neurotransmitters were determined. Sponges that were treated with higher concentrations remain in an spasm-like state or show convulsive twitches before they expand again. Moreover, directly after a stimulated contraction-expansion cycle the threshold level to induce a contraction is increased temporarily. In additional studies we explored the effects of the different substances on the cellular level by microscopic analysis and used specific agonists and antagonists to corroborate our data.

Our results confirm that signalling mechanisms of the phylogenetically oldest metazoans, the porifera, are based on the same molecules existing in the complex neuronal networks of higher metazoa.

**P-23      Transepithelial fluid reabsorption in ducts of salivary glands in the  
cockroach *Periplaneta americana* (Blattodea: Blattidae)**  
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Cockroaches have acinar salivary glands that secrete a NaCl-rich saliva. Acini and ducts are innervated by dopaminergic fibers. The ducts are thought to modify the primary saliva by Na<sup>+</sup> reabsorption and K<sup>+</sup> secretion, whereby the detailed mechanisms for saliva modification and the effects of dopamine are not understood. A basolateral Na<sup>+</sup>/K<sup>+</sup>-ATPase and Na<sup>+</sup>-K<sup>+</sup>-2Cl<sup>-</sup> cotransporter as well as an apical V-H<sup>+</sup>-ATPase in duct epithelial cells have been suggested to be crucial for saliva modification.

We discovered that isolated ducts are capable to transport fluid from lumen to bath. Fluid transport was studied by DIC and fluorescence microscopy after injection of the fluorescent dye sulforhodamine as a volume marker between two oil droplets within the isolated ducts. Shrinking of the water column between oil droplets and/or increase in sulforhodamine fluorescence were used to record transepithelial fluid movements. We show: (1) Ducts reabsorb fluid at a constant rate, (2) stimulation with dopamine induces a transient increase in the rate of fluid reabsorption, (3) fluid reabsorption is energy-dependent because it is reversibly blocked by dinitrophenol (1 mM), (4) bath application of ouabain (100 μM, 1 mM) or bumetanide (10 μM) have no effect on the rate of fluid transport in the unstimulated ducts, (5) bumetanide reduces, and, (6) ouabain blocks the stimulatory dopamine effect. The possible contribution of the V-H<sup>+</sup>-ATPase is under investigation.

We conclude: Fluid reabsorption contributes to the modification of the primary saliva, and its rate is affected by the neurotransmitter dopamine. Na<sup>+</sup>/K<sup>+</sup>-ATPase and Na<sup>+</sup>-K<sup>+</sup>-2Cl<sup>-</sup> cotransporter contribute to the stimulatory dopamine effect.

(Supported by the DFG, Graduiertenkolleg 837)

# SG7 Studiengruppe Verhaltensbiologie

## V-S1.1 Social behaviour and the pack dominance style of four pack-living canid species (*Canis lupus*, *Cuon alpinus*, *Lycaon pictus*, *Speothos venaticus*) Corinna Bogusch

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Pack-living occurs comparatively frequently in the Canidae and it is rare among other mammals. A pack is defined as a social group engaged in both co-operative hunting and alloparental behaviour. It was investigated whether and to which degree the social behaviour related to pack-living differs in four canid species (*Canis lupus*, *Cuon alpinus*, *Lycaon pictus*, *Speothos venaticus*). Data were collected in six zoological gardens (Dortmund, Duisburg, Klein-Auheim, Mulhouse, Munich, Osnabrueck) using direct observation and analysis of videotapes.

The four species studied show a great resemblance regarding their visual display. In their social behaviour related to pack-living both *S. venaticus* and *L. pictus* differ in numerous characteristics, while *C. lupus* and *C. alpinus* show the greatest conformity. *C. alpinus* males impose through scratching the ground with four legs after urinating, a behaviour well known from *Canis* species. All four species have dominance hierarchies within their packs, with a separate rank order among females and males.

The comparison of the studied packs revealed species independent similarities between some packs for which the term “pack dominance style” is a newly introduced characteristic. The two main types are the “despotic” and the “tolerant” pack dominance style. The pack dominance style can be expressed in numerical values and is therefore an important characteristic for the description and comparison of social structures within canids. It appears likely that the pack dominance style is applicable to all social species having dominance hierarchies.

### **V-S1.2 Effects of acute and chronic psychosocial stress on MADB106 tumor metastasis in male Fischer F344 rats**

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Acute stressors have been shown to modulate natural killer (NK) cell numbers and *in vitro* cytotoxicity and substantially increase tumor metastasis. However, these stress induced immuno-modulations may not necessarily be the same under chronic conditions. We therefore studied the effects of both acute and chronic stressful psychosocial conditions on the resistance to experimental tumor metastasis in male Fischer rats.

In the chronic stress experiment, we focused on subordinate males that had been living in mixed-sex colonies for six weeks. Compared to control males that were housed with a single female, subordinate males showed clear signs of chronic psychosocial stress as indicated by negative body mass development, higher adrenal masses and elevated adrenal tyrosine hydroxylase activities. Furthermore, injection of radio labeled MADB106 tumor cells resulted in a 100% increase in lung tumor retention 24 hours later. In the second experiment, acute stress was induced by resident/intruder confrontations. F344 intruders that were socially defeated for 3 hours prior to tumor injection showed a marked activation of the hypothalamo-adrenocortical and the sympathetic-adrenomedullary system. These males showed a 6-fold higher lung tumor retention than the control animals.

To conclude, acute and chronic psychosocial stressful conditions have the potential to reduce resistance to NK-controlled metastatic development in rats. Given that the anti-metastatic suppression persists over weeks in the colony situation, compared to the marked but short immunosuppressive effects of acute stress an even higher threat to the individual's health may accumulate under chronic stressful conditions.

Supported by the Volkswagen Foundation (I/75144)

### **V-S1.3 Group decisions with speed or accuracy in ants**

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One of the strengths of social insect colonies is their ability to integrate the local information gathered by individuals such that, at a collective level, a well-informed decision can be made. Before an emigration, colonies of *Leptothorax albipennis* ants have to make a difficult decision about which new nest site to choose. This decision has to be made with both speed (since the exposure of both queen and brood in a destroyed old nest should be minimised) and accuracy (because the quality of the new nest is important for the colony's future success). We show that the relative importance of speed and accuracy can change, and that the behaviour of individuals is adapted to the existing trade-off. When speed becomes more important, individuals more often decide on their own, rather than integrating information collected by nestmates. We also find that the amount of information used to make a decision varies with colony size. Larger colonies achieve faster decision-making by setting the number of scouts necessary to start the emigration to a new site lower in relation to colony size than smaller colonies. Small colonies are probably unable do this, because reducing the already low number of scouts further would reduce the accuracy of the decision made.

**V-S2.1 Queen signals in ant colonies: Workers discriminate queen eggs along queen age and fertility**  
Annett Endler, Jürgen Liebig & Bert Hölldobler

Vortrag zurückgezogen – Talk withdrawn

**V-S2.2 Mating effort vs. paternal investment: The relevance of nuptial gifts in the scorpionfly *Panorpa vulgaris***  
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Nuptial feeding is a very common strategy shown by males of various insect taxa in order to obtain copulations. In the majority of cases these gifts presented during or after courtship and/or copulation can be considered as mating effort. In this study we present data which indicate that nuptial feeding in *Panorpa vulgaris* (Mecoptera: Panorpidae) represents paternal investment. During copulations males produce salivary secretions which are then consumed by the females. The more salivary masses a male produces the longer copulation will last. Moreover, receiving a high number of salivary masses causes females to produce significantly more eggs compared to females receiving few or no salivary secretions. Thus, in *P. vulgaris* the nuptial gift increases the reproductive output of females and hence must not only be considered as mating effort but also as paternal investment. We believe that the salivary masses operate as carriers for an allohormone that manipulates the females' physiology in terms of increasing egg production.

