it became a flagship group for all of Europe. The Crafoord Prize was the icing on the cake. He spent all of the money associated with the latter on encouraging his favourite science.

Twenty years ago, I went on a joint field trip with Dolf Seilacher to the remote Oman desert. The idea was to investigate Cambrian trace fossils and link them — for once — to a real 'culprit', the trilobite species that made them. Seilacher was an experienced desert hand, as driving through dune country soon proved. His redoubtable and indispensable wife Edith was an even more exciting driver. Once on the rock outcrop, Dolf paced up and down like a terrier in search of a rat. When something attracted him he would study it intently uttering "hah huh!" or something similar, followed shortly by a confident and utterly convincing forensic explanation of the trace fossil in question, in English and German. As night fell, while smoking his trademark Groucho Marx cigar, he astonished by a comprehensive knowledge of the stars in the flawless heavens. In the morning I remarked him conversing with a local in fluent Arabic. The word 'omniscient' came to mind.

Justice could not be done to Seilacher without referring to one of his more extraordinary talents. He was a superb draughtsman. I believe he used drawing as a way of thinking through morphological or behavioural problems. The diagrams of organisms under construction or at work he created for his papers and his text-book have a uniquely convincing solidity, and a peculiar knack for making an apparently obscure point transparent. For this reason they were widely adopted in teaching throughout the paleontological world, and contributed in no small way to his reputation. Seilacher was convinced of the beauty of fossils as 'art objects' and sought to communicate that belief through a travelling exhibition, 'Fossil Art', which he curated in his later years, featuring a range of superb examples, including Ediacaran age fossils from Namibia. He would probably not have made the same artistic claims for his own work. But in the quality of his illustrations he was following a German tradition set by Ernst Haeckel, zoologist, polymath, artist and philosopher. It does not get better than that.

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Q & A

Marie Dacke

Marie Dacke is an Associate Professor of Sensory Biology in the Lund Vision Group at Lund University in Sweden, a position she has held since 2007. She studies the sensory basis of safe and directed movements, specifically those involved in celestial orientation and flight control. These issues allow her to work on animals as varied as zebrafish, spiders, dung beetles and bees. She is a member of the Young Academy of Sweden, competes in popular science presentation, hosts the University Biology Show and has recently received the IgNobel prize in Biology and Astronomy.

What inspired you to become a biologist? My favourite pet as a 10-year old child was a massive lope-eared rabbit, and one morning, to my despair, I found his outdoor cage completely empty and destroyed. This coincided with one of the rare times when a wolf had been spotted in southern Sweden, and the journalists gathered in our garden to tell the story about the girl that had lost her rabbit to the beast. Biologists from Lund University were called in to confirm that the large footprints in our strawberry patch were indeed from a wolf. I watched the scientists in action, measuring, discussing, making casts, discussing… and decided there and then that this was also what I wanted to do. Today, some of these biologists are now my colleagues. Was it the footprint of a wolf? No, in the end the rabbit hunter turned out to be no more than a very large farm-dog on the run.

Was the award of an IgNobel prize primarily an honor, or did it in some way ridicule your research? Once the prize had been announced, we received congratulations from all over the world, but a few friends and colleagues did not know if they should congratulate us or give us their condolences. My answer to all of them was that they should definitely congratulate us! Since the year 2000, the IgNobel prize has been awarded for "research that first makes people laugh and then makes them think", and from my point of view it is quite an achievement to be able to combine these two reactions within the framework of one single paper.

My colleagues and I got the prize for a study published in *Current Biology* at the beginning of 2013 "Dung beetles use the Milky Way for orientation" (*Current Biology* 23, 298–300). What entertained the prize committee was that we put little caps on dung beetles and brought them and their smelly meals to a planetarium show. Overnight, with the IgNobel prize as a media catalyst, our finding that the Milky Way can act as an orientation cue for small navigators reached the homes of more than 120 million people across the globe (and was even mentioned in the cult TV program *The Big Bang Theory*)! In addition to this fantastic opportunity for scientific outreach, the prize ceremony itself was a fantastic experience. It sent shivers down my spine when hundreds of paper aeroplanes were thrown from the wooden balconies of the beautiful Sanders Theater at Harvard University onto the stage. If you are ever offered an IgNobel prize, feel noble and embrace it.

