TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Science, Department of Biology, Institute of Zoology, Applied Zoology

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BSc and MSc projects in the Applied Zoology lab

The Applied Zoology lab is seeking BSc or MSc students with interests in evolutionary or molecular biology to conduct projects relating to sperm biology, cellular metabolism, cuticle biology and/or sexual selection. Opportunities exist for method training in advanced microscopy, gene function analysis, protein analysis, experimental evolution and advanced statistical modelling. We don't encourage research projects for the sake of learning methods but a list of our microscopy, molecular and other equipment can be found at the end of this document.
Minorities, including members of the LGBT community, are particularly encouraged to apply.

Exciting cutting-edge research needs your fresh input - how to apply

Our website (http://tudaz.net) (news, publications and current research) provide an impression on the topics we are working on. However, you can do any project in areas related to our interests, as long as you convince us the project is interesting, or related to Prof. Reinhardt's lectures. More specifically, our interests include:

* **Sperm:** evolution, ecology, physiology and molecular biology, e.g. genetic manipulation (RNAi, CRISPR Cas9), or sexually transmitted microbes
* **Mitochondria:** evolution, physiology, mitochondrial diseases, ageing, ecology, behav.biology
* **Cuticle:** Genetics, protein interactions, material science, incl. genetic manipulation (RNAi, CRISPR Cas9) of the cuticle
* **Experimental evolutionary biology**: incl. epigenetics, reproduction, sexual selection (insects)
* **Cultural zoology**

Below are two pages with more specific research topics. Please call in if you like one or several. Some projects require good English skills. If you haven't developed a specific idea, come by and see what we do or let us know what research area you might be interested in. We will develop a research project together.

Ecological and evolutionary consequences of mitochondria-nucleus crosstalk

Mitochondria and nucleus interact (crosstalk) to form the phenotype. Our mitolines allow us to separate how much the mitochondria and the nucleus contribute to the phenotype. Many projects are possible, such as the question: do mitochondria contribute to body size, to sperm length, to egg size or whatever you might be interested in. Similarly, mitochondria also have a role in adaptation to temperatures - finding out what role, could be your job. Good read to start with: Dowling 2014 Biochimica Biophysica Acta 1840:1393-1403 // Dobler et al. 2014. Journal of evol. Biol 27: 2012-2034

Fitness effects of sperm age

i) Do older sperm produce offspring with lower fitness in Drosophila? Offspring sired by males with young or old sperm will be compared, ideally involving a full-sib female design.
ii) Is there sexual selection on sperm age? Test specific predictions of two episodes: (a) Precopulatory: Do female Drosophila prefer to mate with males that have recently mated, and are thus likely to provide them with younger sperm?

(b) Postcopulatory: Shortly after mating, female Drosophila eject a portion of the transferred sperm. Does the age of a given sperm cell, compared to the age of other sperm cells in the ejaculate, affect its likelihood of being ejected vs. stored?
Good start to read: radio-labelling techniques; Reinhardt & Siva-Jothy 2005. American Naturalist 165: 718-723, Reinhardt 2007. Quarterly Review of Biology 82: 375-393.

Protamines in sperm function
We seek to study the molecular function of the abundant sperm proteins **protamines** in the fertility of the fruit fly. To compact the chromatin, protamines are replaced by histones in the final stages of sperm maturation. Transgenic flies expressing eGFP-tagged protamines will be used to characterise molecular functions during spermatogenesis using biochemical analyses and other approaches.

Physiology and molecular biology of mitochondria-nucleus crosstalk
Mitochondria and nucleus interact (crosstalk) to form the phenotype. Molecular details or the function of specific mitochondrial or nuclear genes of the interaction can be analysed with knock-downs or with our special *Drosophila* mitolines. Good read to start with: Mitochondrial genetics lecture by Dr Krause // Picard & Wallace 2016. Mitochondrion 30:105-116 // Gershoni et al. 2014, Genome Biology and Evolution 6: 2665-2680

Molecular biology, physiology and evolutionary ecology of the insect cuticle
The insect cuticle is an extracellular structure that has to fulfil multiple functions: protection against pathogens, barrier against dehydration and exoskeleton. How are these aspects met at the cellular and molecular level? We use *Drosophila* as a model insect to address these issues combining genetics (including Crispr/Cas9) with several levels of microscopy (light, atomic force, confocal and electron microscopy). Good read to start: cuticle chapter Chapman *Insects: Structure and Function*

Molecular biology of development
Based on recent data, we hypothesise that Insulin signalling triggers developmental progression in bed bugs. To explore this, we want to manipulate Insulin signalling by RNA interference and by application of inhibitory drugs. Good read to start with: Gujar & Subba Palli 2016: Scientific Reports, 6: 26092 // Walkiewicz & Stern 2009: PLosOne, 4: e5072

Evolution, physiology and molecular biology of sperm storage
Insect females store sperm alive in special organs (spermathecae) for months! How do females do that? What happens to the sperm while being stored? This question can be addressed with a variety of experimental, microscopy, genetic knockout/ GAL4 methods, or with comparative methods. See also sperm age topic above. Intro reads: Orr & Brennan 2015 Trends in Ecology and Evolution 30:261-272, Reinhardt & Ribou 2013, Scientific Reports 3:2888

Resilin and other insect materials used for sex
During every copulation, male bedbugs use a penis knife to penetrate the female's skin. We are interested to study the material properties of the penis knife and of the corresponding female skin, including the role of resilin, an elastic protein of the exoskeleton of insects to prevent damage through frequent or fast movement. Mapping the exoskeleton of various insect species for resilin will be possible using histological, genomic or Confocal Laser Scanning microscopy methods.
Good read to start with: Michels et al. 2015. Journal of the Royal Society Interface 20141107
Bar-On et al. 2014, Nature Communications 5:3894

Sex-biased expression of cuticular enzymes
Why would males and females have different expression of genes that are involved in cuticle formation and maintenance? We don't know but we have ideas of how to find out.
Unexpectedly, we found recently that chitin-degrading enzymes may play a role in differentiation and function of sexual organs in Drosophila. To continue and deepen this research field, we plan to

analyse this aspect in genetic (Crispr/cas9) and histological experiments. Good read to start with: Pesch et al. 2016: Scientific Reports 6: 18340 // Zhu et al. 2008: PNAS 105: 6650–6655

Can sperm evolve in response to interactions with microbes?
Sperm cells are currently mainly believed to evolve via sexual selection, a view that in its absoluteness is challenged in our lab. Sexually transmitted microbes, for example, should have a great impact on sperm function and, hence, evolve rapidly. Experimental work will test the effect of sexually transmitted microbes in insects on sperm function.
Good reads: Lockhart et al. 1996. Biological Reviews 71:415-471
Rillig et al. 2016. Trends in Ecology and Evolution 30:470-476
Reinhardt et al. 2016. Annual Review of Ecology Evolution and Systematics 46:435-459

Cultural history of insects (mainly the bedbug**)**
Involves a wide range of questions from the history of bedbug in Dresden and Saxony (work in archives), to representation of bedbugs in films or TV sitcoms.
Good start to read: Reinhardt K. 2014. *Literarische Wanzen*, Neofelis, Berlin.
Dicke, M. 2004. From Venice to Fabre: Insects in western art. Proc. Neth. Entomol. Soc 15: 9-14

Equipment in the Applied Zoology Lab
qPCR machine
metabolism analyzer 'Seahorse'
Fluorescence microscope
Fluorescence stereoscope
Atomic Force Microscope
Two-photon laser scanning microscope with FLIM option
Temperature- and moisture-controlled incubators