**V-S2.3 The mechanism of sperm competition in the scorpionfly *Panorpa germanica* (Mecoptera: Panorpidae)**  
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Scorpionflies of the genus *Panorpa* (Mecoptera: Panorpidae) exhibit an enormous interspecific variance in those traits characterising their mating systems – among these the mechanism of sperm competition, which is currently being investigated for *Panorpa germanica*. Aim of the project is to estimate the influence of position and mating duration of different mates of a female on the paternity in the offspring. Recent investigations on the offspring of doubly mated females have revealed a very high intraspecific variance in the percentage of offspring fathered by the second male (p2-value). The duration of the second mating appears to be crucial for paternity as there is a positive correlation between the copulation duration of the second male and the p2-value, whereas no such correlation can be found for the p2-value and the copulation duration of the first male. This pattern may be due to an incomplete displacement of sperm in which a considerable amount of sperm of the first male is displaced by sperm of the second male only if copulation duration of this second male is long enough.

**V-S2.4 The effect of food availability on the mating effort of male scorpionflies in *Panorpa vulgaris***  
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Males of *Panorpa* scorpionflies provide the females with different numbers of salivary masses during copulation. This costly nuptial gift functions as male mating effort. Former studies revealed that the ability to produce salivary masses depends on the male's nutritional status. Accordingly, males of *Panorpa* are limited in production of salivary masses.

*P. vulgaris* belongs to the *Panorpa* species that have both spring and summer generation. Food availability varies between seasons whereas food conditions are better in spring. Different food availability cause different nutritional status of males and females and differences in female fertility. In this study we present data which indicate that male scorpionflies of *P. vulgaris* invest their mating effort differently with subject to food availability and thus, to female fertility and their own nutritional status. In contrast to males of the summer generation males of the spring generation do not exhibit salivary mass allocation or mate choice in dependency on variance in female fertility as one could expect. The degree of allocation and choosiness seems to depend only on variance in female fertility up to a certain population average value in female fertility. We assume that when the average female quality of a population is above this threshold variance dependent male mate choice is not advantageous as almost every female exhibits high fertility.

**V-S2.5 Traumatic insemination in the bed bug *Cimex lectularius* (Heteroptera: Cimicidae): just where is the conflict?**

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The evolutionary arms race between the sexes has resulted in a number of male and female traits that may decrease the fitness of their mating partners. Such sexual conflict is very evident in the bed bug, *Cimex lectularius*, in which males pierce the females during copulation and inseminate into the female's body cavity. This form of mating causes a strong reduction in female lifespan although it is unclear what the mechanism of this increased mortality is. We here show a) that males have contaminated intromittent organs, b) that female bed bugs have evolved a unique organ (into which males inseminate) that functions to decrease female mortality caused by bacterial introduction during the pierce-copulation. We present evidence that c) females possess additional structural adaptations to reduce the costs of traumatic insemination. However it presently is unclear why mortality of mating females is consistently higher for females with a higher mating rate. We, therefore, tested d) whether the amount of male accessory fluids transferred during mating is responsible for female mortality. Finally we explore the consequences of this harmful mating with respect to the evolution of reproductive isolation between two populations. We test the key assumption of the idea that sexual conflict contributes to reproductive isolation, namely whether e) heterogamic matings are more detrimental to females than homogamic matings.

## V-S2.6 **Repertoire and stability of stereotyped whistles in killer whales (Cetacea: Odontoceti: Delphinidae: *Orcinus orca*) in the waters around Northern Vancouver Island, British Columbia**

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Whistles play an important role in underwater communication among delphinids. Some species, for example the bottlenose dolphin (*Tursiops truncatus*), use stereotyped whistles as individual contact-calls in long-range communication. In contrast to that, members of the northern resident community of killer whales (*Orcinus orca*) off northern Vancouver Island, British Columbia produce whistles at high rates during close-range interactions within the social group as well as between different groups. Some of these whistles are highly stereotyped and can be classified into six distinct types. The aim of this study was an investigation of stability and group-specificity of stereotyped whistles in northern resident killer whales. We analysed field recordings from 1978–2003 using real-time and power spectrum-analysis and measured the parameters of a subset of 475 stereotyped whistles. Based upon our earlier studies, these whistles could be classified into 12 discrete categories. Over a minimum of fifteen years, the parameters of most whistle-types proved to be stable. At least two of the three acoustical clans of the community shared at least 10 of the 12 types. The results of our study show that stereotyped whistles of northern resident killer whales are highly stable over time. The apparent lack of group-specificity suggests that stereotyped whistles play an important role not only within the social-group, but also in close-range interactions among subgroups of the community. Future studies comparing the whistle repertoire of northern residents with those of neighbouring communities will determine if variation exists on a higher level.

## V-S2.7 **Feeding strategy of Pleistocene-Holocene Urus (*Bos primigenius*) and Neolithic cattle (*Bos primigenius f. taurus*) from Denmark**

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For large parts of the Late Pleistocene and Early Holocene, Denmark was covered by dense forest vegetation. During the Subboreal (3800–750/550 B.C.) human impact became evident as agriculture was established. We tested the hypothesis that anthropogenic induced Holocene environmental changes, as well climate changes, are mirrored in the differential dietary regimes of wild and domestic bovids. We employed the mesowear method to investigate the dietary regimes of contemporaneous populations of Urus and early domestic cattle. Mesowear signatures were investigated from 32 fossil Urus and 28 Neolithic cattle populations. Cluster analysis was applied in order to rank populations of *Bos* within the continuum of feeding types in extant ungulates. We found that *B. primigenius* could be classified as a mixed-feeder and *B. primigenius f. taurus* as a grazer. By comparing populations from different Holocene periods, we found significant changes in the Mesowear signature. The dietary signal of *B. primigenius* was found to be much less homogeneous within individual time-slices in comparison to the domestic form. The variability was correlated with local environmental conditions within the Danish coastal zone at the end of the Pleistocene. We consider *B. primigenius* to be a highly adaptable species, which had to cope with rapid environmental changes induced by climate change, habitat dissection and human impact during the Pleistocene and Holocene.

**V-S2.8 The effect of the nuptial gift on the female reproductive output in the scorpionfly *Panorpa germanica***  
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In the mating system of the scorpionfly *Panorpa germanica* the males excrete a salivary mass which they present to the female before and during copulation. Starting feeding on the gift the female will allow the male to initiate copulation. Accordingly the salivary mass functions as mating effort the male has to provide to gain copulation. Demanding a nuptial gift for copulation, there have to be any advantages for the female. Therefore, we hypothesise the salivary mass to be a form of paternal investment increasing the female's fecundity which is advantageous for both, the male and the female.

In the present study we investigate the effect of different numbers of salivary masses on the female reproductive output. We were able to show that females which had consumed a higher number of salivary masses laid more eggs than females which had consumed fewer gifts. Although males invested more salivary masses in females with higher body weight than those with lower body weight and although females disposed more eggs with increasing body weight, the effect of the salivary masses on the number of eggs remains measurable. Accordingly the female is able to increase its reproductive output in form of producing more eggs via the nuptial gifts.

