Recurrent specialization on a toxic fruit in *Drosophila*: a population genomics perspective

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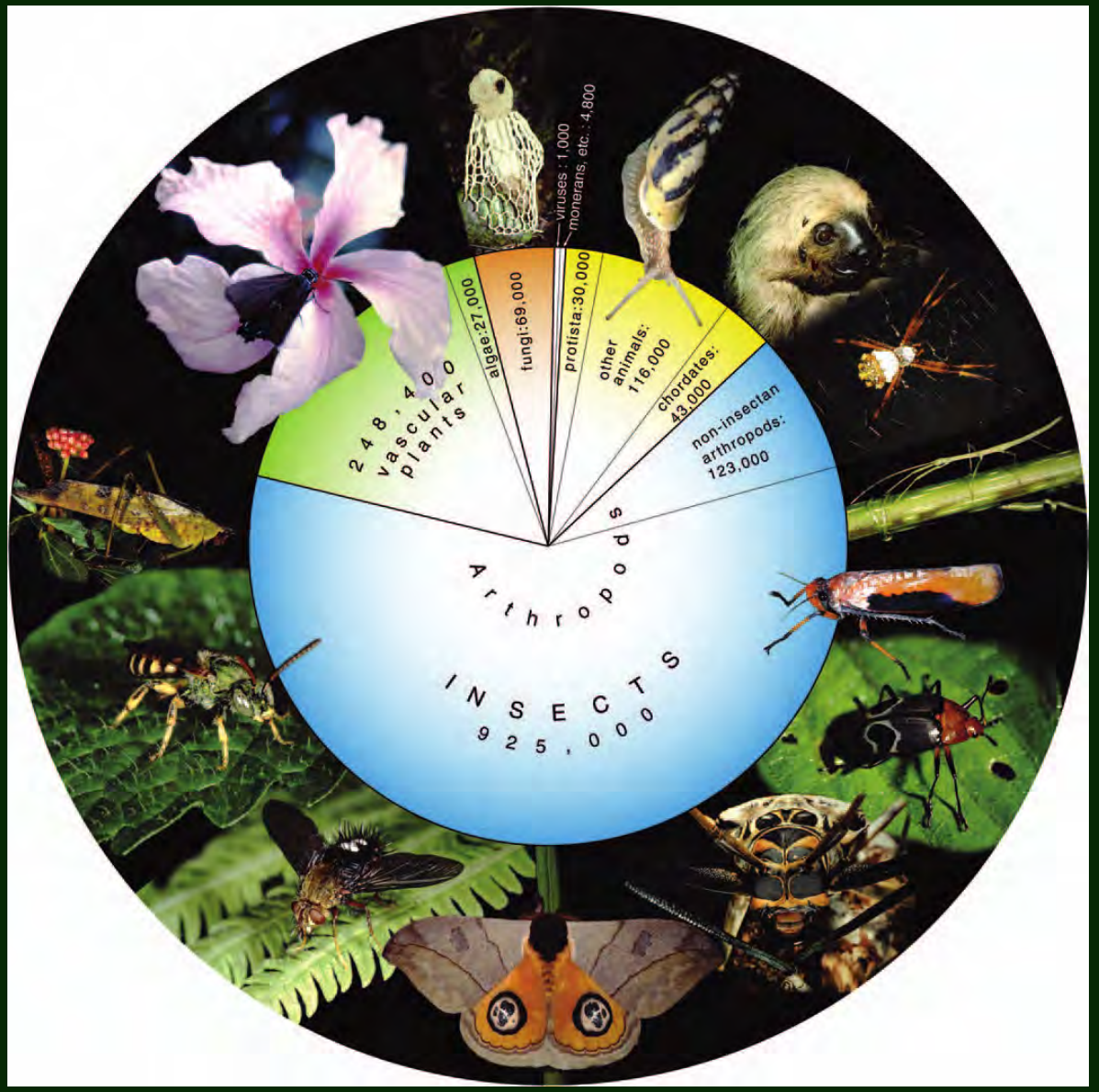
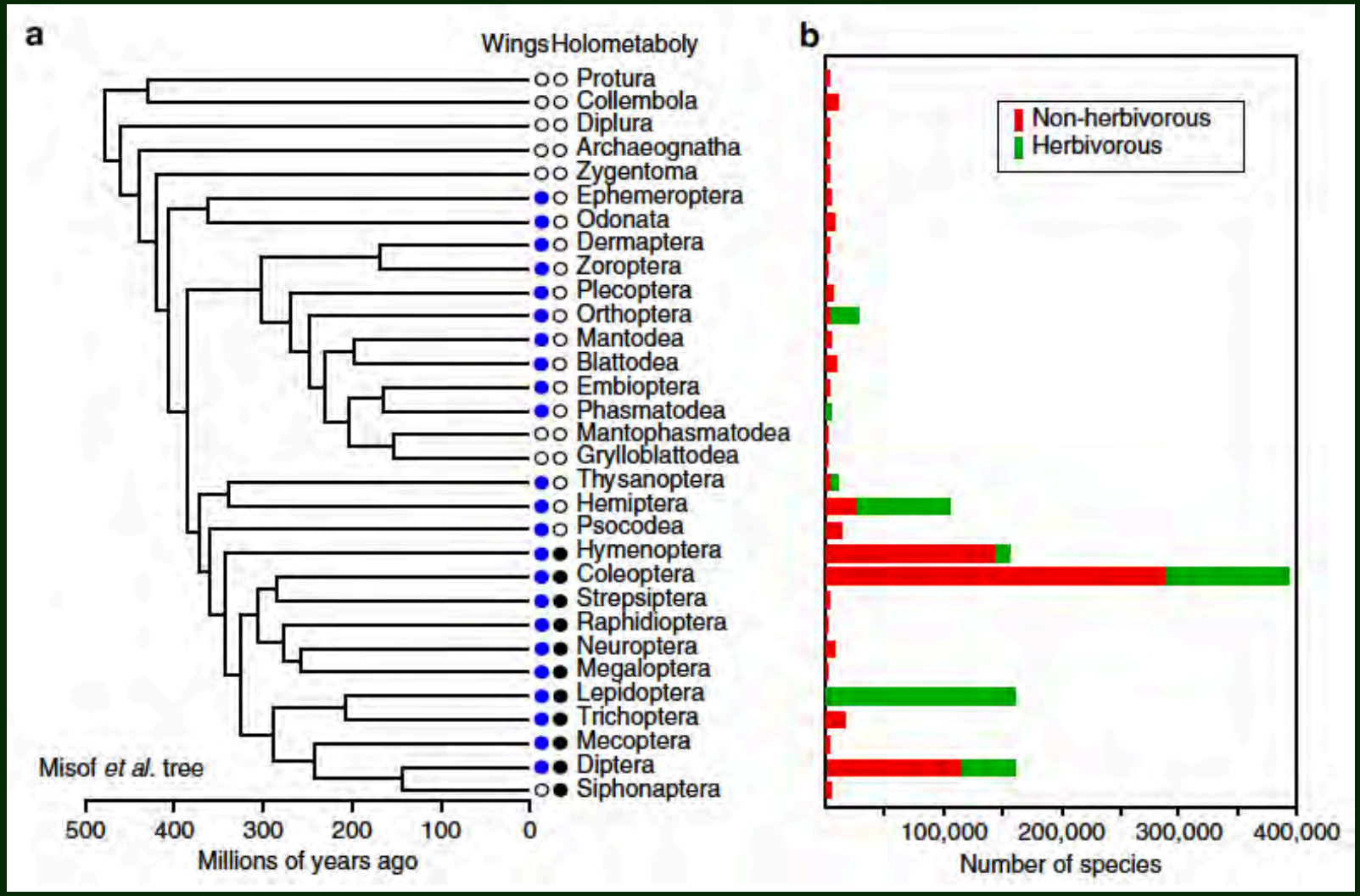
An inordinate fondness for insects



