

Host community structure determines pathogen outbreak potential



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1: Bovine tuberculosis (bTB) spills over into many wildlife mammal species

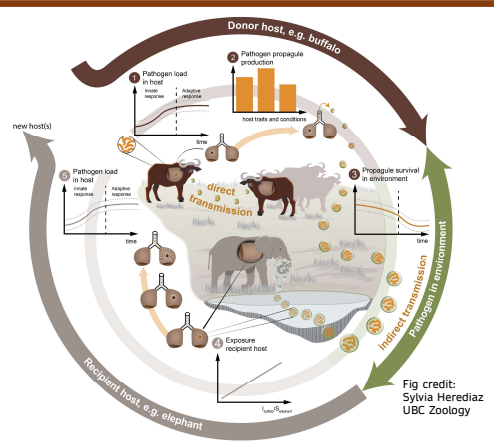
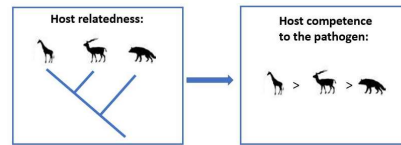


Fig credit: Sylvia Herediaz UBC Zoology

- Buffalo (*Syncerus caffer*) are bTB maintenance hosts.
- Transmission can be:
 - Direct (herds)
 - Indirect (environment)
- Waterholes are high risk for transmission.

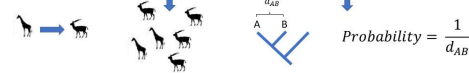
2: Including community structure into multi-host disease model

Dilution effect: High diverse communities have lower disease risk¹. Therefore, define community diversity with phylogeny², e.g.:



Model includes pathogen competence for each species pair, e.g.:

Transmission = Contact rate x Probability of successful transmission



Structure of community can now predict disease outbreak potential (R_0)

3: Definitions of community-structure metrics and multi-host model

Biodiversity metrics:

- Phylogenetic Diversity (PD)³:
 Sum of branch lengths

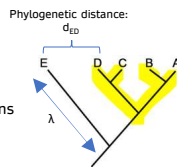
$$PD = \sum \lambda_e$$

- Mean Pairwise Distance (MPD)⁴:
 Mean distances of pairwise combinations

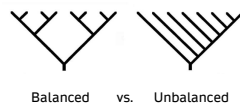
$$MPD = \frac{1}{N_{species}} \sum d_{ij}$$

- Variance (varPPd)⁴:
 Mean variance of distances:

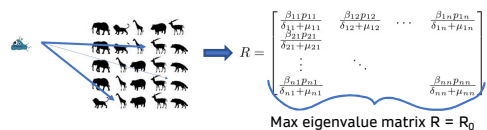
$$varPPd = \text{mean}(\text{var}(\sum d_{ij}))$$



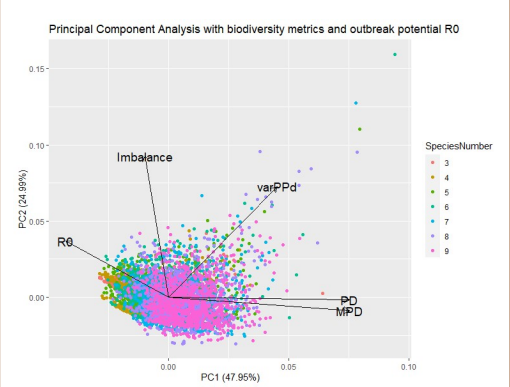
Tree imbalance:



R_0 : Multi-host model predicts outbreak potential & relative importance of each host:



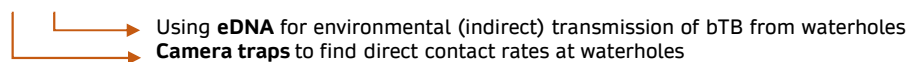
4: Multi-host model shows importance of community structure



- R_0 determined by diversity of the community (PD) and the structure of the tree (imbalance).
- Underlying dynamics of community are of importance when assessing diseases in multi-host systems!

5: Proposed application and **One Health** relevance

Transmission = contact rate x probability of successful transmission



This model will help to identify the hosts that contribute highest to the transmission of the disease and how the structure of the community can explain these spillover and -back events, helping policy makers in finding the right pathways to focus time and resources towards.

References: 1: Ostfeld & Keesing (2000). *Cons. Biol* 14: 722-728; 2: Parker et al. (2015) *Nature* 520.7548 : 542-544; 3: Srivastava et al. (2012) *Ecol. Lett.* 15: 637-648; 4: Cadotte & Davies (2016) *Princeton University Press*.