However, until we are not aware of the exact mode of sperm competition we can't mention the salivary mass as paternal investment for sure.

**V-S3.1 Boy or girl? Host size assessment for sex allocation in *Lariophagus distinguendus***

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The theory of sex allocation predicts for idiobiont parasitoids that females preferably parasitize large hosts with female eggs and small hosts with male eggs because fitness gains from large daughters are higher than from large sons. Since being established this theory has been confirmed for many parasitic wasp species and became one of the most influential concepts in behavioural ecology of parasitic wasps.

However, it is still unknown for most of these species how female wasps measure host size to make their decision. This is also true for *Lariophagus distinguendus*, the first species used to test this theory. To answer this question, the oviposition behaviour of female *L. distinguendus* was studied in detail. *L. distinguendus* is an ectoparasitoid of larvae of the granary weevil *Sitophilus granarius* that are endophytic in wheat grains. Behaviour and especially the ovipositor movements inside the grain were observed using an artificial grain with lateral inspection window. A number of so far non-described behaviours have been identified for oviposition and host feeding behaviour making it possible to explain how size of endophytic hosts is assessed by *L. distinguendus* females.



## V-S3.2 **Analysis of the spitting behavior and the spitting pattern of two species of cobras**

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Spitting cobras have developed the unique ability to eject their venom towards an aggressors face. We analyzed the spitting behavior as well as the spitting pattern of two species of cobras, the black spitting cobra (*Naja nigricollis*) and the red Mozambique spitting cobra (*Naja pallida*).

In general, the likelihood for spitting behavior varied in different animals (between 0 and 100%). In addition, all animals habituated to visual stimuli which initially evoked spitting to a high percentage.

However, in both cobra species, individuals were found that showed high spitting activity when stimulated by the image of a human face (real or a photo). In these animals no spitting could be induced by moving a human hand in front of the snake. While a moving human face readily elicited spitting behavior, a stationary face (real or a photo) remained ineffective.

A photo of a human face, with or without eyes, was equally effective in eliciting spitting behavior and a pair of eyes alone on a white background did not trigger the spitting act.

Furthermore, the venom ejection pattern of both species investigated showed quite different features. While *Naja nigricollis* ejected a fine spray of venom that covered a large area of the targeted face, the venom jets of *Naja pallida* by contrast showed a stereotypic semi-circle pattern which presumably resulted from the movement of the snakes upper body and head. Neither the spitting pattern of *Naja nigricollis* nor that of *Naja pallida* varied significantly if the distance between the eyes on the photos was altered (5,5–11 cm).

Our results suggest that spitting is induced if the stimulus moves and carries the profile of a face regardless of the presence and the position of the eyes. Since the area hit by the venom was large and since the venom is known to cause immense pain on all types of mucous membranes, it may be sufficient for the snake to direct the venom jets at the middle of an aggressors face.

### V-S3.3 *Aggressive versus docile. Defence behaviour in Western honeybees (Apis mellifera)*

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Honeybees have evolved a series of strategies to protect the energy-rich food sources of the nests, including brood, wax, honey and pollen, in addition to the adult bees themselves. The pressure of vertebrate and invertebrate predators, as well of parasites on bee colonies evolved a variety of defence mechanisms in free-nesting (Kastberger G et al 1998 Ethology 104, 27) and cave-dwelling honeybee species (Moritz RFA & Southwick EE 1992 Springer, Berlin). The paper considers colony defensiveness in the Western honeybee *Apis mellifera* in context with environmental and genetic factors, as response to the threat of a predatory stimulus. Here we ask one of the key questions on honeybee defensiveness: Is one and the same colony able to switch from a more *aggressive* to a more *docile* strategy, that is from releasing defence guards to full retreat to the nest. For that, we used three methodological premises: First, we simulated natural perils applying three regimes of threatening stimuli; we shocked the colonies mechanically, exposed them to alarm pheromone, and combined both. Second, we investigated the role of environmental factors such as foraging level, ambient temperature and daytime on defensiveness. And third, we aimed to study the widest genetic variety in *Apis mellifera* and selected test colonies of three African and European sub-species, *scutellata* (McNally L & Schneider S 1996 Environmental entomology, 25, 643), *capensis*, and *carnica*.

Colony-specific defence patterns within a subspecies have been proved to be more variable than differences between subspecies, allowing the following generalisations: (a) under mechanical stimulation the out-flyer rate decreased with increasing foraging activity, signifying the recruitment of defence guards from the pool of foragers. (b) Under mechanical stimulation the test colonies diversified into two types of colony defence; *attacker-typed* colonies allocated ready-to-go defence guards; *retreater-type* colonies ceased their outdoor activity. (c) Alarm pheromone, applied by stingers without mechanical stimulus, brings guard bees to remove the stimulus, but not to generate further-going colony responses. (d) Subjected to mechanical stimulation and exposed to alarm pheromones, most of the colonies tested released more defence guards than under mechanical stimulation, only few intensified their retreat to the nest. (e) Some of African but not European *attacker-typed* colonies mobilised more guards with higher foraging activity. (f) Most of the colonies showed the same defence type irrespective of changing environmental conditions; only one of eleven colonies switched from *attacker* to *retreater* mode in the course of experiments. (g) In comparison to *retreaters*, *attacker-typed* colonies foraged more at colder, and less at warmer weather conditions. (h) *Attackers* foraged at higher intensity earlier in the morning and kept their foraging level throughout the afternoon, *retreaters* showed midday peaking. (i) Colonies under threat released the less defence guards, respectively retreated the stronger to the nest, the higher the ambient temperature was. (j) *Attackers* intensified their defence guards during midday, *retreaters* showed a midday peaking of staying at the nest.

**V-S3.4 Behavioural alterations as indicator of Alzheimer's disease**

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This study focused on behavioural alterations in the transgenic mouse line TgCRND8, an animal model of Alzheimer's disease (AD) expressing a double mutant form of the human amyloid precursor protein. In comparison with other murine models of AD, the TgCRND8 line develops an Alzheimer-like pathology very early (latest by 3 month), which is visible in cognitive deficits and amyloid deposits in the brain.

In former studies, no differences were found between transgenic (T) and wild type (W) mice concerning their general health state, gross sensory functions, reflexes, and motor abilities at 50 days of age. Additionally, the barrier-, open field-, and elevated plus-maze-test did not reveal any differences between T and W mice around day 90.

Here, the spontaneous behaviour in home cages was recorded during the course of the disease at day 30, 60, 90 and 120. Simultaneously, corticosterone metabolites (CM) were monitored from faecal samples. At day 123, the number of amyloid plaques in the brain was quantified. At this age, a large number of amyloid plaques were detected in different brain regions of all T animals. Concerning their spontaneous behaviour T mice displayed significantly more stereotypic behaviour at all test days. CM paralleled the occurrence of stereotypic behaviour, with significantly higher concentrations in T than in W mice resulting even in significant positive correlations between stereotypic behaviour and CM at day 90 and 120.

However, further studies have to reveal if a causal relationship exists between stereotypic behaviours, adrenocortical hyperactivity, cognitive deficits and neuropathological changes in the brain, and if the recording of behavioural alterations could lead to an improved diagnosis of AD.

