



**Dr Marc Holderied**  
**Ph.D.(Erlangen)**

Reader in Biological Sciences

**Area of research**

Behavioural Acoustics and Sensory Ecology

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**Summary**

Topics I am interested in:

- Acoustic camouflage in invertebrates
- Biosonar: adaptive signal design and echo evolution
- Bat flight and sonar-based navigation
- Spatiotemporal use of natural habitats by bats (studied using 3D laser scanning)
- Bioinspired sonar-based movement strategies for robotics
- Bioacoustics in arthropods, amphibians, birds, primates, bats and other mammals
- Flower detection by biosonar in nectar-feeding bats
- Biosonar predator-prey arms races
- Primate bioacoustics, ecology and conservation

**[First imagery from echolocation reveals new signals for hunting bats](#)**

The ability of some bats to spot motionless prey in the dark has baffled experts until now. By creating the first visual images from echolocation using innovative Acoustic Tomography, we reveal that their easiest way to find insects on substrates is by the echo shadow the moths cast on the substrate. By resting on structured surfaces, which do not provide a coherent echo shadow, moths can employ a form of acoustic camouflage against detection by echolocating bats.

*[‘Acoustic shadows help gleanng bats find prey, but may be defeated by prey acoustic camouflage on rough surfaces’](#) by Clare and Holderied in eLife [Open Access].*

**[Bats obey ‘traffic rules’ when trawling for food](#)**

“Collective movements of flocking birds or shoaling fish are amongst the most fascinating natural phenomena, and everyone has experienced the challenges of walking through a moving crowd. What information individuals use for movement coordination is, however, very difficult to know – except in the case of echolocating bats.”

These flying mammals perceive their surroundings by emitting loud and high-pitched biosonar calls and listening for the returning echoes. Because bat biosonar imaging is much sparser in information than vision, Dr Holderied was able to accurately measure the biosonar calls of the interacting bats and then calculate what each of the individuals perceived.

The results indicated that bats obey their own intriguing set of ‘traffic rules’: they chase each other, perform tandem turns and even slow down to avoid collision: “The bats seem to have adopted a simple trick: once another individual is close enough for your biosonar to pick up its echo, copy this individual’s flight direction within four to five of your own wingbeats.”

'Delayed Response and Biosonar Perception Explain Movement Coordination in Trawling Bats' by Luca Giuggioli, Thomas J. McKetterick and Marc Holderied in *PLOS Computational Biology* (2015)

### **Sportive lemurs listen to other species to detect and avoid predators**

As part of her PhD research Dr Melanie Seiler studied the Sahamalaza sportive lemur in its natural habitat and found that it pays close attention to the vocalisations of other species in their habitat to detect and avoid predation by both terrestrial and airborne predators.

[Interspecific Semantic Alarm Call Recognition in the Solitary Sahamalaza Sportive Lemur, \*Lepilemur sa hamalazensis\*](#) Seiler, M., Schwitzer, C., Gamba, M. & Holderied, M. W. 25 Jun 2013 In : *PloS one*. 8, 6, 12 p.67397

### **A new *Boophis* tree frog from south-west Madagascar**

Masters by Research student Samuel Penny (Co-supervised by Dr C. Schwitzer at the BCSF) returned from his field work in Madagascar with a specimen of an unknown tree frog. This has turned out to be a new species. Sam has named it *Boophis ankarafensis* and he is currently preparing the species description for publication.

### **Bats and Acacia trees in deserts**

In a study published in [PLOS ONE](#), Dr Marc Holderied and colleagues from Bristol's [School of Biological Sciences](#) and [Ben-Gurion University of the Negev](#), Israel demonstrate the importance of dense acacia tree habitats for protected bats and their arthropod prey (for example, insects, spiders and scorpions) in comparison to other natural and artificial habitats.

'The importance of Acacia trees for insectivorous bats and arthropods in the Arava desert' by Talya D. Hackett, Carmi Korine and Marc W. Holderied in [PLOS ONE](#)

### **Stealth aerial-hawking in a specialised moth-catching bat**

Like a stealth fighter plane, the barbastelle bat uses a sneaky hunting strategy to catch its prey. A team of researchers from the University of Bristol combined three cutting-edge techniques to uncover the secret of this rare bat's success: whispering.

'An aerial-hawking bat uses stealth echolocation to counter moth hearing' by Holger R. Goerlitz, Hannah M. ter Hofstede, Matt R. K. Zeale, Gareth Jones, Marc W. Holderied *Current Biology*

### **Rainforest plant developed sonar dish to attract pollinating bats**

While it is well known that the bright colours of flowers serve to attract visually-guided pollinators such as bees and birds, little research has been done to see whether plants which rely on echolocating bats for pollination and seed dispersal have evolved analogous echo-acoustic signals. The researchers discovered that a rainforest vine, pollinated by bats, has evolved dish-shaped leaves with such conspicuous echoes that nectar-feeding bats can find its flowers twice as fast by echolocation.

'Floral acoustics: conspicuous echoes of a dish-shaped leaf attract bat pollinators' by Ralph Simon, Marc W. Holderied, Corinna U. Koch and Otto von Helversen in [Science](#).

