Final Report
The International Society of Neurochemistry
5th TReND course on insect neuroscience and *Drosophila* neurogenetics

Content of this report

This report contains the following parts in this order:

- Summary of the course including basic information regarding date, location, participants, outline schedule, contents, goals and how they were fulfilled and student's feedback
- List with information on all participants including: name, academic affiliation and rank.
- Final programme summary
- Break down of disbursement of funds (including funding received from other sources)

In addition we have included the following attachments:

- Full course programme handed to the students
- List of names and photographs of students handed to students and faculty
- Booklet handed to students at the end of the course
- Poster used to announce the course
- One photograph of the entire group
- Extended data on students feedback

Topic of the course

Introducing students to insect neuroscience, from basic concepts to the latest discoveries in the field, with a special focus on state-of-the-art basic science and Africa-relevant problems, all integrated in the frame of promoting the use of low-cost, DIY and open source tools for research.

Location
KIU, Dar es Salaam, Tanzania

Dates
17th August– 5th September 2015

Organisers
Lucia Prieto Godino, Tom Baden, Yunusa Garba and Sadiq Yusuf

Countries represented by the students
Ghana, Sierra Leone, Kenya, Tanzania, Nigeria, Uganda, South Africa and Zambia

Faculty list

Dr. Tom Baden (CIN/BCCN, Tübingen, Germany)

Dr. Matthias Landgraf (Dept. Zoology, Cambridge, UK)

Dr. Chris Elliot (University of York, UK)

Dr. Jeremy Herren (icipe, Kenya)

Dr. Benajmin Matthews (Rockefeller University, New York, USA)

Dr. Laura Lucia Prieto Godino (CIG, Lausanne, Switzerland)

Dr. Horst Schneider (Innowep, Würzburg, Germany)

Prof. Sadiq Yusuf (KIU, Kampala, Uganda)

Dr. Marta Rivera Alba (HHMI Janelia Farm, USA)

Dr. Christen Mirth (Instituto Gulbenkian de ciencia, Portugal)

Dr. Georg Raiser (University of Konstanz, Germany)

Thomas Laudes (University of Konstanz, Germany)

Dr. Sarah Carl (Friederich Miescher Institute, Basel, Switzerland)

Olivia Schwartz (Friederich Miescher Institute, Basel, Switzerland)

Yunusa M Garba (Gombe State University, Nigeria)

Teaching assistant
Mwichie Namumbasa (University of Zambia, Zambia)

Rationale behind the school, activities carried out and basic schedule
The goal of the course was to promote state-of-the-art neuroscience research and education in low-resource environments through the use of insects as model organisms, combined with open source tools.

We taught about the advantages of *Drosophila* as a model organism given the genetic tools available in this model and its low cost. Additionally we discussed in which contexts *Drosophila* can serve as a good model for mammalian systems and also how it could be advantageous given its evolutionary conservation with other insects causing plagues or disease vectors, and in which yet other cases different non-Drosophilid models should be preferred. An illustration of the first point, how *Drosophila* can be a useful model thanks to the conservation of basic molecular mechanisms with mammals, we had a full module dedicated to the use of *Drosophila* as a model for neurodegenerative diseases, where students performed among other experiments, electrophysiology and behavioural assays in *Drosophila* strains that model important aspects of Parkinson's diseases. To illustrate the second point, of how *Drosophila* can be an useful model thanks to its evolutionary proximity to diseases vectors, we had a full module focussed on mosquitoes (*Aedes* and *Anopheles*) and comparing its biology and genetic tools to those of *Drosophila*. During this module we taught how the latest advances in mosquito genetics, achieved thanks to the development of CRISPR/Cas9, combined with the accumulated knowledge of *Drosophila* neuroscience, makes it possible to directly study the molecular and genetic mechanisms that underlie their ability to find humans, and how this can help to design knowledge-driven strategies to control them.

In addition of teaching the technical specificities of each of the topics, we aimed at educating students beyond the subject matter, by introducing lectures and practicals on scientific writing, project creation and development, statistical analysis, bio-informatics, critical interpretation of data and effective usage of online resources to explore the possibilities of open source software and hardware. Particular emphasis was laid on introducing approaches that allow to perform science despite low economic resources.

To attain these goals we introduced the subjects not only theoretically but through practical laboratory sessions where students could learn to perform experiments themselves. We also put a lot of emphasis in students-faculty one to one interactions, in a way that students could easily consult with faculty members regarding their research projects back at their host institution, as well as their research interests at large. The course ran 6 days a week over a period of 3 weeks. From Monday till Friday, each day consisted of morning theoretical lectures, where students were introduced to theoretical concepts in each of the subjects, and afternoon laboratory sessions, where students performed experiments in one of the subjects of the course. On each Saturday, students had to give an oral presentation on the work that they had performed during the week, in a conference format, and answer to the questions posed by students and faculty.

The first week consisted of a series of theoretical and practical session common to all of the students that introduced them to the field of insect neuroscience. The second and third weeks consisted of theoretical lectures common to all students and a series of alternative practical modules. Students had to choose one out of three practical modules running in parallel each week (for more details see the attached School program).

Week 1: **Introduction**

Insects as model organisms in neuroscience, introduction to genetics of *Drosophila* and neurogenetics, electrophysiology methods, introduction to bio-informatics, project creation and development, and scientific ethics. – *Drosophila & Schistocerca (*locust*)*.

Week 2:

Module A: Evolution and environmental control of body size and foraging behaviour. *Drosophila*

Module B: Function and Development of Motor and Mechanosensory systems. *Drosophila*

Module C: Taste sensing and circuitry. *Drosophila*

Week 3:

Module A: Olfactory system – Central processing. *Drosophila*

Module B: Olfactory system – Receptors. *Drosophila* & *Aedes* / *Anopheles* (Mosquitoes).

Module C: *Drosophila* as a model for human diseases.

Importantly, the course was designed to promote active participation from the students, and therefore we encouraged that students interrupt during the theoretical lectures to ask questions, while during the

practical classes any given time we had a ratio of at least 1 faculty per 4 students, which meant that every student could be independently doing his/her experiments and collaborate with other students, while being closely supervised. As mentioned, at the end of each week students had to present their results from the laboratory experiments to the rest of the class in a scientific-conference format, which further increased interaction and discussions.

During the practical sessions we made a particular effort to expose the students to both state-of-the-art equipment as well as more cost-effective alternatives, critically comparing each method's suitability to perform experiments at hand. If the more expensive option clearly yielded superior results, we encouraged students to consider the quality of data needed to satisfactorily address their scientific question. Moreover we attempted to reproduce selected findings published in top-ranked journals, demonstrating that often the same conclusions could have been drawn from a much more basic experiment. Additionally, in every practical module, we aimed at introducing a simple question of unknown results for the scientific community, motivating students at the prospect of making a small discovery within this newly learnt field.

Level of school and students

The students were African scientists of all levels from MSc to full professors, with the majority of the students being either post-docs or PhD students. The background of the students was very varied: Entomology, medicine, neuroanatomy, physiology and pharmacology.
It was an introductory school that aimed at teaching students that had never been exposed before to the field of insect neuroscience, but we aimed at achieving an advanced level in the concepts taught by gradually building up from basic concepts to the latest advances and techniques in the field.

Contribution of the school towards scientific capacity building in the region and how it is benefiting the community at large.

The school contributed to capacity building through two channels. First, we educated students from 8 different African countries, who after the school have gone back to their host institutions to pass newly learnt materials on to their peers. We have received numerous reports of our students giving seminars to their colleagues, for example, in one case, Ella Kasanga, a participant from Ghana, was so excited about this new field of research that she has joined another TReND course on the subject this year (http://fliact.org/welcomeghana). Also, this school has served to established connections among neuroscientists across the continent, and to solidify the basis for a group of insect neuroscientists: For example, our teaching assistant, Mwichie Namumbasa, she was our best student from last year's course, she has set-up a *Drosophila* genetics teaching lab, where she is teaching the basics of *Drosophila* genetics to undergraduates at the Faculty of Natural sciences of the University of Zambia, Lusaka. In addition, Mwichie is also an alumni of TReND's open hardware and 3D printing course (http://open-labware.net/education/), and she has set-up a 3D printing facility at her University that she is using to print at low cost, otherwise prohibitively expensive teaching and research materials. He attendance as teaching assistant to this years' courses was extremely beneficial for all parts, she could learn new concepts by attending the lectures, and gain experience by helping in the organisation of the laboratory practicals, while the students benefiting from interacting with her, seeing her as a role model to follow, and having a local contact to discuss drosophila neuroscience research, open hardware and share knowledge and materials.

