Microbiome – heritable and repeatable? Evolutionary potential of microbiome in a wild animal population

All living organisms contain rich and diverse bacterial communities inside of them. They are called microbiomes, and often play vital roles in their hosts physiology and survival. Microbiomes modulate behaviour, affect immunity and organism's internal homeostasis, and take vital part in supplying the host with nutrients and vitamins. Yet, we still know very little about how microbiomes evolve, and whether they actually can change following the principles of natural selection.

The most important pieces of information we miss to be able to predict the potential of microbiomes to evolve, are its link to individual fitness and survival, and its genetic variance. The latter property is especially important – it ensures that, if a trait confers any survival and fitness advantage, it is passed to the next generation. We have very fragmentary evidence about microbiome heritability, and even worse – we have almost none such evidence coming from wild populations. Obtaining such information is vital, as only wild populations are biologically realistic and the processes happening in them accurately reflect natural evolutionary changes.

In this project, I aim to use microbiome data from a wild population of two bird species – the blue tit and the collared flycatcher – to see if microbiomes are heritable, and if they can undergo natural selection. I will extract gut bacteria from birds' faeces, and through a series of clever molecular analyses I will identify the hundreds and thousands of bacterial and fungal organisms that inhabit the insides of birds' intestines. Then, using mathematical and statistical modelling, I will try to check whether differences between individuals in their microbiome diversity are indeed heritable, and whether variation in microbiomes influences in any way individual fitness and survival. I will also check to what extent microbes actually influence other traits of their hosts – it is possible, that the way host traits evolve depends not only on the way genetic information is passed from generation to generation, but also on the amounts and diversity of microbiomes that different hosts share with each other.

Analyses like these will have important impact on our knowledge about internal microbial communities. First – they will demonstrate to what extent do microbiomes evolve, and to what extent natural selection can actually shape the diversity of microbes in animal bodies. Secondly, evidence of widespread genetic variation in microbiomes would be an important message for many animal and plant breeders. Microbiomes can strongly influence host traits, and in agriculture they can be used to produce more resistant plants, or more productive animals. Since it is bacteria that produce methane in cattle digestive tracts – the same methane, that constitutes an important fraction of greenhouse gases emitted to the atmosphere – microbiome selection could be used to breed animals, that still can digest plant food and at the same time produce less methane. Such selection would be possible only, if microbiomes were heritable.