Deciphering the links between biodiversity and health : rodents, microbiota and zoonotic pathogens

Co-supervision : Nathalie Charbonnel (DR2 INRA-CBGP) & Benjamin Roche (DR2 IRD UMISCO/MIVEGEC), Montpellier, France

Keywords : microbial ecology, infectious diseases, ecohealth, wildlife, dilution effect, conservation biology, association network

Profile and skills required

The student must have an excellent background in population biology, (microbial/community) ecology and biostatistics. Interests in field work, molecular biology, bioinformatics and modeling approaches are essential to this project. We do not expect candidates to have experience in all these fields, but the candidate should be interested in, and not afraid of, mixing these different approaches and techniques. Multi-tasking and organizational skills will be necessary and appreciated. As this PhD will be part of a European project, the candidate is expected to exchange with other PhDs and post-docs from Germany, Ireland, Poland and Belgium (practice of english required).

Project description

Context

Understanding the relationships between wildlife biodiversity and zoonotic infectious diseases when ecosystems are strongly disturbed is a challenging issue that scientists must address to support further policy actions. This PhD project aims at tackling this challenge by focusing on rodent-borne diseases in temperate forests or large urban green spaces. Rodents, that are important reservoirs of threatening zoonotic agents, are extremely abundant within forests and green spaces environments where human/domestic-wildlife interactions are plausible to occur. Within these ecosystems, efforts are undertaken to preserve biodiversity throughout Europe, with therefore possible consequences for public health strategies against many zoonoses.

The originality of this project is to extend previous research on biodiversity/health relationships by including: i) impact of coinfections on epidemiology of thoses zoonoses, ii) interactions between gut microbiome and host susceptibility to infectious agents, iii) temporal variability of biodiversity/health relationships.

Objectives

The candidate will participate in biannual rodent sampling and perform large investigation of zoonotic agents and microbiome using metabarcoding to describe the biodiversity of rodent community and their pathobiome. He/she will apply eco-epidemiological approaches to decipher the processes that influence zoonotic pathogen transmission in rodent populations. Mathematical models will be developed to quantify the influence of spatiotemporal scales and within-host

interactions on the relationships between biodiversity (rodents and microbiome) and zoonotic diseases. Such models would be used afterwards to forecast the public health consequences of conservation strategies. **Starting date** : 1st of February 2020

To apply, send a motivation letter and a CV at Nathalie.Charbonnel@inra.fr and benjamin.roche@ird.fr by January 17th 2020

References

Abbate J, Galan M, Razzauti M, Sironen T, Voutilainen L, Henttonen H, Gasqui P, Cosson JF, Charbonnel N. Pathogen community composition and co-infection patterns in a wild community of rodents. Submitted to PCI Ecology.

Ezenwa VO, Jolles AE. 2015. Opposite effects of anthelmintic treatment on microbial infection at individual versus population scales. Science 347:175-177.

Galan M, Razzauti M, Bard E, Brouat C, Charbonnel N, Dehne-Garcia A, Loiseau A, Tatard C, Vignes H, Vayssier-Taussat M, Cosson JF. 16S rRNA amplicon sequencing for epidemiological surveys of bacteria in wildlife. mSystems. 2016;1(4):e00032-16.

Griffiths EC, Pedersen AB, Fenton A, Petchey OL. 2016. Analysis of a summary network of co-infection in humans reveals that parasites interact most via shared resources. Procs, B, Lond. 281:20132286.

Han BA, Schmidt JP, Bowden SE Drakebet JB. 2015. Rodent reservoirs of future zoonotic diseases. Procs Nat Am Soc, 112:7039-7044.

Hosseini PR, Mills JN, Prieur-Richard AH, Ezenwa VO, Bailly X, Rizzoli A, Suzan G, Vittecoq M, Garcia-Pena GE, Daszak P, Guegan JF, Roche B. Does the impact of biodiversity differ between emerging and endemic pathogens? The need to separate the concepts of hazard and risk. Philos Trans R Soc B-Biol Sci. 2017;372(1722).

Jenkins EJ, Simon A, Bachand N, Stephen CS. 2015. Wildlife parasites in a One Health world. Trends Parasitol 31:174-181.

Jolles AE, Ezenwa VO, Etienne RS, Turner WC, Olff H. 2008. Interactions between macroparasites and microparasites drive infection patterns in free-ranging African buffalo. Ecology 89:2239-2250.

Johnson PTJ, deRoode JC, Fenton A. 2015. Why infectious disease research needs community ecology. Science 349 :1259504_1-1259504_9.

Keesing F, Belden LK, Daszak P, Dobson A, Harvell CD, Holt RD, Hudson P, Jolles A, Jones KE, Mitchell CE, Myers SS, Bogich T, Ostfeld RS. Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature. 2010;468(7324):647-52.

McKenney EA, Koelle K, Dunn RR, Yoder AD. The ecosystem services of animal microbiomes. Molecular Ecology. 2018;27(8):2164-72.

Ostfeld RS, Keesing F. Effects of Host Diversity on Infectious Disease. In: Futuyma DJ, editor. Annual Review of Ecology, Evolution, and Systematics, Vol 43. Annual Review of Ecology Evolution and Systematics. 432012. p. 157-82.

Roche B, Dobson AP, Guegan JF, Rohani P. Linking community and disease ecology: the impact of biodiversity on pathogen transmission. Philos Trans R Soc B-Biol Sci. 2012;367(1604):2807-13.

Telfer S, Lambin X, Birtles R, Beldomenico P, Burthe s, Paterson S, Begon M. 2010. Species Interactions in a Parasite Community Drive Infection Risk in a Wildlife Population. Science 330:243-246.

Vayssier-Taussat M, Albina E, Citti C, Cosson JF, Jacques MA, Lebrun MH, Le Loir Y, Ogliastro M, Petit MA, Roumagnac P, Candresse T. 2014. Shifting the paradigm from pathogens to pathobiome: new concepts in the light of meta-omics. Frontiers in Cellular and Infection Microbiology 4, 1-7.