1.3. The diversity of life shown as proportions of named species.

Grimaldi & Engels (2005) *Evolution of the Insects*

A role of herbivory in diversification



Wiens et al. (2015) *Nature Communications*

Herbivory gradient in the Drosophilidae

Herbivory — Detritivory

Specialism — Generalism

Scaptomyza nigrita

D. pachea

D. sechellia

D. suzukii

D. melanogaster

Transition from generalism to specialism

Herbivory

Detritivory

Specialism

Generalism

HOW?

Scaptomyza nigrita

D. pachea

D. sechellia

D. suzukii

D. melanogaster

Transition from generalism to specialism

1. Long-range attraction
2. Tolerance of plant defensive toxins
3. Digestion of ingested ripe plant material
4. Oviposition preference

Herbivory — Detritivory

Specialism — Generalism

HOW?

Scaptomyza nigrita

D. pachea

D. sechellia

D. suzukii

D. melanogaster

Transition from generalism to specialism

Herbivory

Detritivory

Specialism

Generalism

WHY?

Scaptomyza nigrita

D. pachea

D. sechellia

D. suzukii

D. melanogaster

Transition from generalism to specialism

1. Ecological predictability
2. Inter-specific competition
3. Genetic constraints
4. Escaping predators/parasites

Herbivory — Detritivory

Specialism — Generalism

WHY?