Second, through TReND in Africa (http://trendinafrica.org/activities/furnishing-african-labs/), we brought important equipment to Dar es Salaam, including a confocal microscope. All of this equipment has remained in Dar es Salaam, and will be used for next year's course. Additionally, we have strengthened links between research institutions within Dar es Salaam, by linking the University of Dar es Salaam (where we did our 2014 course) with KIU, Dar es Salaam (location of our 2015 course). This type of trans-institutional collaboration within the region is rare, but very advantageous, and we are happy to catalyse this new dialog. It is our hope that the equipment we have donated to both of these institutions and the education we have imparted to researchers of both universities will provide the basis for the creation of a hub that any scientist in Tanzania can benefit from. Proof of principle that this model works is the Institute for Biomedical Research (IBR) at the Kampala International University branch in Ishaka, Uganda (http://shs.kiu.ac.ug/) which was created thanks to previous instalments of this school in Uganda. Today the IBR runs independently using the equipment we donated, supporting the research of more than 20 scientists, competitively winning international grants (e.g. an International Outreach Grant from the Wellcome Trust 2013), and publishing in international journals.

Additionally, the school benefited the local community by increasing the number of volunteers working for the outreach branch of TReND, which was founded by a group of alumni from previous years and it is devoted to organise outreach events at primary and secondary schools across the continent (http://trendinafrica.org/activities/outreach/).

Student's assessment of the course

To assess the effectiveness of the course and to gather feedback suggestions for future improvements we asked students to fill out an online questionnaire hosted by SALG (Student Assessment of Learning Gains, http://www.salgsite.org/). Here, we surveyed items ranging from individual teaching units to more general terms like class dynamics and time allocations for different course aspects. Out of the 17 students we received valid questionnaire responses from 13. The full SALG report is provided (see Extended data on student's feedback files).

In short, feedback was overwhelmingly positive. Out of a total of 75 directly course related questions where 1 was extremely negative and 5 was extremely positive, the mean rating was 4.56 ± 0.33 (s.d.). These included questions about gains in understanding and attitude as well as course structure and overall organisation. For example, gains in understanding how and why to work with Drosophila as a model system, their basic genetics and the basics of concepts in neuroscience were all rated as 4.8. The lowest rating (3.8) was given for "gains in finding articles relevant to a particular problem in journals or elsewhere" – presumably as many students were already quite happy how to do that prior the course.

We also asked to rate the duration and difficulty of the classes on a scale of 1:5, with 3 being "just right" and 1 and 5 being too short or long, respectively. Students rated all 4 out of 5 questions pertaining duration [time for (i) entire course; (ii) lectures; (iii) lab-work; (iv) student presentations] as 2.1 (2= "a little too short") and the 5th one (time for in-class discussions) as 3.6 (4 = "a little too long"). Accordingly, while it will be difficult to further extend the 3-week course to even longer, as requested for most aspects of the course, we will in the future move some of the time allocated to in-class discussions to other activities. Regarding the level of the course, students rated Theoretical lectures and Practical exercises as 3.0 and 2.9, respectively ("just right") but rated the level of chosem papers to read and discuss as 4.4 (4= a little too difficult, 5 = too difficult). Evidently there is need for further training to allow students to more comfortably keep up with state of the art developments in the field.

We also had free-text fields for students to express their views on a range of course-related topics (see Extended data on student's feedback files). While it would be impossible to fairly summarise all comments here, the overall response was, as before, overwhelmingly positive. For example, one students commented "Great teachers, always willing to go the extra mile to help students understand". Another student wrote: "The course opened my eyes about real science".

Pictures of the course can be found at:
https://www.flickr.com/photos/trendinafrica/albums/72157655172936284

List of Participants that received ISN funding

Given that ISN funding was used not only for travel scholarships but also to cover accomodation for all participants as well as to provide continous electricity for everyone and other general necessities for the successful outcome of the school, we consider that every participant received ISN funding
This is the list of all participants of the school

Organisers

Name	Academic affiliation	Country	Rank	Sex
Lucia Prieto Godino	University of Lausanne	Switzerland	Postdoctoral Researcher	Female
Thomas Baden	University of Tuebingen	Germany	Postdoctoral Researcher	Male
Yunusa Garba	Gombe State University	Nigeria	Lecturer	Male
Sadiq Yusuf	Kampala International University	Uganda	Principal Investigator	Male

Members of the faculty

Name	Academic affiliation		Rank	
Matthias Landgraf	University of Cambridge	UK	Lecturer	Male
Chris Elliot	University of York	UK	Lecturer	Male
Christen Mirth	Instituto Gulbenkian de Cienca	Portugal	Principal Investigator	Female
Marta Rivera Alba	Janelia Research Campus	US	Postdoctoral Researcher	Female
Benjamin Matthews	Rockefeller University	US	Postdoctoral Researcher	Male
Olivia Schwartz	Friedrich Miescher Institute	Switzerland	PhD student	Female
Sarah Carl	Friedrich Miescher Institute	Switzerland	Postdoctoral Researcher	Female
Georg Raiser	University of Konstanz	Germany	PhD student	Male
Thomas Laudes	University of Konstanz	Germany	Research assistant	Male
Jeremy Herren	ICIPE	Kenya	Principal Investigator	Male
Horst Schneider	DAQ-Solutions	Germany	Staff Scientist	Male

Teaching assitants

Name	Academic affiliation		Rank	
Mwichie Namumbasa	University of Zambia	Zambia	Lecturer	Female

Students acepted in the course

Name	Academic affiliation		Rank	
Sadiq Garba	University of Maiduguri	Nigeria	Head of Department	Male
Fiona Nelima	University of Pretoria	South Africa	PhD student	Female
Onesimus Mahadi	Gombe State University	Nigeria	Lecturer	Male
Ella Kasanga	Kwame Nkrumah University of Science and Technology	Ghana	MSc student	Female
Mustapha Shehu	Gombe State University	Nigeria	Lecturer	Male
Nyakurz Ndaro	Kampala International University	Tanzania	Lecturer	Female
Isa Sherif	Ahmadu Bello University	Nigeria	Lecturer	Male
Farmanga Jaka	University of Sierra Leone	Sierra Leone	Medical Student	Male
Metson Hamusokwe	University of Zambia	Zambia	Lecturer	Male
Theophilous Kure	Kampala International University	Tanzania	Lecturer	Male
Asha Lushino	Kampala International University	Tanzania	Lecturer	Female
Aidah Musoke	Kampala International University	Tanzania	Lecturer	Female
Imaam Tamimi	University of Sheffield	UK	BSc student	Female
Keneth Kasozi	Kampala International University	Uganda	Lecturer	Male

Students attended the course as observers

Name	Academic affiliation		Rank	
Manju Thomas	Kampala International University	Tanzania	Lecturer	Female
Neel	Kampala International University	Tanzania	Lecturer	Male
Ogah	Kampala International University	Tanzania	Lecturer	Male

Disbursment of Funds

Funds from ISN

Airplane tickets of faculty and organisers	**Original price**	**Price in US dollars**
Thomas Baden	700 Euro	784
Chris Elliot	451.63 GBP	636.66
Matthias Landgraf	797.49 GBP	1125.15
Horst Schnider	700 Euro	784
Tom Laudes	648 Euro	727
Mwichie Namumbasa	237 USD	237
Sarah Carl	1036 CHF	1066
Yunusa Garba	700 Euro	784
Acomodation for students: Shemsi Hotel		
1 double room (Keneth Kasozi and Farmanga Jaka) 23 nights 50K shillings /night	1'150'000 Tanzanian shillings	530
1 double room (Mustapha Shehu and Isa Sherif) 21 nights 50K shillings /night	1'050'000 Tanzanian shillings	484
1 single room (Metson Hamusokwe 23 nights 40K shillings / night	920'000 Tanzanian shillings	424
4 single rooms (Ella Kasanga, Fiona Nelima, Sadiq Garga) 21 nights, 40K shillings / night	3'360'000 Tanzanian shillings	1549
Acomodation for faculty: Mara Courtyard Hotel		
It excludes the nights paid by APS (detailed below)		
76 nights in total room rate 35 USD / night (total 141 nights of which 65 covered by APS)		2218
Other costs		
3 LED Torches	32.97 USD	32.97
4 Arduino boards	30.76 USD	30.76
Independent power units (for unexpected multiple power cuts)	1'200'000 Tanzanian Shillings	554
Final dinner ceremony to hand diplomas	125'000 Tanzanian Shillings	60
Coffee breaks, snacks, coffee, tea and milk	661'600 Tanzanian Shillings	305
Ground transportation	386'125 Tanzanian Shillings	178