**V-S3.5 Simulation of tactile searching behaviour of the stick insect in a gap crossing paradigm**

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In a three dimensional natural environment, the ability to climb across large gaps and obstacles is fundamental for an insect. The same ability is desired for an artificial walker that operates in a complex habitat. In this study, the neural network simulation WALKNET that has been modelled on stick insect walking behaviour is used as a basis for the introduction of new behaviours that enable it to climb across large gaps. Compared to other obstacles, gaps provide a special difficulty as they have to be detected as absence of a tactile signal, not as a tactile signal like steps. In the stick insect, this task is accomplished by the front legs when stepping into the gap, not by vision or antennal probing. The front legs repeatedly step into the gap and perform extensive searching movements the pattern of which has been analysed in detail. Searching strategies of the middle and hind legs are less complex and slightly different. Based on the results of the behaviour study, new modules for the generation of searching movements have been implemented into the WALKNET controller, and the velocity control and leg coordination have been adapted to support searching behaviour. With these innovations, the artificial insect is able to climb across gaps of more than twice its normal step length, using similar strategies as the biological model. The new behaviours improve its adaptability and performance under challenging environmental conditions. Results of the simulation study are compared to results of biological experiments and discussed with respect to their value for robotic applications.

### V-S3.6 **Behavioural analysis and modelling of the active tactile sense of insects**

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The antennae are the most important part of the insect tactile sense. Often, active movements are an integral part of the tactile sensory process: extero- and proprioceptors supply mechanoreceptive information about contact location and surface properties, but also on antennal posture and movement, flagellar bending and vibration. Here we study tactile sensing behaviour of the stick insect *Carausius morosus*, and analyse a generic model of insect antennae with two hinge joints (the typical situation in Orthoptera and Phasmatodea).

During locomotion, stick insects sample the space ahead by continuous antennal movement. Hair fields at the joints are necessary to perform the typical motor pattern. The cyclic movement is coordinated with stepping movements of the legs, and trajectories are both well-suited for obstacle detection, and necessary for early body axis inclination prior to climbing an obstacle. Antennal contact causes context-dependent reactions: low horizontal bars are 'ignored' and surmounted, whereas high horizontal and vertical bars are climbed upon. Contacts can cause grasping reactions that are well-targeted, with a tendency to overshoot. Grasping may also include re-targeting of on-going swing movements, indicating access of descending position cues to thoracic motor centres.

The modelling study shows how morphological parameters, such as the angle between the joint axes, affect size of the sampling volume, location of out-of-reach zones, and positioning accuracy. Movement strategies are systematically evaluated for their tactile efficiency, the ratio of sampling density and velocity-dependent energy consumption. The results can be related to species-specific properties of antennal construction and movement.

### V-S3.7 **Paternal care in wild guinea pigs**

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In most species, females invest more in their offspring than males. In mammals, this holds true also after birth of the young since only mothers can lactate and fathers thus are more likely to desert and seek additional mating opportunities. These are largely dependent on the resource distribution and the resulting distribution of females. The emerging social and mating systems of different species give rise to different benefits of investment in paternal care. Paternal care should have evolved in relation to the frequency of losing paternities to other males. Hence, in species living in one-male systems with little opportunity for female extra-pair copulations, it should be more common than in those living in multi-male groups.

The guinea pigs (Caviinae) comprise closely related species exhibiting different social organisations and mating systems. We investigated the amount of paternal behaviours and offspring-directed aggression in three species kept under laboratory conditions: The polygynous *Cavia aperea*, the promiscuous *Galea musteloides* and a newly described monogamous species (*Galea* sp. n.).

*C. aperea* as well as *G. sp. n.* males showed high amounts of direct paternal care. In contrast, *G. musteloides* males never engaged in paternal behaviours but directed more aggressive behaviour towards their offspring. Mating with multiple partners and multiple paternities are common in *G. musteloides* whereas in the former two species there is a much higher certainty of paternity. We conclude that paternal investment in guinea pigs co-evolved in alignment with the certainty of paternity that males of a species face under natural conditions.

## P-1 Differences between orangutan (*Primates: Pongo*) populations based on long call analysis

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Although studies on orangutan systematics were carried out for the last twenty years, much confusion still exists as to their phylogenetic relationship. A fundamental problem with these studies is that captive or rehabilitated orangutans were often chosen as subjects. When investigating phylogenetic relationships, however, lack of identification of exact populations is unacceptable. For the first time in a phylogeographical work on orangutans, detailed information on study sites for both Borneo and Sumatra were considered to reconstruct a phylogenetic tree of orangutans when analyzing long calls of adult flanged males. A total of 78 orangutan long calls of six populations from Borneo and of three from Sumatra were measured for 64 variables. Three monophyletic clades resulted: Ketambe in Sumatra (73–78%), Northwest Borneo (69–72%), and Northeast-East Borneo (62–74%). We found Sumatra topology with its Ketambe clade to contradict presumptions of sympatric populations based on two morphs seen on this island (e.g. Rijksen, 1978). This way, we believe that the conclusion on two or more Sumatran phylogenetic lineages found in previous studies cannot be explained by the existence of sympatric taxa, as often stated. Furthermore, the two Bornean monophyletic clades indicate that differences between populations within one island can be larger than differences between the two island groups. Therefore, orangutan populations need to be dealt with separately for conservation management purposes.

## P-2 Investigations on the control of nest-building in the leaf-cutting ant *Acromyrmex lundii* (Hymenoptera: Formicidae)

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Ants build nests to protect themselves against enemies and to create a suitable microclimate for workers, brood and the queen. Leaf-cutting ants build conspicuous nests with separate chambers for fungus gardens and refuse material. It is an open question whether the size of the chambers housing the symbiotic fungus depend on its size or on the number of workers inhabiting the nest. In order to investigate whether the fungus volume or the number of workers in the nest is responsible for the final size of a fungus chamber, we created artificial nest arenas of clay in which workers could enlarge a small pre-existing chamber in order to place a fungus garden located outside of the arena. Two experimental series were performed: in the first one, we presented 1000 workers with either 40, 80 or 160 ml fungus in independent tests. In the second one, we presented either 500, 1000, 2000 or 3000 ants with a fixed volume of 80 ml fungus. In both series, both the final chamber size excavated by the ants after the fungus garden had been placed inside the chamber, and the total volume of the excavated tunnels, were recorded. It was observed that the overall size of the nest, i.e., the total volume of the chamber plus the volume of the tunnels, depended on the number of inhabiting workers. However, results suggest that the volume of the fungus serves as a blueprint for the final size of a chamber, independent on the number of workers presented in the colony.

### **P-3 Assessment of the Upright Posture in Operant Bipedal Rats**

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The bipedal rat is known as an experimental animal for investigating the relation between bipedal locomotion and muscular-skeletal morphology. However, in the forelimbs removed bipedal rats, the hind limbs and trunk can not be fully extended (Moravec & Cleall, 1987 *Am. J. Anat.*, 180: 357–364; Matsumura, 1991 *J. Anthropol. Soc. Nippon*, 99: 297–318), and maintenance time of taking upright posture of them does not differ from the quadrupedal rats (Bailey et al., 2001 *Spine* 15: 26(14)E308–313). On the other hand, in the bipedal animal under operant conditioning, a rat can take upright bipedal posture in which the hip and knee joints are extended nearly to the maximum. In the operant bipedal rat, an animal can get a reward of small pellet food when it stands bipedally under the lever in a restricted area of a box and pushed up the lever upward by nose. In correspondence with changing the lever height continuously from the maximum to the lower levels, a rat takes several levels of upright posture in the box. An improved bipedal training box was developed to examine the upright posture of a rat in detail by using the method of video analysis, cineradiography, ground reaction forces and EMG.