Scaptomyza nigrita

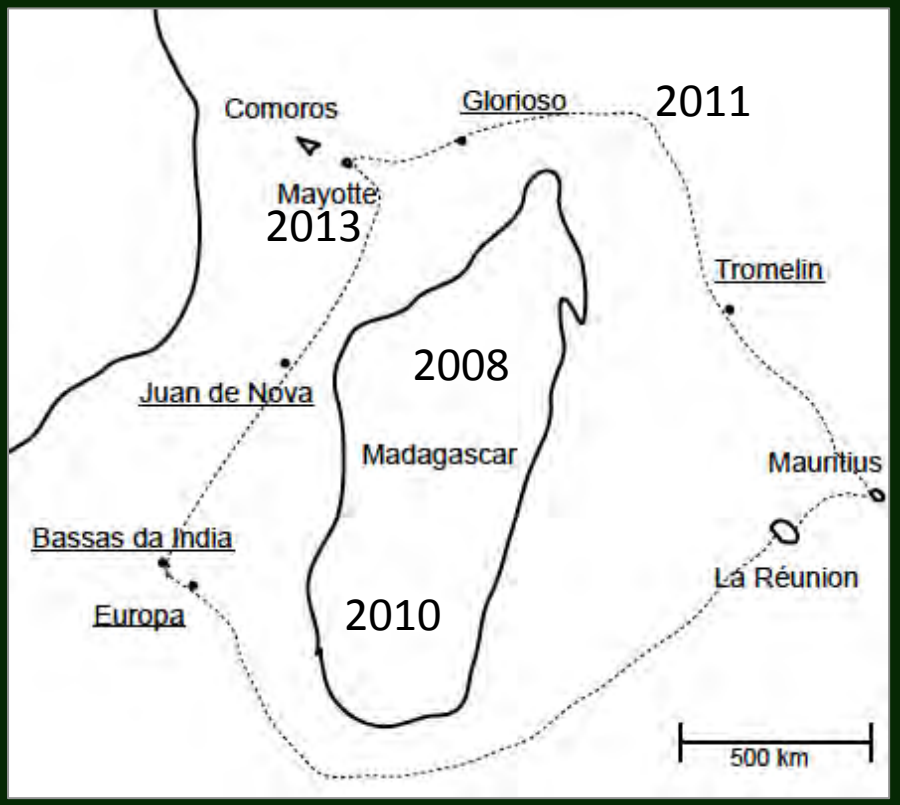
D. pachea

D. sechellia

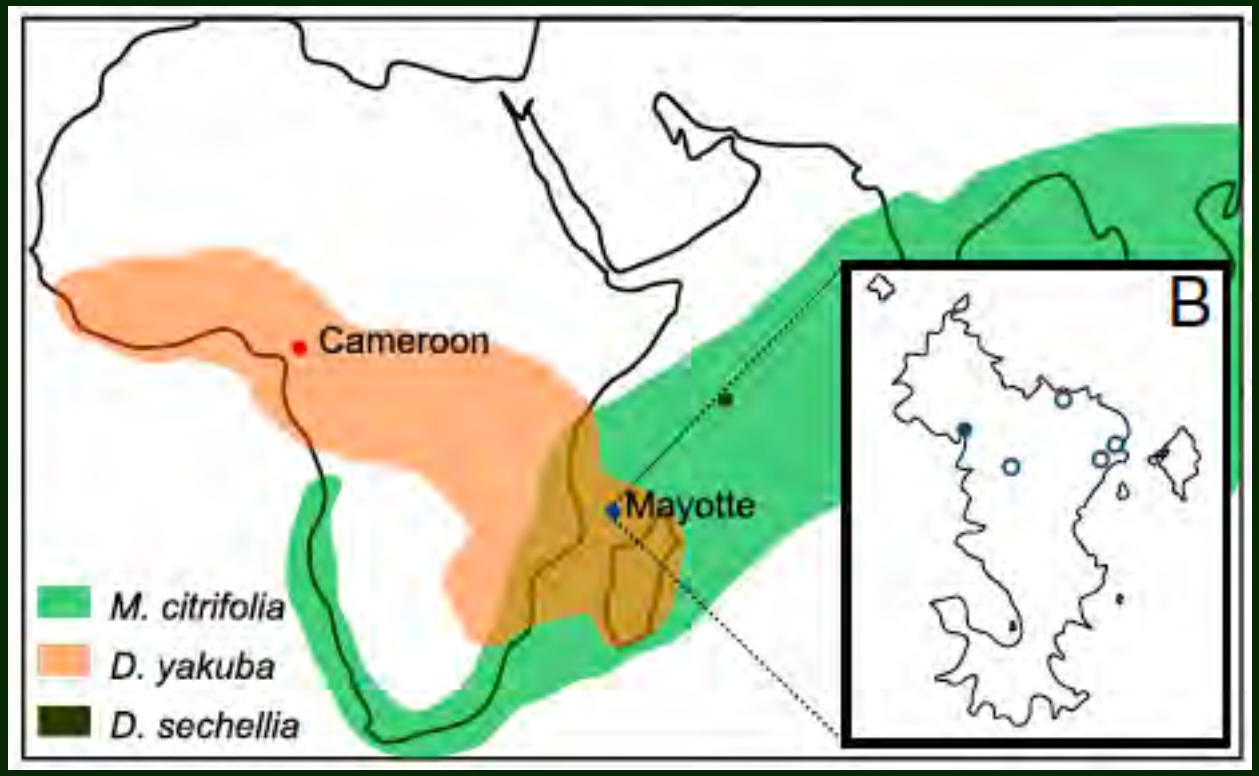
D. suzukii

D. melanogaster

Drosophilids collection in the Indian Ocean



Drosophila yakuba is strictly associated with noni on Mayotte



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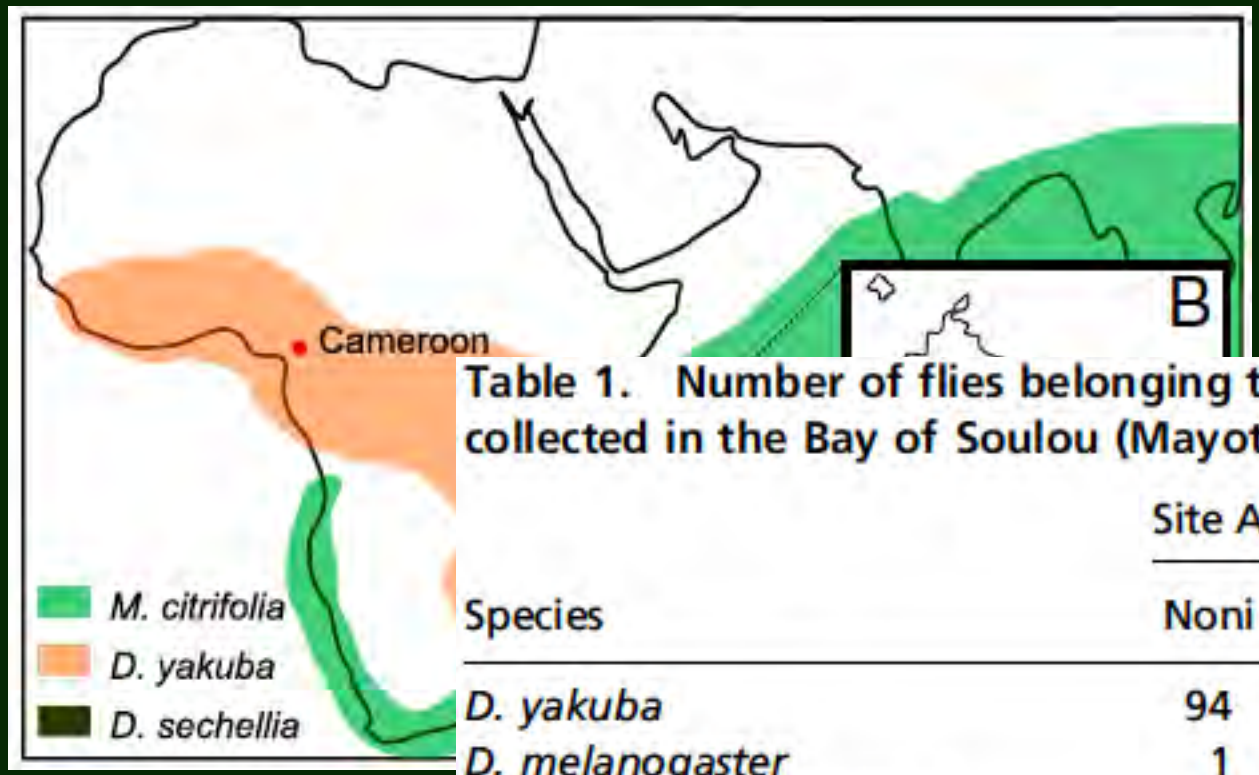
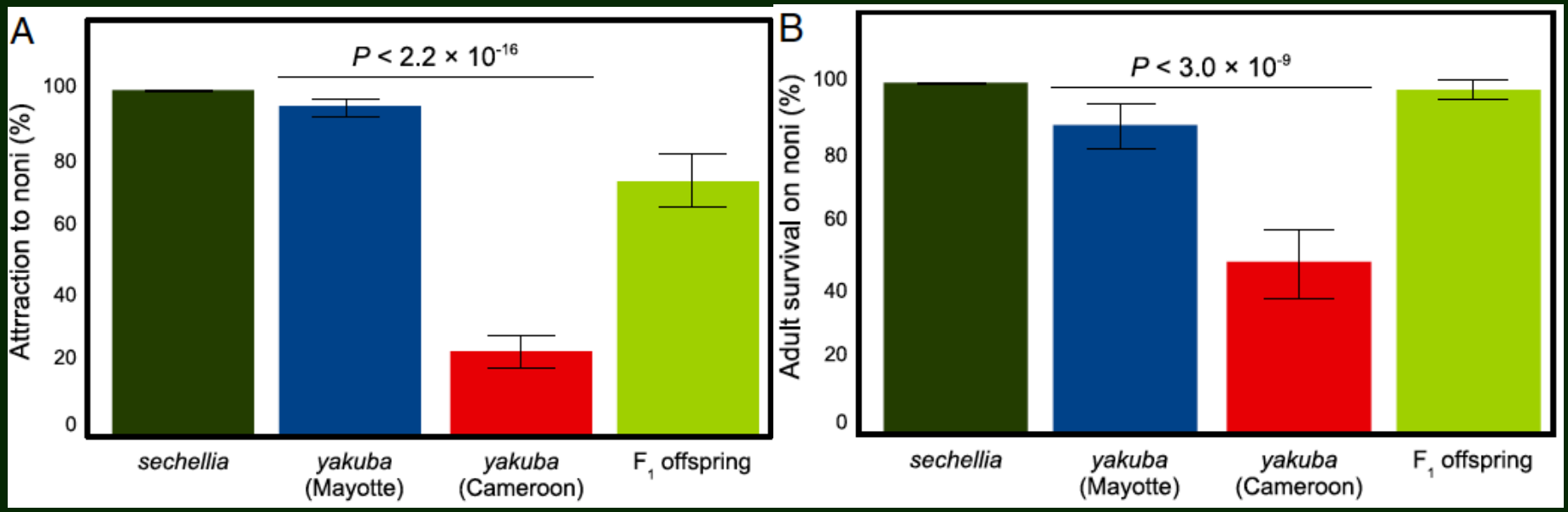