Total covered by ISN **12509.54**

Funds from The Company of Biologists		
Plane tickets for the 9 International participants (Imaam Tamimi was local, as she is from Dar es Salaam, currently based in the UK, she covered her airfaire and stayed at her family house)	6000 GBP	**9110**
Funds from Janelia Farm		
Plane ticket of Marta Rivera Alba	1300 USD	1300
Backyard Brains amplifier kits	626 Euro	700
Total covered by Janelia Farm		**2000**
Funds from American Physiological Society		
Lucia Prieto plane ticket		1596.45
Chris Elliot plane ticket		685.48
Christen Mirth plane ticket		1266.84
Ben Mattews plane ticket		1286.8
Jeremy Herren plane ticket		442
Accomodation Lucia Prieto (24 nights X 35 US dollar/night)		840
Accomodation Ben Matthews (7 nights X 35 US dollar/night)		245
Accomodation Yunusa Garba (24 nights X 35 US dollar /night)		840
Accomodation Jeremy Herren (3 nights X 35 US dollar / night)		105
Accomodation Sarah Carl (7 nights X 35 US dollar / night)		245
Total covered by APS		**7552.57**
Funds from FMI, Basel		
Olivia Schwarz's plane ticket	995 CHF	1024
Funds from Kampala International University		
Lunch for all participants every day	price not known	
Lecture and laboratory space at no cost	price not known	
Funds from TReND in Africa		
Consumables for lab practicals (reaction enzymes, antibodies, etc..)	estimated 1500 USD	

5th TReND School on Insect Neuroscience and *Drosophila* neurogenetics

<u>17th August-Monday</u>
09:20- 09:45: Welcoming from Lucia
09:45- 10:00: Student introductions
10:00- 10:30: Introduction to insects as model organisms (Tom)
10:30- 11:00: Coffee break
11:00- 12:00: Introduction to *Drosophila* as a model organism (Sarah)
12:00- 12:30: Introduction to Twitter and social media (Sarah)
12:30- 14:00: Lunch

14:00- 19:30:
Lab practicals. Lab practicals on *Drosophila* as a model organism and bioinformatics tools (Lucia/Sarah). Building electrophysiology amplifiers and EMG recordings (Tom/Horst/) (2 separate groups)

<u>18th August- Tuesday</u>
9:00-10:00: Gene cloning technology (Sarah)
10:00-11:00: Introduction to the physics of neural signals (Horst)
11:00-11:20: Coffee break
11:20-12:30: Introduction to neurophysiology (Tom)

14:20-19:20 p.m.
Lab practicals. Lab practicals on *Drosophila* as a model organism and bioinformatics tools (Lucia/Sarah). Building electrophysiology amplifiers and EMG recordings (Tom/Horst/) (2 separate groups)

<u>19th August- Wednesday</u>
9:00-10:00: Principles of biological membrane excitability (Horst)
10:00-11:00: Genetics of *Drosophila* I (Sarah)
11:00-11:20: Coffee break
11:20- 12:20: The functional organisation of the nervous system (Tom)

14:00-19:00 p.m.
Lab practicals. Lab practicals on *Drosophila* as a model organism and bioinformatics tools (Lucia/Sarah). Building electrophysiology amplifiers and EMG recordings (Tom/Horst/) (2 separate groups)

20th August- Thursday
9:00-10:00: Electrophysiological recording techniques (Horst)
10:00- 11:00: Genetics of *Drosophila* II (Sarah)
11:00-11:20: Coffee break
11:20- 12:30: Genetic tools in *Drosophila* for studying the nervous system (Lucia)

14:00-19:00 p.m.
Lab practicals. Lab practicals on *Drosophila* as a model organism and bioinformatics tools (Lucia/Sarah). Building electrophysiology amplifiers and EMG recordings (Tom/Horst/) (2 separate groups)

21st August- Friday
9:00-10:00: Introduction to the scientific method and statistics (Sarah)
10:00- 11:00: Insect endosymbiotic bacteria; from basic science to practical applications (Jeremy)
11:00-11:40: Coffee break and round questions with Jeremy
11:40- 12:30: Online resources: Pubmed, Flybase, Bloomington, etc… (Sarah)

13:30-19:00 p.m.
Lab practicals. Lab practicals on *Drosophila* as a model organism and bioinformatics tools (Lucia/Sarah). Building electrophysiology amplifiers and EMG recordings (Tom/Horst/) (2 separate groups)

24th August- Monday
9:00-10:00 : Evolution and environmental control of body size and foraging behaviour in Drosophila larva (*Marta / Christen)*
10:00-11:00 : Taste in Drosophila (Olivia)
11:00-11:20: coffee break
11:20-12:20: Function and Development of Motor and Mechanosensory systems. (Matthias)

14:00-19:30 p.m
Module specific laboratory practicals. This week students choose one of the following:

1- Evolution and environmental control of body size and foraging behaviour in Drosophila larva (Marta and Christen*)*
2- Taste in Drosophla (Olivia)
3- Function and Development of Motor and Mechanosensory systems (Matthias)

25th August-Tuesday
9:00 -10:00: Taste in Drosophila (Olivia)
10:00 -11:00 : Evolution and environmental control of body size and foraging behaviour in Drosophila larva (Marta / Christen)
11:00-11:20: coffee break
11:20-12:20: Function and Development of Motor and Mechanosensory systems. (Matthias)

14:00-19:30 p.m
Module specific laboratory practicals

26th August-Wednesday

9:00-10:00: Evolution and environmental control of body size and foraging behaviour in Drosophila larva (*Marta / Christen)*
10:00-11:00: Function and Development of Motor and Mechanosensory systems. (Matthias)
11:00-11:20: coffee break
11:20-12:20: Taste in Drosophila (Olivia)

13:30-19:00:
Module specific laboratory practicals

27th August-Thursday
9:00-10: 00: Function and Development of Motor and Mechanosensory systems. (Matthias)

10:00-11:00: Taste in Drosophila (Olivia)
11-11:20: coffee break
11:20-12:20: Evolution and environmental control of body size and foraging behaviour in Drosophila larva (*Marta / Christen)*

13:30-19:00 p.m.
Module specific laboratory practicals

28th August-Friday
9:00-10:00: Taste in Drosophila (Olivia)
10-11: Function and Development of Motor and Mechanosensory systems. (Matthias)
11:00-11:20: coffee break
11:20-12:20: Evolution and environmental control of body size and foraging behaviour in Drosophila larva (*Marta / Christen)*

13:30-19:00 p.m.
Module specific laboratory practicals/ Preparation of presentations

29th August- Saturday
9:00- 13:00: Students presentations of practical projects

31st August-Monday
9:00-10:00: Introduction to Chemosensory systems (Lucia)
10:00-11:00: *Drosophila* as a model for human diseases (Chris)
11:00-11:20: coffee break
11:20-12:20: Processing of olfactory information (Tom / Georg)

13:30-19:00 p.m.
Module specific laboratory practicals. This week students choose one of the following:

1- Processing of olfactory information in D.melanogaster (Tom and Georg)
2- *Drosophila* as a model for human diseases (Chris)
3- CRISPR-Cas9 technology for studying olfaction in mosquitoes and Drosophila (Lucia and Ben)

1st September-Tuesday
9:00-10:00: *Drosophila* as a model for human diseases (Chris)
10:00-11: 00: Evolution of chemosensory systems (Lucia)
11:00 -11:20: coffee break

11:20-12:20: Processing of olfactory information (Tom / Georg)

13:30-19:00 p.m.
Module specific laboratory practicals

2nd September-Wednesday
9:00-10:00: Chemosensory system research in mosquitoes (Ben)
10:00-11: 00: Processing of olfactory information (Tom / Georg)
11:00-11:20: coffee break
11:20-12:20: *Drosophila* as a model for human diseases (Chris)

13:30-19:00 p.m.
Module specific laboratory practicals

3rd September-Thursday
9:00-10:00: Processing of olfactory information (Tom and Georg)
10:00-11:00 Chemosensory system research in mosquitoes (Ben)
11-11:20: coffee break
11:20-12:20: *Drosophila* as a model for human diseases (Chris)

13:30-19:00 p.m.
Module specific laboratory practicals/ Preparation of presentations

29th September-Friday
9:00-10:00 : Processing of olfactory information (Tom and Georg)
10:00-11:00 Chemosensory system research in mosquitoes (Ben)
11-11:20: coffee break
11:20-12:20: *Drosophila* as a model for human diseases (Chris)

13:30-18:30 p.m.
Module specific laboratory practicals/ Preparation of presentations

18:30- 20:00: Students presentations
20:00- 02:00: Goodbye diner and party!

