EMBL Podcast September 2012: How studying biodiversity is enhancing understanding of evolution in Detlev Arendt’s group at EMBL Heidelberg

Adam Gristwood: For the scientists in the Arendt group at EMBL Heidelberg, the variety of life forms that inhabit our planet is shedding light on how the human brain evolved from primitive beginnings and in understanding the living the world as it is today. Elia Benito-Gutierrez, a post doc in the lab explains more:

Elia Benito-Gutierrez: Biodiversity is showing you basically the footprint of evolution. How nature finds the way of making life forms more efficient – or not, evolution is a very random process. But opening the way to finding a way to survive, finding a way to improve, thinking, talking, nocturnal vision, all these things that if you said them like this they sound like science fiction but they are part of nature’s art. It is part of what we see out there if we pay attention – biodiversity is nature’s technology basically.

Adam: While on a research expedition in the Indian Ocean, Elia made a very personal contribution to our knowledge of biodiversity. She discovered two new types of cephalochordate, each distinctly different from the 25-plus species already known to scientists. Cephalochordates are small and primitive marine animals with elongated bodies thought to be surviving members of the group that all animals with a backbone evolved from. The two cephalochordates had been described by scientific explorers in very old scientific literature. But the information about them was muddled and contradictory – and crucially, none had been spotted since.

Elia: Following a very old coordinate from one of these old-style researchers that went in expeditions, in the Maldives Islands we found that these two genus not only exist, they are different and they really, really, really live. After hours of filtering, I was thinking it was a legend that had been written paper through paper. Then, all of a sudden, it was there. It was still a cephalochordate, very small, yet very different. For someone who is used to working with cephalochordates it was just unbelievable.

Adam: The unique characteristics of the animals could give scientists clues as to how vertebrates, or animals with a backbone, evolved from primitive spineless organisms.

Elia: There have been intermediary evolutionary states hypothesised in the literature. But the problem is that there is no animal form alive that is able to testimony this. This could be the case with the animals from the Maldives islands, which are much more primitive.

Adam: Elia has added her new protégés to the set of animals the Arendt lab use to study the evolution of our own central nervous system – our brain and spinal chord. The human brain is often regarded as a marvel of evolution – it endows us with memory, language, intelligence and consciousness. But to get to this point, our complex brains had to evolve from very simple nervous systems, like those found in spineless invertebrates, such as jellyfish, urchins, and anemones. By studying and comparing simple marine invertebrates
Detlev’s group can tease out what features we inherited from a shared ancestor 520 million years ago, and what features the different species acquired later on.

**Detlev Arendt**: These primitive organisms are chosen by us for their specific characteristics, in that they display a lot of ancestral features. They resemble very much the old versions of organ systems that probably were present in very old days on the planet Earth. If you start looking at the nervous system of these animals, when you start getting a first impression of the genes and molecules that they use to interact with their environment, you realise that a lot of these have direct counterparts in the vertebrate brain. This really came as a surprise, in that these primitive little swimming plankton larvae, all of a sudden there are a few neurons that by their genetic, molecular inventory resemble our cortex in effect – this structure that makes us human somehow.

**Adam**: The cortex is a region near the front of the brain that is thought to give us our ability to talk, rationalise, and feel complex emotions. But, as Detlev’s work has shown, the roots of this very human feature appear to have much simpler origins. To understand how the nervous systems of worms, flies and humans, have arisen from such humble ancestors, Detlev’s group is turning to diversity not only between species, but within species.

**Detlev**: If you look at different populations within a different species – how are they different? How do they vary? And what can we maybe learn from animal evolution from this? If we sequence a litre of seawater and see that there is something differing at the level of genes between planktonic organisms, we would take these genes and then find out what their job is in these little planktonic organisms. For this our model system is good, so we can go into *Platynereis*, our marine annelid worm, and interrogate it. We can ask: what are these genes doing? Where are they expressed? What is their function in the cells where they are expressed? So we can get the biological significance of genetic variations between marine populations and this way learn about how their interactions with the environment changes between populations and even at the micro-evolutionary level.

**Adam**: The remarkable and unique characteristics of these tiny organisms are proving central in understanding the history and complexity of biological systems, which form a crucial part of our own species.