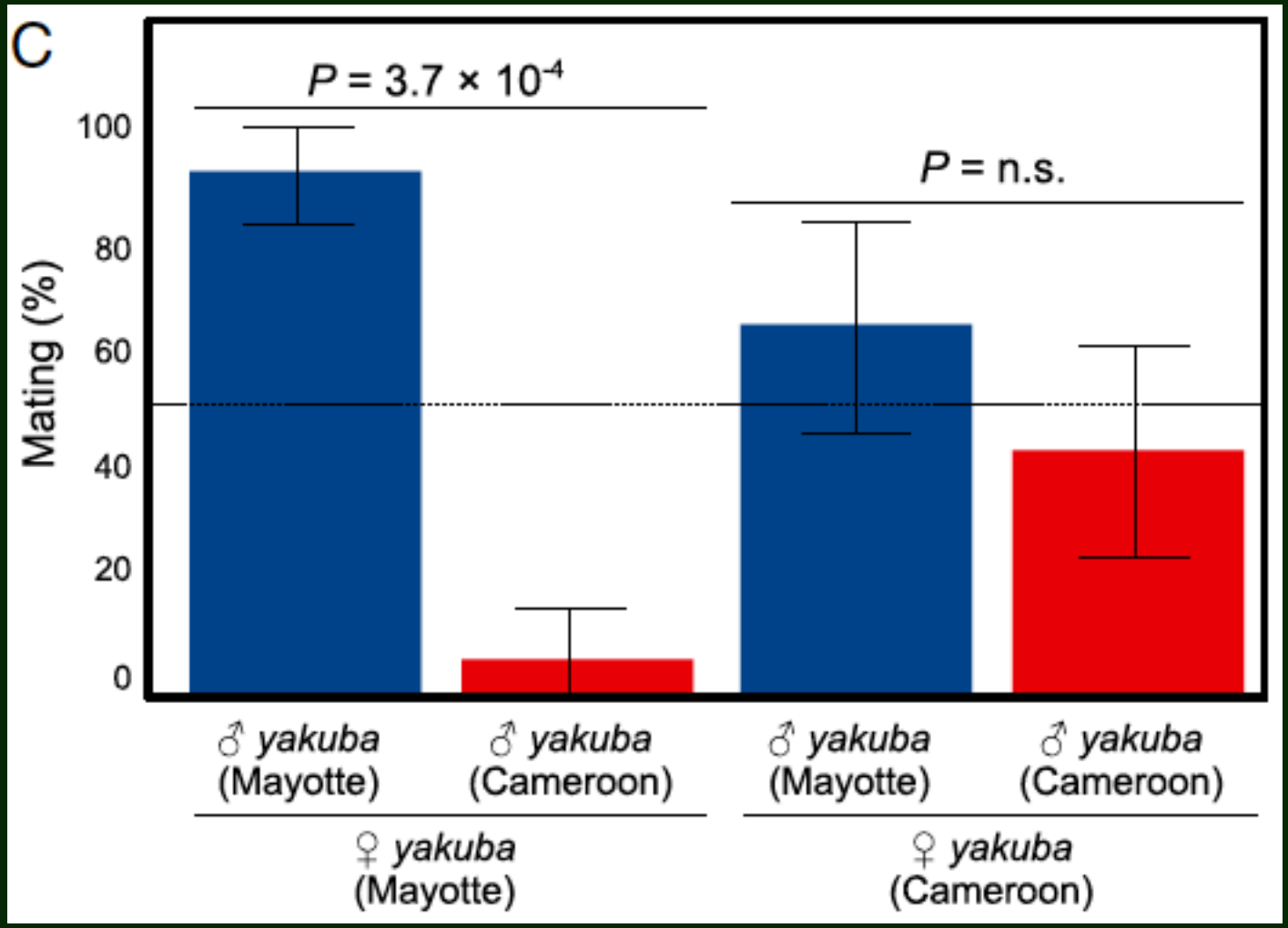
Table 1. Number of flies belonging to different species collected in the Bay of Soulou (Mayotte)