Why dung beetles? From the beginning, I studied the ball-rolling dung beetles during my pastime while my other study animals refused to come out of their nests. As it turned out, these beetles were not only active for most of the day (and night), but also showed an extremely robust and easily manipulated orientation behaviour. As soon as these strong insects are in the possession of a dung ball, they will unconditionally and immediately transport this package of food along a given course until they reach soft and easily manipulated ground. Here, they dig down and feed on their take-away meal in underground security. To support this straight-line travel over the African Savannah, the beetles are guided by a compass that is so sensitive that they can rely on the dim polarization pattern around the moon, or even the Milky Way for orientation, an achievement that is so far unequalled in the animal kingdom. In contrast to other insects, we also find that the dung beetles rely exclusively on cues from the sky for orientation. This makes it possible to evaluate the function of their celestial compass without the confounding influences of, among other things, landmarks.

The large body and brain size of our current model species further make them ideal for neurophysiological recordings and the attachment of more or less sophisticated pieces of scientific equipment. In addition to caps, we have placed little silicone boots on their feet, made them roll frozen scoops of dung and tracked them over tennis courts and hockey pitches. People often wonder if our beetles can be made to roll a golf ball, and yes indeed, this works as well. Dung beetles are ideal model animals to investigate a highly-sensitive sky-compass navigation system, from neurons to behaviour, in one single species. Revealing the principles underlying this simple straight-line orientation system is an important step towards understanding more complex navigation, such as that employed when returning to a nest or food source.

You are a member of one of a rapidly increasing number of 'Young Academies' that are forming around the world — what can these academies contribute to the scientific community? It started with 'Die Junge Akademie' in Germany in 2000, and since then young academies have formed in several countries in Europe, Africa, South America and Asia. These academies are typically cross-disciplinary and serve with a common voice for researchers that will remain in the academic system for at least another 25–30 years. In my experience, this is a voice that our policy makers had desired for a long time, and as a member of the Young Academy of Sweden I have had the opportunity to have direction discussions with the Minister of Education as well as with the Director of the Swedish Research Council.

These academies thus serve as an excellent platform to discuss and influence the research policy of the home country. With a close connection to the next generation of scientists, young academies also often serve to make science better understood by the general public and to evoke their interest for academic studies. To keep the academies young, the members can by default only serve for a limited time: I will become too old two years from now, and then be forever excluded from this fantastic network of researchers, multidisciplinary discussions, endless outreach possibilities and hotlines to the people that influence our academic future.

What is the best advice you have been given? Independent of each other, both of my PhD supervisors gave me the same advice, in actions and in words: enjoy what you do. In my experience, the meaning of these four words stretches far beyond the simple satisfaction of the individual. Everything from the exhilaration of having a new idea, to the final evaluation and presentation of the data, involves creative processes that benefit from the inborn energy of doing something we enjoy. When designing behavioural experiments, it also helps to have a bit of humour. The animals often do something completely unexpected, such as escape, sting or — as in most cases — do nothing at all. But then again, designing and re-designing the experiments is a part of science that I really enjoy.

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Quick guide

Paneth cells

Johan H. van Es and Hans Clevers*

What are Paneth cells and when were they discovered? Paneth cells, along with goblet cells, enterocytes, tuft cells and enteroendocrine cells, represent the principal cell types of the epithelium of the small intestine. The secretory Paneth cells are pyramidal-shaped cells with basally situated nuclei, an extensive endoplasmic reticulum and Golgi network, and prominent, large apical granules that occupy most of their cytoplasm. These cells can be found at the base of the crypts of Lieberkühn — tiny invaginations that line the mucosal surface — where they can persist for at least a month. Although originally discovered by Schwalbe in 1872, their eponym derives from the detailed description made by Dr. Josef Paneth, an Austrian physician, published in 1888. Classical Paneth cells are absent in some species (e.g. pig), while they are exceptionally abundant in others (e.g. some South American anteaters).

What is the classical role for Paneth cells in the intestine? The large granules in Paneth cells are rich in antimicrobial peptides (e.g. lysozyme and α-defensins/cryptdins), immune modulators and trophic factors. Paneth cells are functionally similar to neutrophils and release their granules into the crypt lumen via exocytosis when exposed to a variety of stimuli, including acetylcholinergic agonists and bacteria or their antigens. The response involves an increase in cytosolic calcium levels, which in turn effectuates granule secretion. Antimicrobial peptides released from Paneth cells protect the host from enteric pathogens, help to shape the composition of the colonizing microbiota, and act as a safeguard against bacterial translocation across the epithelium.

Do Paneth cells have other functions in the intestine? The stem cell niche is defined as the microenvironment that is in close proximity to the stem cells and controls stem cell activity and maintenance by providing short-range molecular signals. Paneth cells, like