Organizers

Dr. Lucia Prieto Godino (CIG, University of Lausanne, Switzerland)

Dr. Tom Baden (CIN/BCCN, Tübingen, Germany)

Prof. Sadiq Yusuf (Kampala International University , Uganda)

Teaching assistants

Yunusa Garba (Gombe State University, Nigeria)

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Faculty

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Dr. Chris Elliot (University of York, UK)

Dr. Lucia Prieto Godino (CIG, University of Lausanne, Switzerland)

Dr. Horst Schneider (DAQ-Solutions, Nehren, Germany)

Olivia Schwarz (FIM, Switzerland)

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Dr. Sarah Carl (FMI, Switzerland)

Dr. Ben Matthiews (Rockefeller University, USA)

Dr. Tom Laudes (University of Konstanz, Germany)

Dr. Georg Raiser (University of Konstanz, Germany)

STUDENTS 2015

Imaan Tamimi
Imaan
Tanzania / UK

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Fiona
South Africa / Kenya

Garba Uthman Sadiq
Sadiq
Nigeria

Faramanga Jaka Ngobeh
Faramanga
Sierra Leone

Aidah Kiiza Musoke
Aidah
Tanzania / Uganda

Mustapha S Muhammad
Mustapha
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G Theophilus Kureh
Theo
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Isa Ahmed-Sherif
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Keneth Iceland Kasozi
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5th TReND/ISN School on Insect Neuroscience and *Drosophila* Neurogenetics

Kampala International University (KIU)
Dar es Salaam campus, Tanzania

17. August – 5. September 2015

ISN
International Society for Neurochemistry

ORGANISERS

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Marta Rivera Alba (Instituto Gulbenkian de Ciencia, Portugal)
Horst Schneider (DAQ Solutions, Nehren, Germany)
Olivia Schwartz (FMI Basel, Switzerland)
Sadiq Yusuf (KIU, Bushenyi, Uganda)

TEACHING ASSISTANTS

Yunusa M Garba (Gombe State University, Nigeria)
Mwichie Nambusamba (University of Zambia, Zambia)

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Besigye Rowland
Michael Owiru
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Tom Baden

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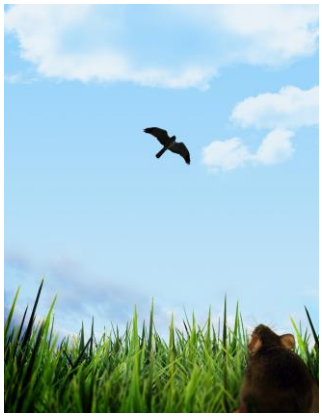
Sensory computations in neuronal microcircuits

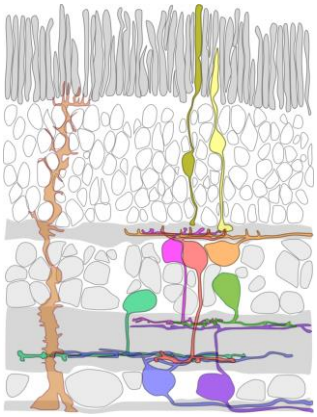
Tom studies how individual and small groups of neurons arranged into microcircuits break sensory patterns into parallel, highly specific representations of the outside world. Following his PhD on auditory processing by neurons of the cricket auditory pathway (lab of B. Hedwig, Dept. Zoology, Cambridge, UK) he studied visual processing by retinal bipolar cells in fish (lab of L. Lagnado, MRC-LMB, Cambridge, UK). His current research focuses on visual processing in the mice, with special focus on the principal neurons of the retina's vertical pathway: Photoreceptors, bipolar cells and retinal ganglion cells. He uses a combination of 2-photon imaging of synthetic and genetically encoded calcium biosensors and patterned light stimulation to probe the visual processing of individual and networks of neurons in the isolated retina.

Selected publications:

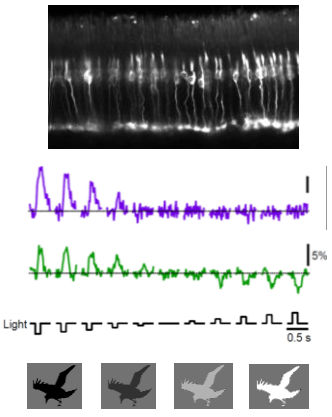
Baden et al. 2011,13 Curr. Biol; Baden, Schubert et al. 2013 Neuron.
Baden, Nikolaev et al. 2014 PloS Biol., Baden et al. 2015 PLoS Biol.

Mouse dorsal & ventral cone-photoreceptors differentially encode contrast – a trick to better spot birds?





Schematic by T Euler



Baden, Schubert 2013, Neuron

Sarah Carl

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4058 Basel
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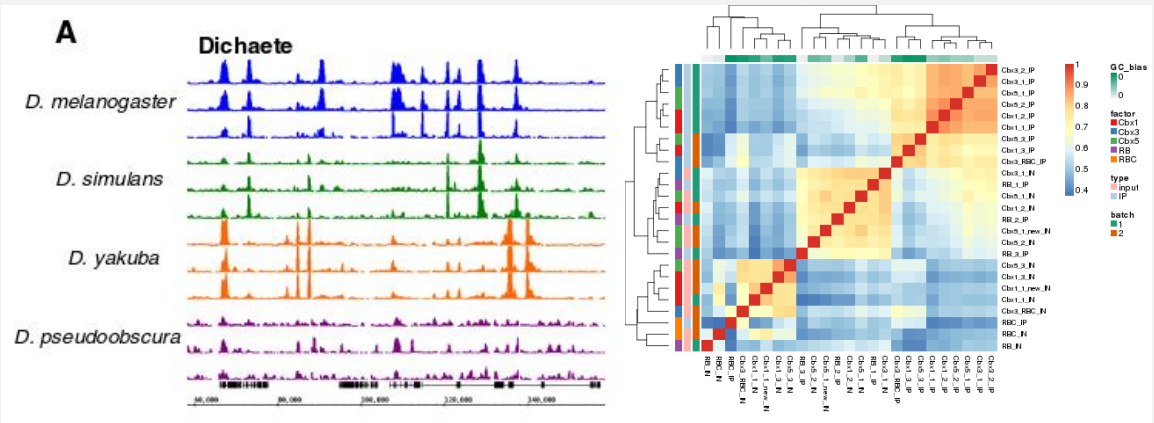
Transcription factors, epigenetics and gene regulation

Sarah obtained her B.A. from the University of Chicago, where she completed an honors thesis working on creating a Drosophila model for human neonatal diabetes in the lab of Martin Kreitman. Afterwards, she moved to the UK to do a 4-year Wellcome Trust Ph.D. programme in developmental biology at the University of Cambridge. She worked with Heliconius butterflies, Aedes mosquitos and Tribolium beetles during lab rotations for her M.Phil., but eventually came back to Drosophila, joining Steve Russell's lab for her Ph.D. There she was introduced to the world of genomics, studying comparative Sox transcription factor binding in four Drosophila species.