Species	Site A	Site B		Emergence
	Noni	Noni	Jackfruit	from noni
D. yakuba	94	331	2	44
D. melanogaster	1	0	0	0
Drosophila malerkotliana	71	129	151	30
Drosophila nasuta	5	39	11	12
Scaptodrosophila latifasciaeformis	0	10	227	0
Zaprionus indianus	0	8	1	0
Zaprionus tuberculatus	5	105	24	8

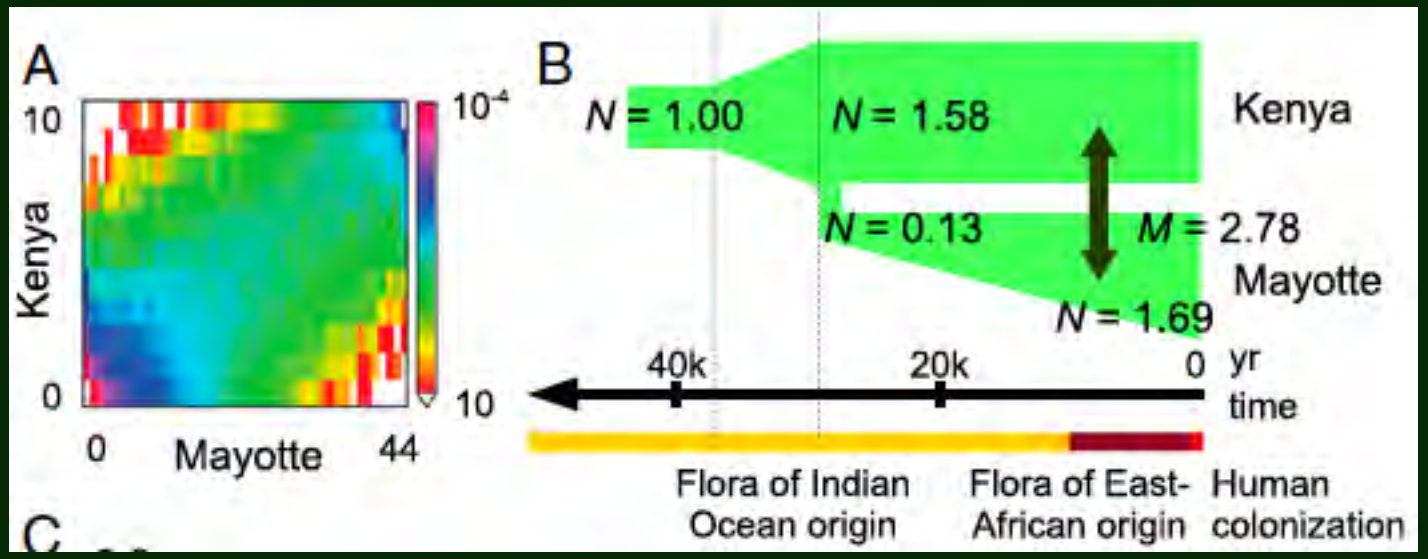
Laboratory experiments



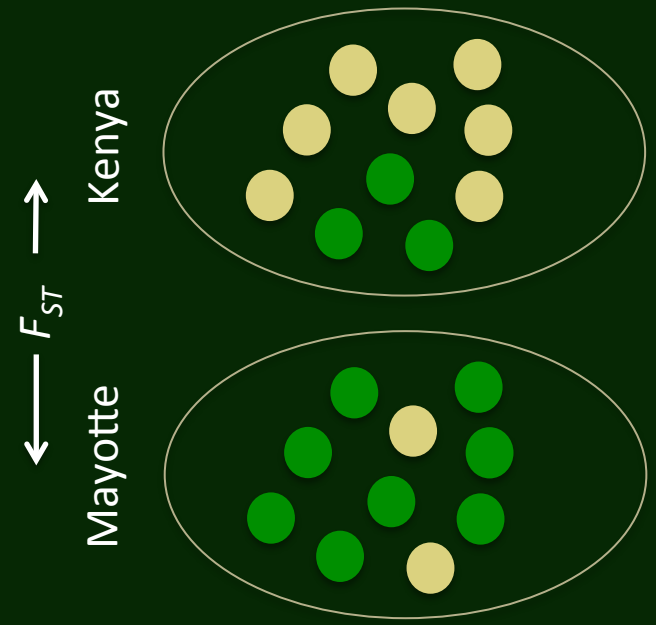
Assortative mating



Demographic history



« Population Branch Excess »