### **P-4 Behavioural and stress response of European rabbits to fox odour**

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Animals display a variety of anti-predator strategies in response to the presence of chemical cues from mammalian predators. However, there is no general agreement regarding whether or not the detection of a potential predator is innate. We conducted an experiment on European rabbits *Oryctolagus cuniculus* naïve to any contact with predators. We aimed on investigating (i) if the animals possess an innate mechanism for the detection of the odour of a predator, and (ii) how the animals respond behaviourally and physiologically to that odour. We used red fox *Vulpes vulpes* faeces as the source of the predator odour and domestic sheep *Ovis aries* faeces as a non-predator control odour. The experiments were conducted in small outdoor enclosures where the animals were kept singly. We tested for behavioural and physiological responses by looking at patterns of vigilance, activity and feeding, and changes in corticosterone and body mass. The animals showed a clear anti-predator response to the presence of fox faeces suggesting that the detection is genetically fixed. They avoided food from the feeding dish provided with this source of odour, whereas they were neutral in response to sheep odour. When fox odour was presented, the animals significantly increased their vigilance while feeding and showed a higher degree of investigation prior to any feeding event. Furthermore, the animals displayed an alarm response which was apparent by the significant increase in corticosterone levels and body mass losses. The total activity budget, the time spent feeding, and the amount of food ingested remained largely stable during the whole experiment.

## P-5 **Creating an acoustic environment for tank-based behavioural studies on fish**

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Offshore wind energy is a promising application of wind power and there has been much recent interest in this technology. The effects on cetacean populations of the low frequency sounds emitted by such installations have been investigated, but so far, no studies have focused on fish. In order to investigate the influence of such noise and identify frequencies that may affect the behaviour of fish, a carefully controlled acoustic environment is required which allows fish to choose between different sound levels.

This has been created using a 10 m diameter circular concrete tank divided into four quarters using barriers made from styrofoam and wood with gaps for the fish to swim through. In one of the quarters a loudspeaker produces sound at frequencies of between 25 and 250 Hz and the barriers create a gradient of sound throughout the remainder of the tank.

Due to the wavelength characteristics of the low frequency sounds used (between 57.6 m at 25 Hz and 5.76 m at 250 Hz), many reflections were predicted. In order to map the acoustic environment in the tank more than 3400 point measurements were made at different sound levels and frequencies. Contrary to expectations, the results showed a stable acoustic environment, with a clear sound gradient in the tank. Depending on frequency and sound level there are differences of between 32 and 52 dB re 1  $\mu$ Pa between measurements adjacent to and distant from the loudspeaker.

Now that the experimental set-up has been tested, behavioural experiments are planned using both cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*), two North Sea species that are different both in their habits and their sensitivity to sound.

## P-6 **Influence of the emotional state on landing strophes in the bat, *Megaderma lyra***

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Bats use different social calls in various behavioral contexts. Hitherto, it is unclear whether and how the emotional state of the animals is reflected in social call structure. The Indian false Vampire bat, *Megaderma lyra*, regularly emits series of short, multiharmonic sounds when landing in the presence of conspecifics. Here, we examine the structure of these landing strophes emitted in two situations representing different arousal states: when the bats land without physical contact to others, or during landings resulting in direct body contact (bc). We compared 20 strophes with and 54 strophes without subsequent body contact from six captive bats. The number of sounds per strophe, the median interpulse interval, and the median peak frequency of the first harmonic were analyzed. When all strophes were considered, we found significant differences (median test) between the situations for both the number of sounds per strophe (19 with bc/ 7 without bc, chi-square:  $p < 0.001$ ) and the median interpulse intervals (10.3 ms/ 11.9 ms,  $p < 0.001$ ) whereas the peak frequency remained unchanged (18.5 kHz/ 17.7 kHz,  $p = 0.79$ ). For identified individuals, we found a significant difference in the number of sounds per strophe in two bats (E: 14 with bc/ 8 without bc,  $n = 3 / 10$ , Fisher:  $p = 0.04$ ; F: 18 with/ 6 without bc,  $n = 3 / 21$ ,  $p = 0.04$ ). These data provide a first evidence that the emotional state of *M. lyra* is coded in the number of sounds and the interpulse intervals of a landing strophe. On the other hand, the peak frequency of the call may convey individual- rather than emotion-specific information.

**P-7 Ethophysiological investigations on the influence of animal housing systems on the behaviour of reproducing domestic rabbit does (*Oryctolagus cuniculus*)**

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The aim of this study was to investigate the influence of different animal housing systems on the behaviour of lactating domestic rabbit does and thereby to draw a conclusion on the animal welfare. The mother-child relationship and the behaviour of the doe during the course of the day played a central role in this investigation. Furthermore, the concentration of the corticosteroid metabolite 5 $\alpha$ -pregnane-3- $\beta$ , 11 $\beta$ , 21-triol-20-one in the doe's faeces were measured to get an indication of stress situations due to the husbandry.

The rabbits were kept in four different animal housing systems which varied in their size and structure. An infrared video system allowed a 24-hour monitoring of the behaviour of the animals on two days of each week during the 4-week breeding period. The faeces samples were collected the day after a 24-hour video observation. We used a newly established EIA to determine the concentration of the corticosteroid metabolite in the faeces.

On the basis of our results, we could show that providing the animals with more space and a structured environment led to a decrease in the nursing frequency, in the frequency of changes in the activity of the doe and in the concentration of the corticosteroid metabolite in the faeces.

Our investigations confirm the influence of the animal housing system on the behaviour and the animal welfare of domestic rabbit does and show the necessity of offering the lactating animals an adequate space and environmental structure.

**P-8 Behavioural thresholds of *Crotalus atrox* and *Python regius* to infrared stimuli**

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Pit vipers (*Crotalinae*) and boid snakes (*Boidae*) have evolved highly sensitive infrared receptors. The ability of crotaline and boid snakes to image infrared radiation allows accurate predatory targeting in the absence of visual cues. To do so, the infrared sensitive system assesses the direction and distance of a stimulus source and perhaps even provides the information necessary to identify warm blooded prey.

So far predominately electrophysiological investigations have been carried out to study infrared perception in snakes. The goal of our study was to examine the sensitivity of the infrared sense by means of behavioural experiments.

Six western diamondback rattlesnakes (*Crotalus atrox*) and six ball pythons (*Python regius*) were tested in a circular arena. Infrared sources of constant size and a surface temperature (34°C) were presented at various distances (10–120cm) from the snake's head. Behavioural responses were quantified by measuring head movements and tongue flicking frequencies. In general, data collection was time consuming because responses to infrared stimuli could not be conditioned. In addition, the more often an infrared stimulus was applied in a given session the faster habituation occurred. To minimize habituation snakes of both species were tested only every second or third day for not more than 60 minutes. Notwithstanding these restrictions our behavioural results show that the tested animals respond to heat stimuli up to a distance of 55cm (*Python regius*) and 98cm (*Crotalus atrox*), respectively.



# SG8 Studiengruppe Zoologische Systematik

## V-S1.1 Is rostrum morphology a good character for species distinction in shrimps of the genus *Hippolyte* (Decapoda, Caridea)?

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The genus *Hippolyte* has a worldwide distribution, with the exception of cold waters. The identification of the species is extremely difficult and nothing is known about phylogenetic relationships within this genus. There is an ongoing discussion about the taxonomy and classification with special emphasis on certain species or species complexes: *H. sapphica* forma A and B, the *H. varians* – *H. holtuisi* complex, and the *H. leptocerus* – *H. garciarasoii* complex.