She is currently a post-doctoral fellow with the computational biology group at the FMI in Basel, where she collaborates with the labs of Helge Grosshans and Marc Buehler to study the roles of micro-RNAs and chromatin structure in gene regulation using a variety of genomic techniques. At the moment she works primarily with mice, yeast and C. elegans, but she still misses flies!

Key publications:

SY Park et al. (2014) Genetics; S Carl and Russell, SR (2015) BMC Genomics



Chris Elliot

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York, YO1 5DD
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Parkinson‘s disease

My current research focuses on the physiology of fly models of Parkinson’s disease. My background is in the integrative action of amines in the nervous system, e.g. of octopamine in the snail feeding system, Despite the small size of the fruitfly, I have developed novel physiological techniques, to measure oviduct contraction, the force developed when a fly jumps, the strength and frequency of larval contractions, and the visual response. I have applied these to the parkin and LRRK2-G2019S models of PD, showing key neuronal deficits as a result of the high demand for energy in the CNS. The G2019S defects can be rescued by inhibitors targeted at the kinase of LRRK2 and by the drug UDCA (licensed for liver disease).

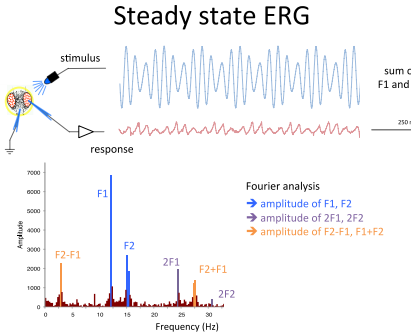
Key publications:

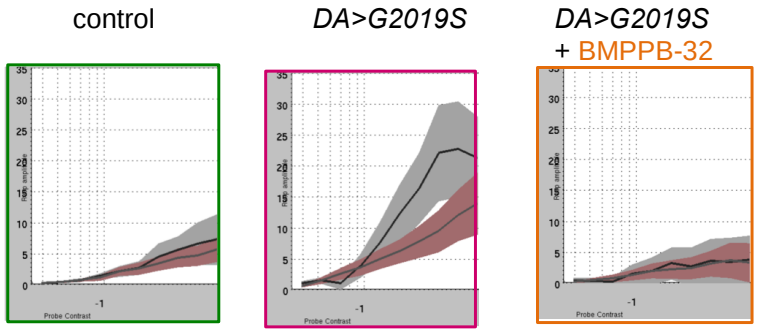
Afsari, F., Christensen, K.V., Smith, G.P., Hentzer, M., Nippe, O.M., Elliott, C.J.H. and Wade, A.R. (2014) Abnormal visual gain control in a Parkinson's Disease model Hum. Mol. Genetics 23 (17): 4465-4478. http://dx.doi.org/10.1093/hmg/ddu159

Wade, A.R. and Elliott, C.J.H. (2014) Could the detection of visual disturbances associated with Parkinson’s disease genes in flies lead to new treatments for the disease? Neurodegenerative Disease Management 4:291-293 http://www.futuremedicine.com/doi/full/10.2217/nmt.14.30

SSVEP technique

Output from SSVEP analysis of fly vision showing *in vivo* rescue of the hyperactivity by the kinase inhibitor BMPPB-32, specific to LRRK2





Jeremy Herren

Emerging Infections Disease Laboratory
International Centre for Insect Physiology and Ecology
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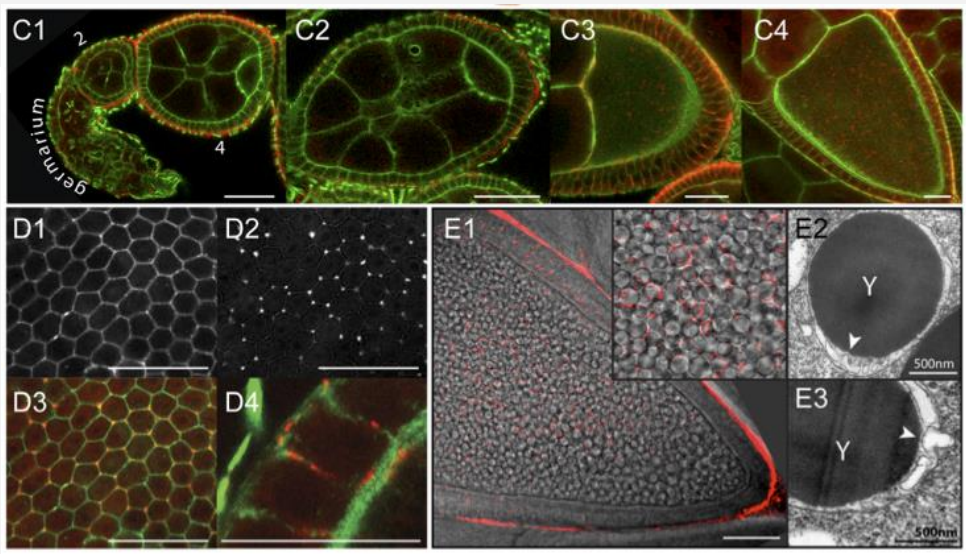
Interactions between vector insects and endosymbiotic bacteria

Jeremy Herren's research focus is the interaction between maternally transmitted endosymbiontic bacteria and their insect hosts. He carried out his PhD in the Lemaitre Lab (Drosophila immunity), where he utilized the powerful genetic tools available in Drosophila research to identify factors involved in endosymbiont transmission and regulation of proliferation. While in the Lemaitre lab, he developed the Drosophila-Spiroplasma system as a model endosymbiosis. After continuing Drosophila-Spiroplasma research for a short post-doc in Switzerland, he received funding from the Swiss National Science Foundation and the R. Geigy Foundation to move to the International Centre for Insect Physiology and Ecology (icipe) in Nairobi, Kenya to establish an independent line of research focused on the interactions between endosymbionts and disease vectors (see www.spirovector.is). His current research goals are centered on gaining a better understanding insect endosymbioses on a mechanistic and physiological level and exploring their potential use as a means to control insect-vector borne diseases.

Key publication:
Herren and Lemaitre, Cellular Microbiology, 2011; Herren et. al., mBio, 2013; Herren et. al., eLife 2014



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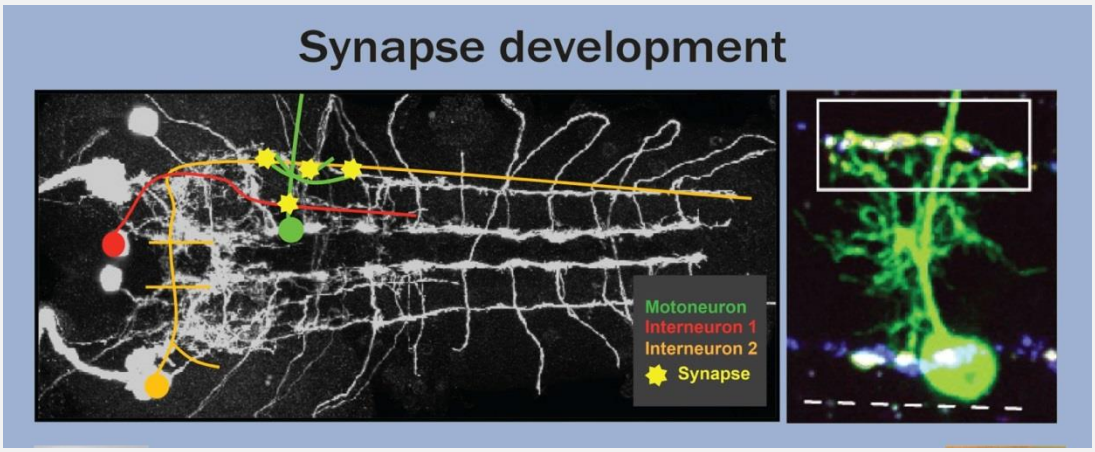
http://www.zoo.cam.ac.uk/directory/dr-matthias-landgraf

I am interested in understanding how locomotor networks are specified and assembled. Working with the locomotor network of the *Drosophila* embryo and larva as a model we developed genetic tools to access identified sets of connecting nerve cells.

Connectivity: We discovered that the motor system has a straightforward organisational logic: motor neurons position their dendrites so that these form a neural map of the body wall musculature. Using serial transmission electron microscope reconstructions we are reconstructing the locomotor network. Experimentally, we are studying how these connections form in the CNS.