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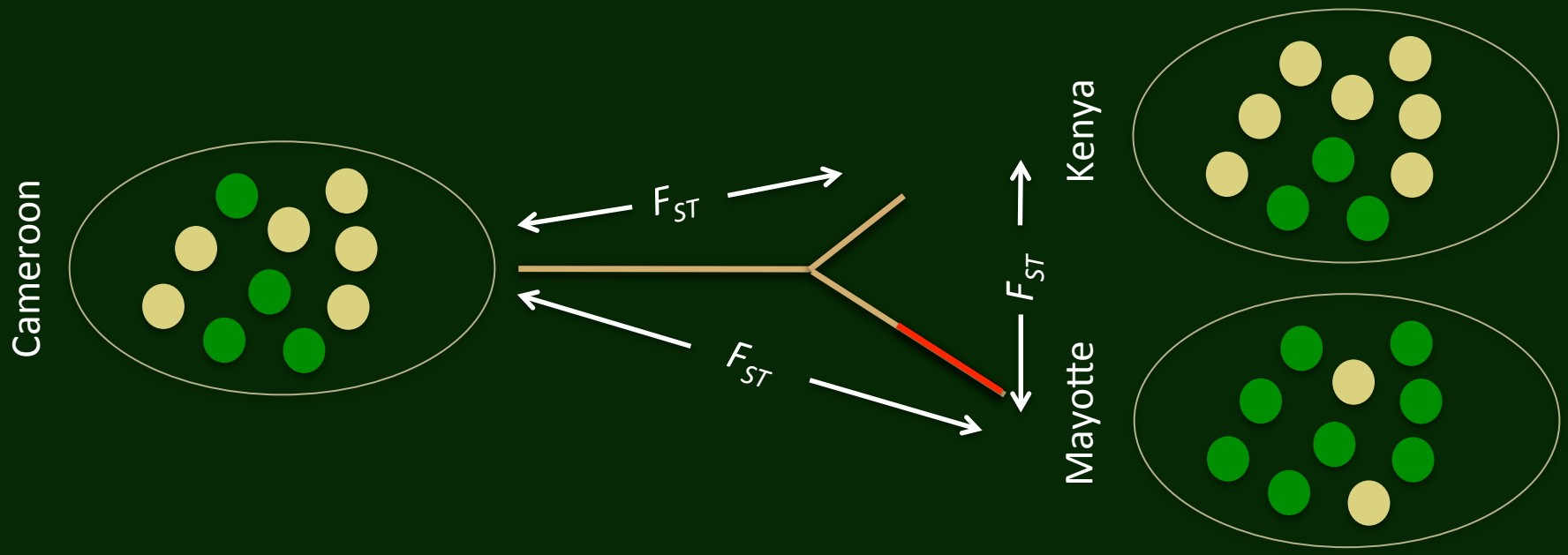
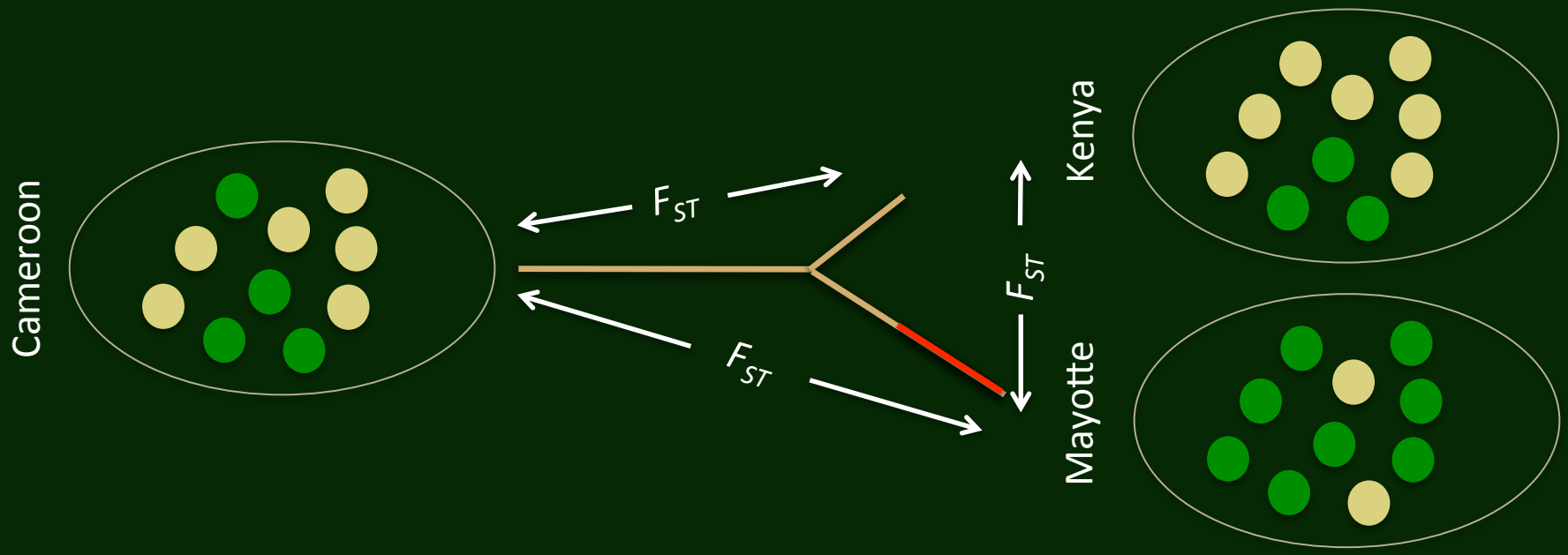


$$PBS = [- \log (1-F_{ST\_MK}) - \log (1-F_{ST\_MC}) + \log (1-F_{ST\_KC})] / 2$$

Yi et al. (2010) *Science*

« Population Branch Excess »