To help clarify the taxonomic confusion and to decide, if the rostrum morphology is a good phylogenetic character, we extracted and sequenced fragments of the mitochondrial 16S rRNA and cytochrome oxidase I genes and collected morphometric data of relevant species.

Based on our results, we suggest the following classification of the mentioned species:

*H. sapphica* A and B are indeed different morphological formae, belonging to the same species, showing a discontinuous rostrum variation. They cannot be distinguished genetically. However, form A constantly has a very long rostrum while in form B it is always reduced to a toothless spine. *H. varians* and the Mediterranean *H. holtuisi* are genetically clearly distinct, despite their rostral similarities. Also *H. varians* from Madeira shows genetic differences to conspecifics from mainland Europe. Finally, *H. leptocerus* and *H. garciarasoii*, two highly debated forms or species exhibiting great rostrum variations, can be genetically distinguished and do not belong to the same species.

In conclusion, we herewith show, that the rostrum is not a good character to distinguish the different species within the genus *Hippolyte*. An exception to this is the absence or presence of the postrostral tooth that is in agreement with an early split of the European species of *Hippolyte*. We furthermore partially clarified phylogenetic relationships within the genus suggesting monophyly of the European representatives.

## V-S1.2 Variability of neuropeptides in cockroaches (Insecta: Dictyoptera) – lessons from molecular and phylogenetic research

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Neuropeptides are a very diverse group of messenger molecules in the nervous system of insects and are part of the hormonal system. Many of the neuropeptides of insects are likely to be ancestrally related to peptides from other phyla, including the chordates, whereas other neuropeptides seem to be specific for insects or arthropods. Knowledge about the variability of neuropeptides from related species, however, is still fragmentary. In the present study, we have focused on neuropeptides of Blaberidae, a species-rich family of Dictyoptera. The molecular mass and the sequences of neuropeptides were analysed by using mass spectrometric methods (MALDI-TOF and ESI-QTOF MS). The neuropeptides of two neurohemal organs (the abdominal perisymphatic organs and the corpora cardiaca) from 10 blaberid cockroach species were studied. Peptides that were abundant in the corpora cardiaca were structurally not different in the various species. Peptides of abdominal perisymphatic organs, however, differed remarkably in primary structure between species. Trees denoting phylogenetic relationships were constructed for all species investigated on the bases of the primary sequences of the neuropeptides and on DNA sequences of the CO II gene (cytochrome oxidase subunit II). The resulting trees were compared with those recently published for cockroaches.

**V-S1.3 Phylogenetic analysis within the class Spirotrichea (Ciliophora) inferred from small subunit (ssu) rDNA**

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The Spirotrichea represents one of the most diverse classes of the Ciliophora. The main goal of our study is to clarify the phylogenetic relationships within the Spirotrichea. Therefore, we examined the ssu rDNA of more than 20 species, which belong to 3 orders and approximately 6 families of the subclass Stichotrichia.

In particular our investigation focuses on the relationships within the Oxytrichidae and the Urostylidae. Former studies which dealt with the phylogenetic relationships of the Oxytrichidae indicate a separation into the Oxytrichinae and the Stylonychinae. The analyses of our expanded dataset confirms this separation. However, only the Stylonychinae forms a monophyletic group, while the Oxytrichinae seems to be paraphyletic in these analyses.

Sequence analyses of further species of the Urostylidae show that this family is not monophyletic. One group of the Urostylidae forms the sistergroup to all remaining representatives of the subclass Stichotrichia, while the other species are found within this subclass.

Supported by the DFG (Schl 229/12-1), German National Academic Foundation, FWF (Vienna) P-14778 (Berger) and P-15017 (Foissner)

**P-1 Changes in metabolism, physiology and behaviour as function of oxygen acclimation in *Daphnia magna***

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Limnic organisms exposed to changes in oxygen availability have to face trade-offs optimizing oxygen transport and minimizing oxygen damage. In the present study, *Daphnia magna* kept in long-term culture at hypoxic, normoxic and hyperoxic conditions (oxygen partial pressures were adjusted to 3 kPa, 21 kPa and 62 kPa) were examined for adjustments in behavioural (swimming activity) and metabolic (antioxidant enzymes) variables as well as survival rates dependent on ambient oxygen partial pressure and oxidative stress caused by hydrogen peroxide. The swimming activities of all acclimation groups increased with enhanced oxygen partial pressure. A marked decrease of swimming activity during the one-hour measurements could be shown at low oxygen partial pressures. Hyperoxically acclimated *Daphnia* showed the lowest sensitivity against exogenously applied hydrogen peroxide. Hypoxically acclimated animals showed a half-maximal lethality already at substantially lower peroxide concentrations than animals from normoxic and hyperoxic medium. Sensitivity against hydrogen peroxide was negatively correlated with animal size. The highest values of catalase (CAT) activity were found for normoxically acclimated animals. CAT activity of the hypoxically and hyperoxically acclimated animals was significantly lower. The CAT activity decreased in large animals compared to small and medium-sized animals, the latter showed the highest CAT activities. A stimulation of CAT activity by sublethal amounts of hydrogen peroxide or varying oxygen partial pressure conditions could not be observed within 48 h. A superoxide dismutase activity could not be detected.

**P-2 Exploring poriferan biodiversity in the northern Adriatic Sea (Rovinj, Croatia) from the past to today**

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Research on the diversity of Adriatic sponges is one of the most traditional topics of marine ecology and taxonomy, some of the most well known early sponge workers contributed considerably to the knowledge of Adriatic sponges, e.g. Donati, Olivi von Lendenfeld, Nardo or Schmidt. The first systematic overview over the sponge fauna around Rovinj on the Istrian peninsula in Croatia was given in 1907 by Zimmermann, who noted 25 sponge species. This list was enhanced by Vatova (1928), Rützler (1967), Müller et al. (1984) and Brümmer et al. (2002) to 141 sponge species around Rovinj. More than 70 % of all known marine sponge species in Croatian waters occur in this region. Areas of a high sponge diversity near Rovinj are the Limski kanal, a fjord-like bay north of Rovinj and the submarine caves of the small islands of Banjole and St. Katarina. Though the sponge fauna of the surroundings of Rovinj is obviously well examined, 6 more species could already be added to the list of known species during systematic studies in its surroundings. Recent investigations revealed that several still undetermined species showed certain characteristics that suggest that they can be regarded as new to the Adriatic Sea, new to the Mediterranean Sea or even new to science.

**P-3 Partial sequences of invertebrate Na<sup>+</sup>/K<sup>+</sup> ATPase alpha-subunits – coincidence of molecular structure and classical systematics**

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The Na<sup>+</sup>/K<sup>+</sup> ATPase is a P-type cation pump. Gradients for Na<sup>+</sup> and K<sup>+</sup> across the plasma membrane determine the electrical properties of cells and control cell volume as well as secondary active transport processes. The Na<sup>+</sup>/K<sup>+</sup> ATPase is a heterodimer composed of one alpha- and one beta-subunit with molecular masses of 100 or 36 kDa, respectively.