Adjustment of connections – reactive oxygen species and homeostasis: We previously discovered that neurons respond to changes in activity by adjusting their synaptic terminals, called 'structural homeostasis'. We have now discovered a novel mechanism by which neurons use Reactive Oxygen Species (ROS) as a proxy for measuring their activity levels. ROS are by-products of mitochondrial ATP production, until now associated with ageing and neurodegenerative conditions. We are investigating the signalling pathways associated with ROS-mediated synapse regulation.

Publication: Zwart, M. F. Randlett, O., Evers, J. F. and Landgraf, M. (2013). Dendritic growth gated by a steroid hormone receptor underlies increases in activity in the developing Drosophila locomotor system. *PNAS*; 110(40):E3878-87.



Tom Laudes

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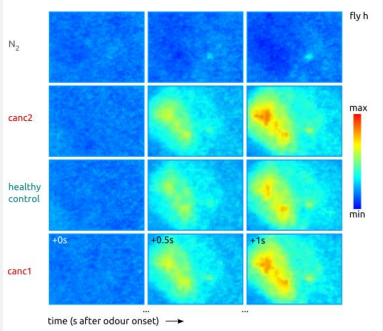
More than apples and oranges

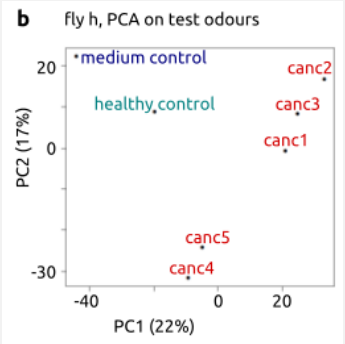
Tom studied Biology and Neurobiology in Tübingen and Magdeburg, respectively. For his diploma thesis he inverstigatet the role of the neurotrophin BDNF in the thalamocortical network in mice. Using patch-clamp technique in whole cell mode he was able to show that synaptic transmission in the thalamus of mice was modulated by a reduction of BDNF.
In 2011 he moved to University of Konstanz to both study Mathematics and work with Prof. Dr. Giovanni Galizia and Dr. Daniel Muench. Using calcium imaging they explore the presentation of different odors on the antennae of *Drosophila melanogaster.* The main goal ist to understand how mixtures and different temporal dynamics of odors are detected by olfactory receptor neurons. For a nice database please check: neuro.uni-konstanz.de/DoOR.
In 2014 they could even show that *Drosophila melanogaster* is able to distinguish between the smell of human cancer cells and healthy cells.

Key publications:

1) More than apples and oranges–Detecting cancer with a fruit fly's antenna; Scientific Reports 2014
2) Impaired transmission at corticothalamic excitatory inputs and intrathalamic GABAergic synapses in the ventrobasal thalamus of heterozygous BDNF knockout mice; Neuroscience 2012

Cancer odours exhibited a spatially broader and higher amplitude response than healthy control





Ben Matthews

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bmatthews@rockefeller.edu

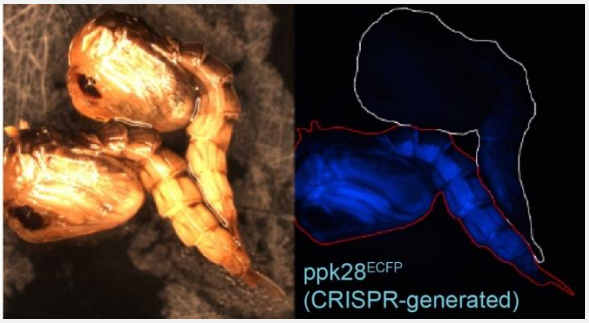
Genome engineering and chemosensation in mosquitoes

I am broadly interested in how genes and neural circuits regulate insect behavior, and in particular, in applying genetic and behavioral analyses to the study of disease vectors and agricultural pests. I obtained my Ph.D. in 2010 with Wes Grueber at Columbia University, studying the role of the alternatively spliced Ig-superfamily molecule Dscam1 in dendrite self-avoidance in *Drosophila melanogaster* larvae. I am currently investigating the genetics and neurobiology of egg-laying preference in the mosquito *Aedes aegypti* with Leslie Vosshall at Rockefeller University. Understanding how female mosquitoes evaluate and select egg-laying substrates will provide molecular targets for population control strategies of this deadly arboviral vector and insights into the regulation of innate behaviors by internal state and environment.

I currently develop and utilize methods for tracking multiple insects during behaviors such as free-flight, host-seeking, and egg-laying. To investigate the molecular basis of these behaviors, we use transcripome profiling of sensory tissues and genome editing with CRISPR-Cas9 to generate and study mutations in mechano- and chemo-receptors that are candidate sensors of osmolarity and other mosquito egg-laying cues. The development of genome engineering tools will allow for the study of behavior in non-traditional model organisms with important implications for public health and basic sciences.

***Aedes aegypti* mosquito**

***Aedes aegypti* pupae: wild-type and mutant**



Christen Mirth

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Oeiras, Portugal

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The Development and Evolution of Environmentally-Sensitive Traits

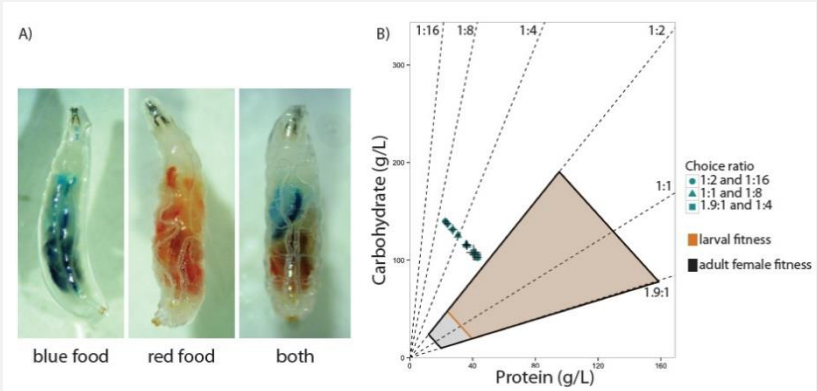
Organisms in the wild live in highly variable and unpredictable environments, environments that interfere with and affect their development and behaviour. This variation in habitat forces developing organisms to make decisions about what to eat, where to live, and with whom to associate. Further, plasticity in foraging choice forms a template on which evolution can act to generate diversity in foraging preferences. Our studies focus on the regulation and evolution of body/organ size and foraging behaviour in species from the genus *Drosophila*.

We use the genetic tools available in *Drosophila melanogaster* to dissect how environmental signals, like nutrition, regulate body size, developmental timing and foraging choices. Further, we explore how manipulating the combination of macronutrients in the diet alters these characters. By analyzing the changes in optimal macronutrient space and foraging behaviour across species, we hope to identify how species-specific differences in foraging behaviour and adult body size evolves.

Key publications:

Mirth CK, Shingleton AW. (2012) Frontiers in Experimental Endocrinology; Mirth CK, Truman JW, Riddiford LM. (2009) Development; Mirth CK, Truman JW, Riddiford LM. (2005) Current Biology.

Larvae choose foods that do not produce optimal larval or adult fitness



Larval food choice does not correspond to the optimal nutrient combination for larval fitness. Larvae were offereda choice between foods containing two different protein to carbohydrate ratios (1:2 and 1:16, 1:1 and 1:8, and 1.9:1 and 1:4). The foods were dyed either red or blue, and larval choice was monitored by assessing the food content in the guts (A) by spectrophotometer. B) shows the larval food choice (in teal) plotted against the nutritional optima for larval fitness (survival x body size x 1/development time) or for adult fitness (survival x ovariole number). Error bars are 95% confidence intervals. The dashed lines denote the different protein to carbohydrate ratios.