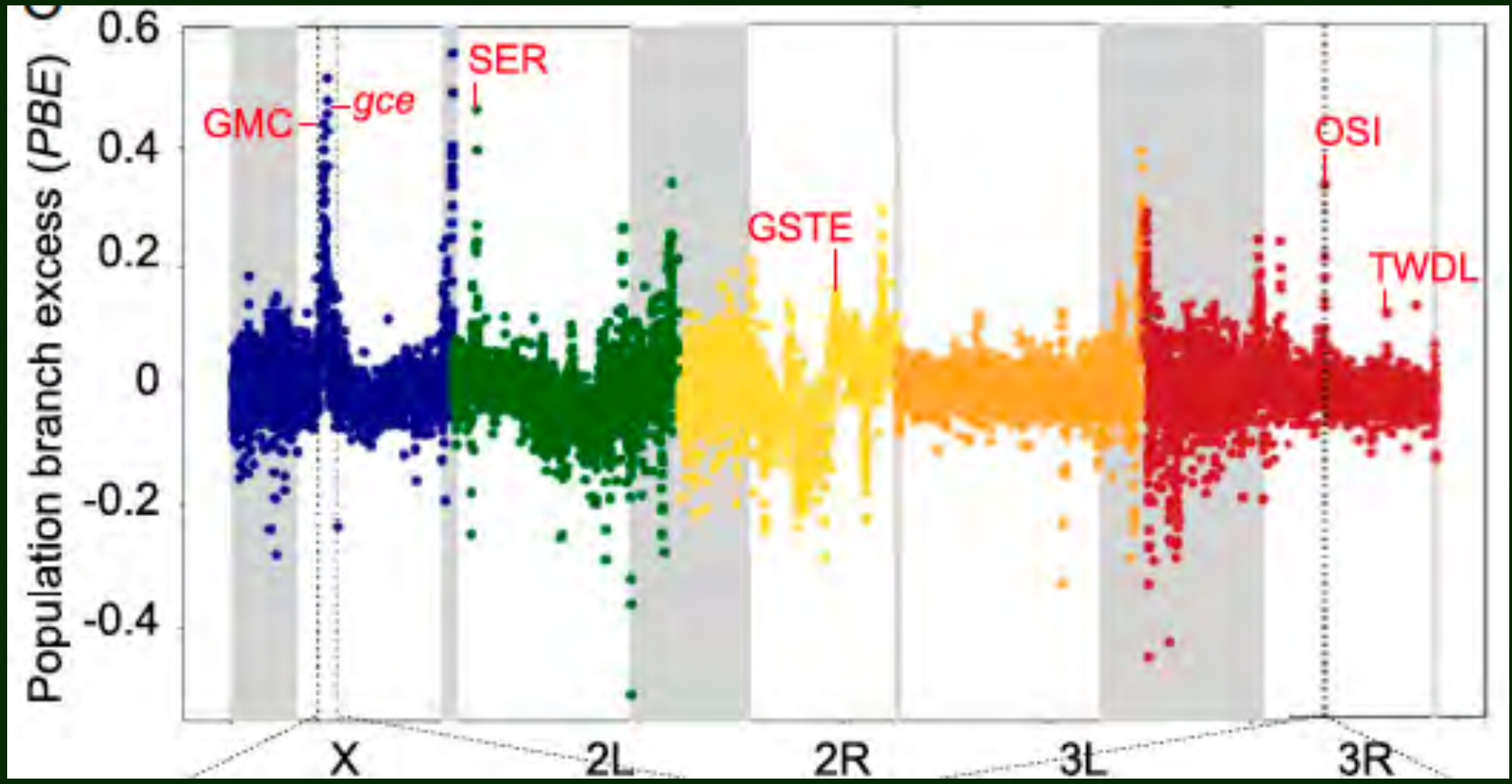
$$PBS = [- \log (1-F_{ST\_MK}) - \log (1-F_{ST\_MC}) + \log (1-F_{ST\_KC})] / 2$$

Yi et al. (2010) *Science*

$$PBE = PBS_{obs} - PBS_{exp} = PBS - [- \log (1-F_{ST\_KC}) \times (PBS_{med} / \{- \log (1-F_{ST\_KC})\}_{med}]$$

Yassin et al. (2016) *PNAS*

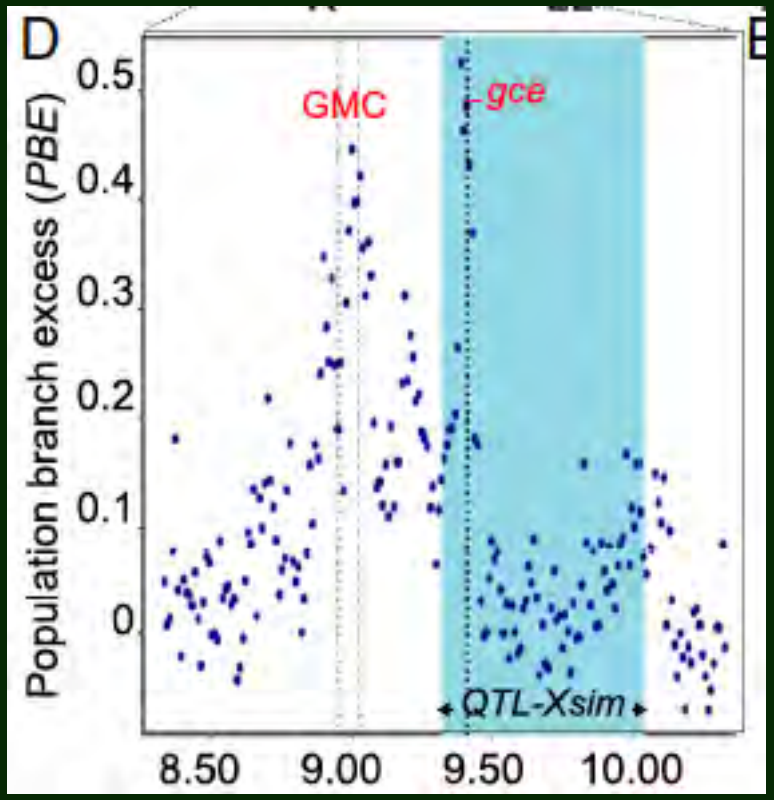
« Population Branch Excess »



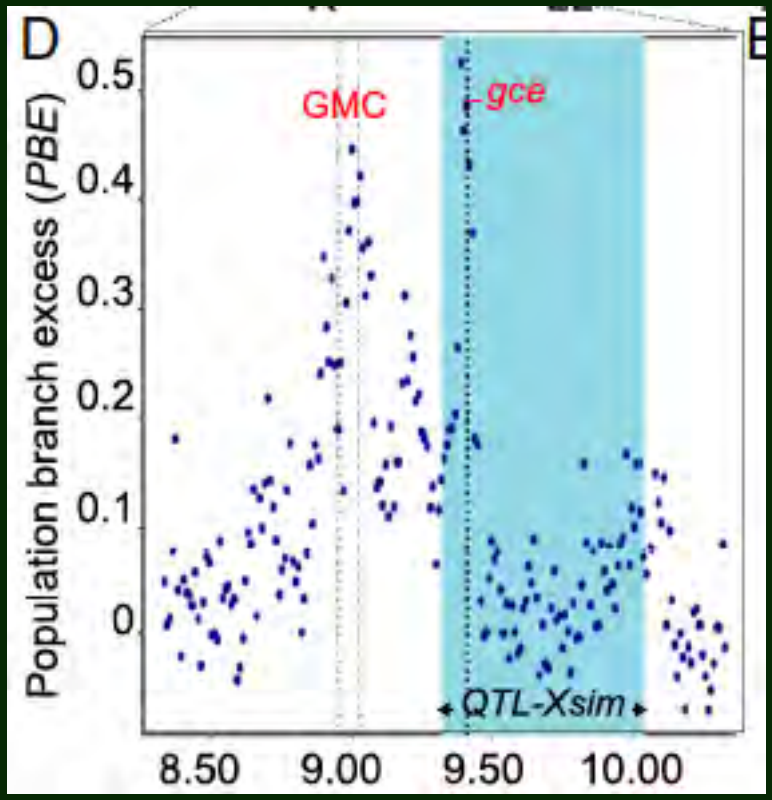
Grey areas = low recombining regions (telomeres, centromeres)