## **Biography**

**University of Bristol**, School of Biological Sciences, UK

since August 2008 Senior Lecturer; since 2011 Senior Admissions tutor; since 2012 in charge of Recruitment

November 2006 – July 2008 Lecturer

March 2002-October 2003 Research Assistant with Prof. Gareth Jones, funded by BBSRC

**University of Erlangen**, Germany

2001-2002 and 2003–2006: Assistant Lecturer

1999-2001: Research Assistant

**University of Maryland**, College Park, MD, USA

December 2003-April 2004: Visiting Scientist at the lab of Prof. Cynthia Moss. Honours scholar in residence

## **Higher Education**

**Dr. rer. nat. *summa cum laude*, (maximum) 1997-2001 University of Erlangen**

- Implemented 3D acoustic tracking of animals in the field
- Studied bat flight and echolocation behaviour and sonar beam shape in the field

**Dipl. biol. degree: 1.0, (maximum) 1991-97 University of Erlangen**

- Developed and applied miniature earphones for grasshoppers
- Investigated grasshopper directional hearing using behavioural tests, laser vibrometry, electrophysiology and acoustic modelling

## Activities / Findings

### [First imagery from echolocation reveals new signals for hunting bats](#)

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### [Bats obey 'traffic rules' when trawling for food](#)

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## Teaching

### Level one

**BIOL12000** 'Sensory ecology' on including practical on analysis of animal sounds and acoustic identification of British bats (with popular voluntary field work) ranks 1<sup>st</sup> in student feedback in many categories

### Level two

**BIOL20009** Field course on the biology of bats either to the Negev desert in Israel or to Costa Ricas rainforests.

**BIOL20010** My most substantial teaching contribution continues to be 'Science & Success: Writing, Speaking and Communicating Science' on transferable skills, which has won me the University's 2011 e-learning award. Through role play, practicals and online peer collaboration students learn Scientific writing, Writing for the media, Presentation skills, Job hunting and Interview skills, Digital literacy, Career planning and the unit culminates in an evidence-based Personal development plan. The highly and ambitious complex unit is extremely popular with students, and to allow us to extend the range of acquired skills it has gone up from 10 to 20 credit points starting in 2013. Several departments and faculties have started to copy (elements of) this unit for their own transferable skills training.

### Level three

**BIOL31132** Since 2012 I teach the unit on 'Sensory ecology' shared with Profs Robert and Partridge, which was an instant success with student feedback being almost unanimous 5\* for being inspiring.

### Keywords

- Bioacoustics Acoustic camouflage Bat echolocation Plant-pollinator co-evolution Bat-insect interaction Primate ecology and conservation Movement ecology Bio-inspired robotics

### Methodologies

- Acoustic ultrasound 3D tomography of natural targets
- Acoustic flight path tracking of free-ranging bats
- Source levels of free ranging bats in flight
- 3D laser reconstruction of natural habitats
- Chirocopter - a flying drone to map natural soundscapes (Dr Vanderelst) Acoustics and ecology of bats
- primates
- elephants
- amphibians
- and insects Behavioural and electrophysiological audiograms of invertebrates

### Memberships

#### Organisations

[School of Biological Sciences](#)

#### Other sites

- [Neuroscience](#)

#### Research groups

- [Animal Behaviour and Sensory Biology](#)

#### Labs

- [Behavioural, Acoustic and Sensory Ecology \(BASE\) lab](#)

#### Links

-  [home page](#)

#### Recent publications

- Troxell, SA, Holderied, MW, Petersons, G & Voigt, CC, 2019, '[Nathusius' bats optimize long-distance migration by flying at maximum range speed](#)'. *Journal of Experimental Biology*, vol 222.
- O'Reilly, L, Agassiz, D, Neil, T & Holderied, M, 2019, '[Deaf moths employ acoustic Müllerian mimicry against bats using wingbeat-powered tymbals](#)'. *Scientific Reports*, vol 9.
- Holderied, MW, Thomas, LA & Korine, C, 2018, '[Ultrasound avoidance by flying antlions \(Myrmeleontidae\)](#)'. *Journal of Experimental Biology*, vol 221.

- Shen, Z, Neil, TR, Robert, D, Drinkwater, BW & Holderied, MW, 2018, '[Biomechanics of a moth scale at ultrasonic frequencies](#)'. *Proceedings of the National Academy of Sciences of the United States of America*, vol 115., pp. 12200-12205
- Georgiev, K, Balleri, A, Stove, A & Holderied, MW, 2018, '[Bio-inspired processing of radar target echoes](#)'. *IET Radar, Sonar and Navigation*, vol 12., pp. 1402-1409
- Mandl, I, Holderied, M & Schwitzer, C, 2018, '[The Effects of Climate Seasonality on Behavior and Sleeping Site Choice in Sahamalaza Sportive Lemurs, \*Lepilemur sahamalaza\*](#)'. *International Journal of Primatology*.
- Voigt, CC, Frick, WF, Holderied, MW, Holland, R, Kerth, G, Mello, MA, Plowright, RK, Swartz, S & Yovel, Y, 2017, '[Principles and patterns of bat movements: From aerodynamics to ecology](#)'. *Quarterly Review of Biology*, vol 92., pp. 267-287
- Penny, SG, Crottini, A, Andreone, F, Bellati, A, Rakotozafy, LM, Holderied, MW, Schwitzer, C & Rosa, GM, 2017, '[Combining old and new evidence to increase the known biodiversity value of the Sahamalaza Peninsula, Northwest Madagascar](#)'. *Contributions to Zoology*, vol 86., pp. 273-296
- Georgiev, K, Balleri, A, Stove, A & Holderied, M, 2017, '[Bio-inspired two target resolution at radio frequencies](#)'. in: *2017 IEEE Radar Conference, RadarConf 2017*. Institute of Electrical and Electronics Engineers (IEEE), pp. 436-440
- Hackett, TD, Holderied, MW & Korine, C, 2017, '[Echolocation call description of 15 species of Middle-Eastern desert dwelling insectivorous bats](#)'. *Bioacoustics*, vol 26., pp. 217-235

[View complete publications list](#) in the University of Bristol publications system