Lucia Prieto Godino

Center for Integrative Genomics
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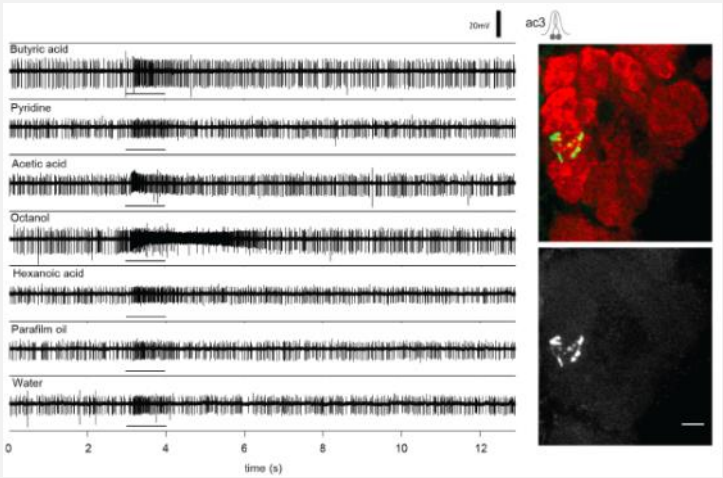
Evolution of Olfactory Pathways

Lucia obtained her B.A. from the Universidad Autonoma de Madrid, where she did her research thesis on olfactory processing in flies in the lab of Gonzalo Garcia de Polavieja. After a summer working on vision evolution in box jellyfish in the lab of Dan Nilsson at Lund University, she joined Michael Bate's group at the University of Cambridge for her PhD. During her PhD she studied the embryonic development of the *Drosophila* olfactory system, receiving her PhD in 2011. She was awarded a FEBS long-term post-doctoral fellowship to join the lab of Richard Benton in CIG, Lausanne in March 2012 where she is studying the evolution of olfactory pathways using species of *Drosophilids*.

Key publications:

Prieto-Godino et al. 2012, PLoS Biol; Prieto-Godino & dePolavieja 2010, PLoS ONE, Prieto-Godino* et al. 2011, Adv Educ Physiol.

Recordings and backfilling of AC3 sensillum in *D.Sechellia*



Georg Raiser

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Department of Neuroscience
Lab Prof. C. Giovanni Galizia
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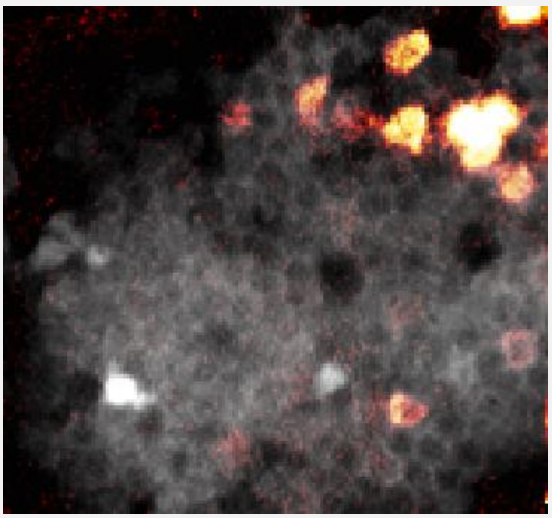
I am studying the processing of olfactory stimuli in insect brains. Mainly, I am interested in the representation of temporally complex odor mixtures, simulating realistic odor stimuli how they would appear in the real world. To do this, I use mainly calcium imaging to record the activity of the individual cell types in the olfactory system of *Drosophila melanogaster*: Olfactory receptor neurons, Projection neurons and Kenyon cells of the Mushroom body. Additionally, I am performing electrophysiological recordings in the honey bee *Apis mellifera*.

For my PhD, I joined the Max-Planck graduate research school for Organismal Biology when I joined Giovanni Galizias lab in Konstanz. Before that, I studied biology at the Georg-August University of Göttingen, where I did my diploma studies on the mechanosensory bristles of *Drosophila melanogaster.*

Calcium imaging of *Drosophila melanogaster* Kenyon Cells in response to odor stimulating



Marta Rivera-Alba

Branson Lab
Janelia Farm Research Campus, HHMI
19700, Helix Drive, Ashburn, VA. USA

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Evolution and Development of Behavior

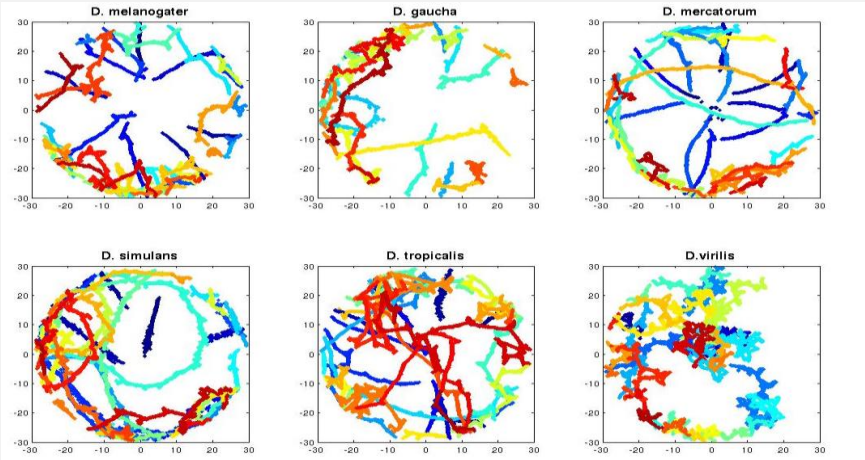
I completed a 5-years Bachelor Degree (2001-2006) on Physics in Madrid (Spain). Right after, I did a Masters in Biophysics (2007) and a PhD also in Biophysics (2011) between Gonzalo G de Polavieja lab in Spain and Dmitri Chklovskii lab at JFRC (HHMI) in USA. At the beginning of 2012 I joined Christen's Mirth Lab at IGC, Portugal as a Postdoctoral Researcher. In parallel to my research on June 2013 I finished a Masters on Science Education at The National Distance Education University (UNED, Spain). On July 2013 I joined Kristin Branson Lab in JFRC (HHMI), USA, also as a Postdoctoral Researcher.

I am interested in the evolution and development of foraging behavior in Drosophilids. Due to my background my approach is multidisciplinary, I combine biological, mathematical and computational techniques to generate and analyze large data sets.

Currently, I am studying foraging behavior by automatically analyzing a large video collection of foraging larvae from 47 different species at 2 developmental stages. For that, in collaboration with Kristin Branson we developed automatic image analysis techniques like tracking (see image) or automatic behavior annotation (see reference) and original mathematical models. Also I am modeling nutrient-dependent larval growth in collaboration with Christen Mirth and Maria Carvalho.

Key publication:

JAABA: Interactive machine learning for automatic annotation of animal behavior. Kabra, M., Robie, A. A., Rivera-Alba, M., Branson, S. and Branson K. Nature Methods 10:64-67 (2013)



Horst Schneider

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horstkschneider@gmx.de

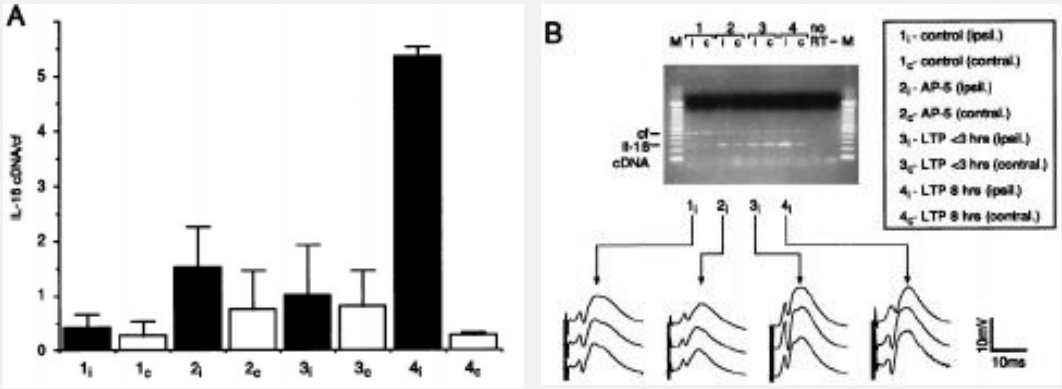
Pharmacological and electrical stimulation of neural activity

I obtained my PhD in Neurophysiology in 1993 at the University of Gießen (Germany) and the Max-Planck-Institute of Brain Research in Frankfurt (Germany), investigating ON Bipolar cells in slices of the rat retina using electrophysiological techniques (Patch-clamp). I then moved to the Institute of Physiology, University of Marburg and worked on the question how signal substances of the immune system affect neuronal functions in the healthy brain. This research was done by investigating the effect of Interleukins on Long-Term-Potentiation (LTP) in the Hippocampus of freely moving rats and hippocampal slices using extracellular- and intracellular recording techniques. Since then I've worked in various labs on how the function of neurons in vertebrate brain are modulated by pharmacological and electrical stimuli. About three years ago I have left University and now work as a Research and Development Manager for a company (DAQ-Solutions, Nehren, Germany).