To extend our knowledge about distribution and structural similarities in the alpha-subunits in animal cells, we used degenerated primers to obtain RT-PCR amplification products using RNA-isolates from various animal species from different invertebrate phyla (cnidaria, molluscs, nematodes, annelids, arthropods). Sequencing of the 640 kb products allowed sequence alignment and comparison with GenBank entries. Although the number of bases in our products was much too small to draw phylogenetic conclusions, it was obvious that the sequences were clustered in a way that coincided with the established systematic groups of invertebrates. The most similar proteins (approx. 65 % identity at the amino acid level) were the vertebrate Na<sup>+</sup>/K<sup>+</sup> ATPase alpha-subunits which constitute a very homogenous (monophyletic?) group. Other P-type ATPases (H<sup>+</sup>/K<sup>+</sup> ATPases and SERCA Ca<sup>2+</sup> ATPases) were clearly less similar even in the same species indicating an early origin of Na<sup>+</sup>/K<sup>+</sup> ATPases in the evolution of multicellular organisms.

Our aim is to determine full length sequences of Na<sup>+</sup>/K<sup>+</sup> ATPase alpha-subunits of representative species of each animal phylum and characterize their functional properties (kinetics, stoichiometry, pharmacology, regulation) in a heterologous expression system to relate these parameters to structural features of the proteins and to the environmental conditions these animals have to deal with.

**P-4 A new endemic freshwater crab of the genus *Sesarma* (Crustacea: Brachyura: Sesarmidae) from central Jamaica, as evidenced by morphology and two mitochondrial genes**  
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Among the Caribbean islands, Jamaica plays a special role in terms of its freshwater crab fauna, as it completely lacks members of the family Pseudothelphusidae. Instead, it has a very diverse fauna of terrestrial and freshwater crabs of the family Sesarmidae. These endemic species evolved from a common ancestor through adaptive radiation and today occupy five different ecological niches. Until ten years ago, five species were known which corresponded to five different ecotypes. New morphological and genetic evidence allowed description of four new species of crabs from freshwater mountain streams of different regions of Jamaica, formerly belonging to *Sesarma bidentatum* Benedict, 1892. Among these new species is *S. windsor* Tuerkay & Diesel, 1995 from central Jamaica. In this study we compared populations of *S. windsor* from freshwater streams draining to the north with those from streams draining south. Consistent morphological differences were found between these populations, which were corroborated by diagnostic genetic differences in the 12S and 16S mitochondrial rRNA genes. The type locality of *S. windsor* is the Mouth River draining to the north. Consequently a new species is described for the populations of freshwater crabs from southern watersheds of central Jamaica (Rio Minho and Rio Cobre).

**P-5 Phylogeography of the Hierofalcon-species-complex (*Falco biarmicus*, *Falco cherrug*, *Falco jugger*, *Falco rusticolus*)**

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Sequence variation in non-coding mitochondrial (mt) genome regions of 157 Hierofalcon specimens covering the whole distribution ranges was performed to reconstruct the most likely phylogeographic scenario for this complex of closely related species. The phylogenetic analysis revealed two main mt DNA lineages within the sakerfalcon (*Falco cherrug*): Europe with southwestern Asia, and northeastern Asia respectively. In the latter lineage haplotypes are shared between *F. cherrug* and the gyrfalcon (*Falco rusticolus*). The two taxa have a nearly allopatric distribution and there is no documentation of recent natural hybridisation. Therefore, the results suggest that hybridisation between the two taxa must have occurred during glacial periods. The sequences of the two other Hierofalcon species (*Falco biarmicus*, *Falco jugger*) do not form monophyletic groups in our tree, but instead appear at the base of the northeastern clade. Interestingly, within each of the clades only little phylogeographic structure was detected. In both clades sequence diversity is rather low. The only exception is the Lanner falcon (*F. biarmicus*) in which high haplotype variation was observed. This could be taken as indication of an African origin of the Hierofalcon-complex. Because of to the limitations in the use of mt DNA, additional microsatellite analyses were carried out. The results confirm the presence of two genetic groups in *Falco cherrug*. However, allelic variation is rather low and no species specific alleles were found. The study also confirmed further presumptions that the North American Prairie falcon (*F. mexicanus*) does definitely not belong to the Hierofalcon-complex.

**P-6 Molecular phylogeny, population genetics and morphology of the crab genus *Xantho*, (Decapoda, Brachyura) and their potential endemism in the mediterranean sea**

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Within the crab family Xanthidae, the type genus *Xantho* shows a great interspecific as well as intraspecific morphological variability. All four species of the genus, i.e. *Xantho poressa* (Olivi, 1792), *X. hydrophilus* (Herbst, 1790) (= *X. incisus* Leach 1814), *X. sexdentatus* (Miers, 1881) and *X. pilipes* A. Milne-Edwards, 1867 are restricted to the northeastern Atlantic Ocean. While *X. sexdentatus* is only found in the tropical Atlantic, the other three species are distributed in the Atlantic as well as in the Mediterranean Sea. For the Mediterranean populations of *X. hydrophilus*, Forest (1953) described a variety, *X. h. granulicarpus*, which was later often used as subspecies. *X. h. hydrophilus* and *X. h. granulicarpus* differ in the acuteness of the lateral carapace spines and the extent of the dark pigmentation on the chelae of adult males of *X. h. granulicarpus*. In this study, we reconstruct the phylogenetic relationships within the genus *Xantho* and determine whether the Atlantic and Mediterranean populations of *X. hydrophilus* can be separated by morphometric, genetic and larval morphological methods. The use of DNA-sequences corresponding to two mitochondrial genes (16S rRNA and CO1) revealed a preliminary phylogeny for the genus *Xantho* and some related genera. However, within *X. poressa* and *X. hydrophilus* no geographically consistent genetic differences were found. The morphometric and larval morphological analyses, on the other hand, indicated morphological distinctness of the two potential subspecies of *X. hydrophilus*.

**P-7 Morphometric and genetic analyses of the genus *Pilumnus* (Decapoda: Brachyura) in the mediterranean sea**

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Hairy crabs of the genus *Pilumnus* are widespread throughout the northern Atlantic Ocean and the Mediterranean Sea. They show a wide variety of forms in terms of setation and colouration patterns. Consequently, there are uncertainties about the exact number of valid species in Europe. In this study, we address this question by combining morphometric with mitochondrial and nuclear molecular analyses. Measurements were taken from crabs that were collected or obtained from museum collections covering the whole Mediterranean Sea, the northeastern Atlantic and the Black Sea. Sampling different geographical localities allowed to compare individuals of distant populations. Morphometric analyses revealed no significant intraspecific differences but significant differences among all five species. Genetic comparisons were done with the mitochondrial 16S rRNA gene and the nuclear Internal Transcribed Spacer 2 (ITS2). Both, the morphometric analyses and the molecular phylogeny, suggest the existence of an undescribed species. Furthermore, the genetic results support the monophyly of the European Pilumnidae, using congeneric species from Asia and North America as outgroups.

**P-8 The “Link-Type Collection” of the University of Rostock: Stabilizing the Nomenclature in Marine Mollusc Taxonomy**  
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The zoological collection of the University of Rostock was founded in 1775. It contains approximately 100,000 series today. After World War II the collection was completely neglected, in part unsuitably stored and pillaged in favour of other museums. For years one of the most important tasks has been to put the objects into a multifunctional shape and to make them accessible again for the scientific community. As a result of growing international marine biodiversity research there was an increase in inquiries regarding the specimens of the so-called “Link-type Collection” which contains marine molluscs from all over the world. These inquiries could not be answered satisfactory. Heinrich Friedrich Link (1767–1852) has worked in Rostock from 1792 to 1811 as the first professor for ‘natural history’. Being the administrator of the collection of the “Academic Museum” he compiled the first scientific catalogue in 1807 and assigned new names to some species which entered the literature as first descriptions. Since the collection has not been dealt with later and has even been forgotten for some time, the identity of the specimens and their significance as types remained unknown. The core material, containing approximately 350 series, still exists today, so it is possible to re-integrate the ‘Link Collection’ into the process of taxonomy. After the clarification of synonymes the objects of the collection were determined. Many of them represent “Link-types” and are legible as holotypes or lectoholotypes.