Key publications:

Schneider et al. (1998) PNAS; Boos et al. (1993) J Neurosci

Interleukin-1b gene expression during LTP *in vivo.*



Olivia Schwarz

Friedrich Miescher Institute for Biomedical Research
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Switzerland

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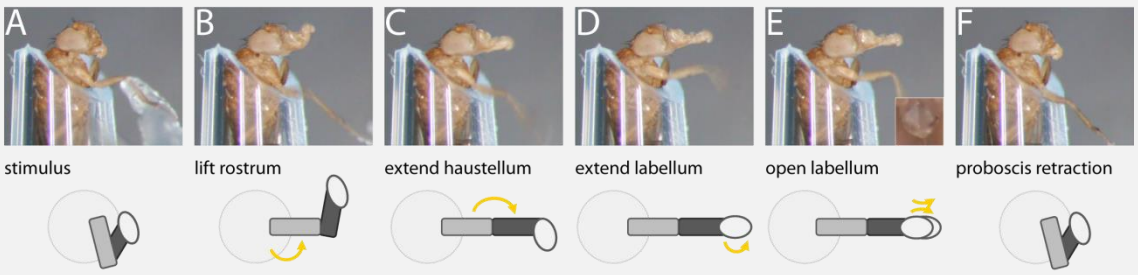
Identification of the Taste Circuitry

I studied Biochemistry at the Swiss Federal Institute of Technology (ETH) in Zurich where I also did a Masters Degree in Neuroscience. I performed my research thesis in the lab of Martin Schwab focusing on spinal cord regeneration in mice. At the end of 2011 I started my PhD at the Friedrich Miescher Institute for Biomedical Research in Basel in the lab of Jan Pielage where I am interested in the adult taste circuitry of *Drosophila*.

The sense of taste is essential for the survival of most animals as it enables the discrimination between nutritious and harmful substances prior to ingestion. We are using the gustatory system as a model to study the principles underlying the development and function of a simple sensory-motor circuit. In adult Drosophila, attractive and aversive substances are detected by gustatory sensory neurons that relay taste information to the primary gustatory center, the subesophageal ganglion (SEG). Sweet stimuli evoke a robust and highly stereotypic motor behavior, the extension of the proboscis towards the food source.
My aim is to identify and characterize motoneurons and upstream regulatory interneurons that are necessary and sufficient for the execution of the motor program. The combination of opto- and thermogenetic tools with classical genetic approaches will allow us to unravel the principles underlying information processing, integration and computation of the taste circuitry.

The Proboscis Extension Response



Sadiq Yusuf

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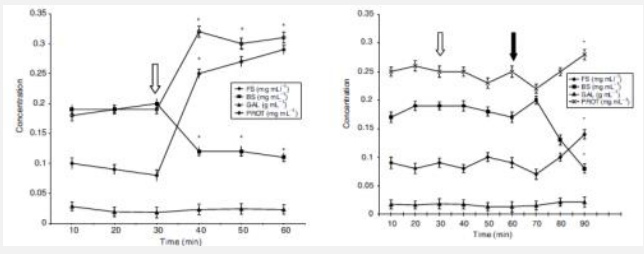
Iron deficiency and memory

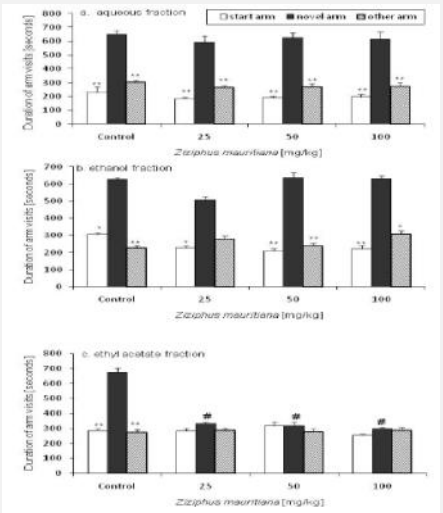
Sadiq obtained his PhD in Physiology with a special focus on Gastroenterology from Ahmadu Bello University of Zaria in Nigeria, his research focused on elucidating the neural mechanism involved in gastric mucosa protection. He is now a professor and the head of the Faculty of Health Sciences and he teaches Physiology to medical Students at Kampala International University, Uganda.

The focus of his current research is to elucidate role of dietary iron in modulating the activity of neural networks during the process of learning and memory and to identify dietary precursors that can improve cognition or memory. This involves studying cellular mechanisms underlying functional configuration of neuronal networks and the mechanisms that are involved in the regulation of communication between cells e.g. by what extracellular information is the communication between neurons cells regulated, and by what mediators is it communicated in the cells.

Key publications:

Yusuf et al. (2009) J Nat Products; Yusuf et al. (2009) Med Plant Res; Yusuf et al. (2008) Afr J Biotech., Yusuf et al. (2013) Met Brain Disease





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SUPPORT

Special thanks to:

Thomas Euler, Leon Lagnado, Richard Benton, Axel Borst, Stefan Pulver, Matthias Gerbering, Christine v Hertzberg, Jim Hasseloff, Stefan Pulver, Christopher Zaugg, Martine Trevisan, Christian Frankhausen, Katharina Anton-Erxleben, Wael Mohammed, Abdul Mohammed, Mike Bate, Patrick Meyer, Peter Parslow, Greg Gage, Timoty Marzullo, Janis Weeks, Giovanna Vinti, Kevin Rainey, Frances Jones, Pauline Essah, David Dunne, Jacqueline Dreyer, Kristin Branson, Christian Liebig; Jimena Berni, Arne Seitz, Giovanni Galizia, Isa Peset Martin, Fabiana Arieti, Marie Pertin, Jorge Castillo Quan, SDV Geis Suisse,

and many more...

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Aims and scope

To introduce the use of insects as powerful yet inexpensive model systems in neuroscientific research. With their comparatively simple nervous systems, tractable genetic access and low maintenance costs, *Drosophila* and other insects have rapidly consolidated their status as key model systems in scientific research. We will explore questions on basic research in neuroscience as well as research with important applications, such as mosquito genetics or how Drosophila can be used as a model for human diseases. For example, combining the knowledge we have on *Drosophila* neurogenetics with research in mosquito biology is a powerful strategy to understand the molecular and neural basis of their devastating host seeking behaviour, and how this can help to design knowledge-driven strategies to control it. This course aims to introduce key concepts in insect genetics and neuroscience to scientists at African institutions to promote the use of such model systems in their research. Subjects covered will range from lab maintenance and grant writing to state of the art neurogenetics, behavioural and electrophysiological research techniques.

Who should apply?

- All African scientists: Master students, PhD students, Postdoctoral Fellows, Group Leaders and Heads of Department
- The course is intensive, running 6 days a week from 9am in the morning to 8pm in the evening, and requires strong involvement, motivation and drive to learn from the students.
- Only applicants from African Institutions will be accepted
- Students will be selected on the basis of their academic record and written statements concerning their interest in neuroscience and how they expect to benefit from participating in the course
- There will be no attendance fee.
- There will be a number of grants for students coming from outside Dar es Salaam. The grants will cover round plane ticket from a major international airport and accommodation.

Program and faculty of the course

The course will be divided in three (3) weeks. The first week will be a general theoretical and practical introduction to the field. The second and third weeks will consist of theoretical lectures common to all students and a series of alternative practical modules. Students will choose one out of three practical modules running in parallel each week.

Organisers

Dr. Laura Lucia Prieto Godino (CIG, Lausanne, Switzerland)
Dr. Tom Baden (CIN/BCCN, Tübingen, Germany)
Yunusa M Garba (Gombe State University, Nigeria)
Prof. Sadiq Yusuf (KIU, Bushenyi, Uganda)