**P-9 Morphological and genetic patterns of Central European spring snail species *Bythinella* (Gastropoda: Prosobranchia)**  
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*Bythinella* spp. are tiny prosobranch snails in springs and subterranean waters of Europe and Asia Minor. Within Germany currently five putative species are recognized. These species show allopatric distributional ranges and morphological discrimination is not convincing. Here, we analyse the phenotypic and genetic relationship of the German taxa by means of shell morphometrics and allozymes. We sampled individuals from 10 populations across the five German taxa. Discriminant function analysis of shell measurements using putative species as groups allowed a posteriori to assign individuals to the respective species. However, cluster analysis of Mahalanobis-distances between populations failed to group populations according to species.

The analyses of allozymes revealed for each species loci with diagnostic alleles. A more detailed analysis of genetic distances (cluster analyses of genetic distances) showed two lineages: one lineage comprising *B. austriaca* and *B. bavarica* (distributional ranges in southern Germany) and one lineage with *B. badensis*, *B. compressa* and *B. dunkeri* (ranges in western Germany). Genetic distance between lineages is rather large (Nei-distance > 0.6). Within lineages differentiation between species was only moderate (Nei-distance 0.1 to 0.3). Morphological differentiation was not correlated to genetic differentiation across species. Furthermore, we found no correlation between geographic distance and morphological differentiation as well as genetic distance.

Apparently shell-morphology is not an reliable guide to the phylogenetic relationship among species. The genetic analysis and the current distribution patterns suggest that allopatric speciation is of major importance for this genus of snails.

**P-10 Comparative studies on the head and shoulder bones of the most abundant fish species in the Baltic Sea and development of a corresponding identification software**  
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For sub-fossil records from archaeological assemblages and for diet analysis of carnivore vertebrates it is necessary to identify the fish species by single bones of the cranial and the axial skeleton. In this study bones from the head and shoulder of 34 fish species from the Baltic Sea were extracted and compared with the aim to provide an identification key. For a better use an identification software was programmed, completed with a database of bone pictures and a simple way to compare bone types for the different species.

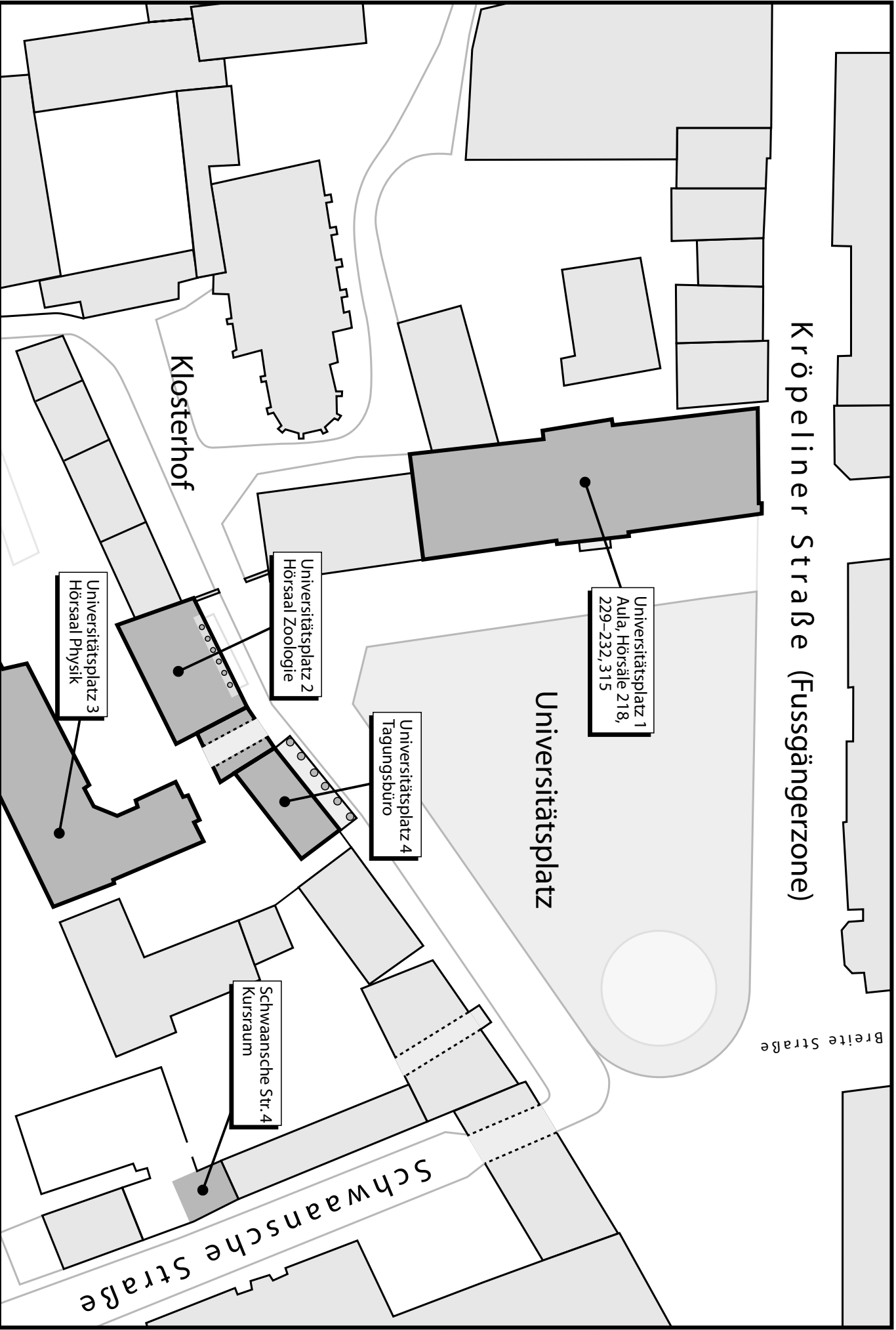
**P-11 Structure, systematics, and biology of selected species of Monogenea on the Carp (*Cyprinus carpio* L., 1758) in Europe and Middle East**  
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Parasitic flatworms (Monogenea) play an important role as a pest in fish farms and aquaculture. Especially artificial carp populations (*Cyprinus carpio*) suffer from such infections which diminish their yield and therefore are of economic importance. Although a lot of studies are available, many details of structure, systematics and biology of these fish-parasites still are little known. For the present study 495 carps from Germany and Syria were examined. The present study aims to revise the species of the genus *Dactylogyrus* (Diesing, 1850). Four species were recorded: *D. extensus* (Müller & Van Cleave, 1932), *D. vastator* (Nybelin, 1924), *D. anchoratus* (Wegener, 1910), *D. minutus* (Kulwiec, 1927). Additional information is presented on *Gyrodactylus sprostonae* (Ling Mo-In, 1962) and *Diplozoon nipponicum* (Gotto, 1891). The latter which is known from East Asia, is found and described for the first time in Europe from a Mecklenburg carp hatchery.







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Hörsaal Physik

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Hörsaal Physik