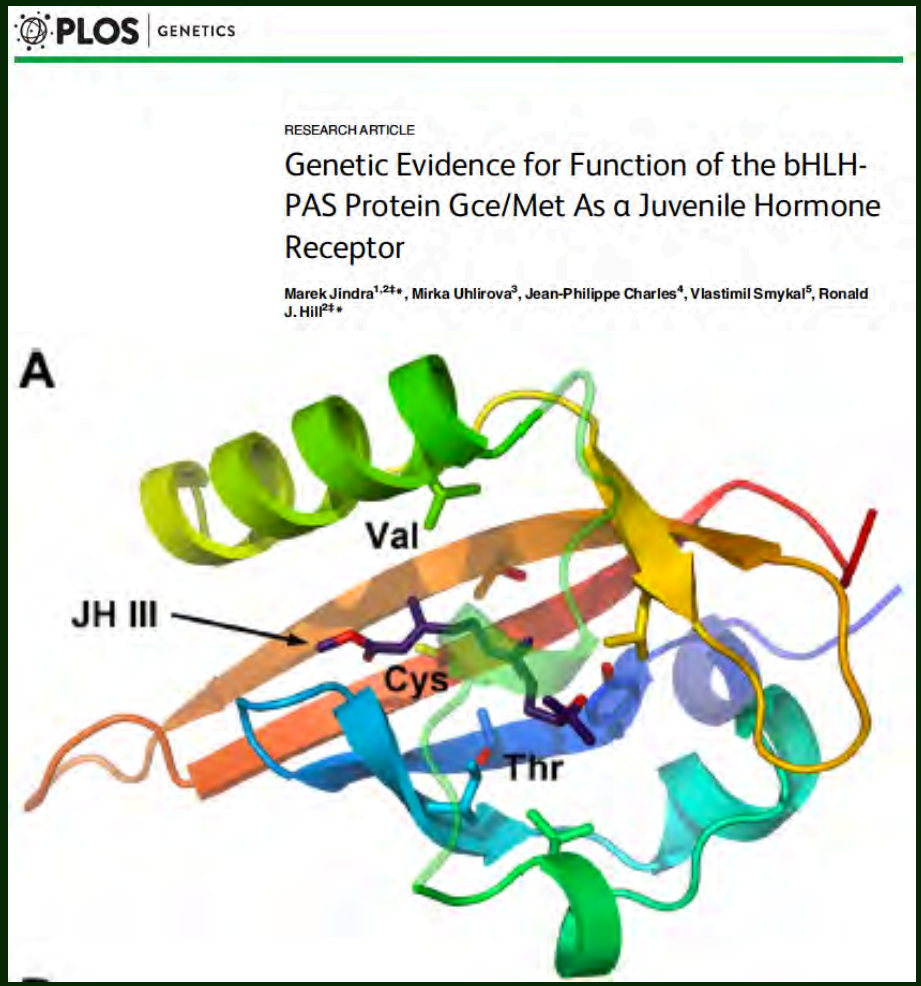
GMC = glucose-methanol-choline oxidoreductases, *gce* = *germ cell elongation*, SER = serine endopeptidases, GSTE = Glutothamine S transferases, OSI = Osiris, TWDL = *Tweedle*

Candidate region 1: *gce*

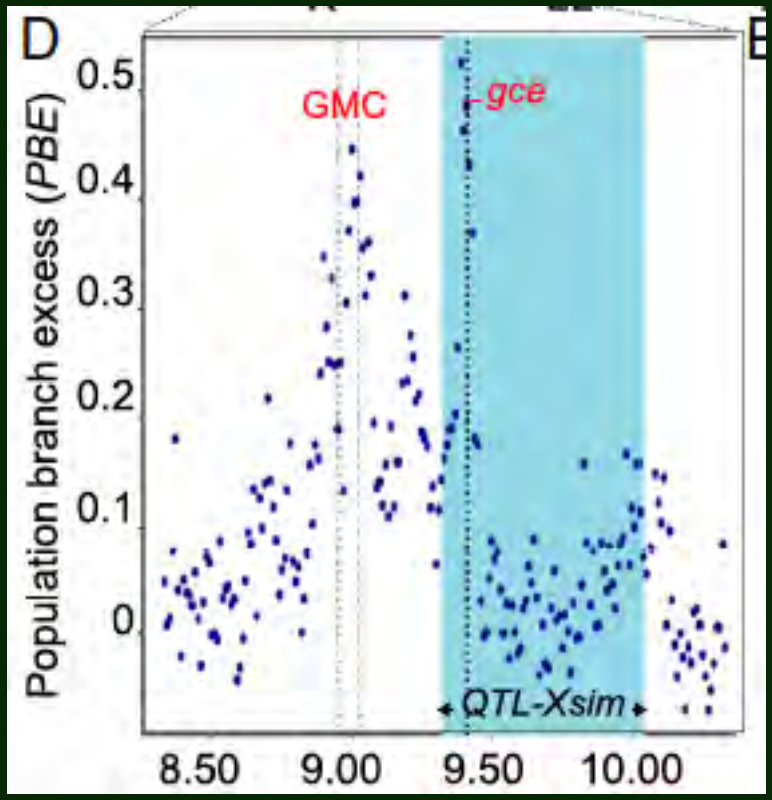


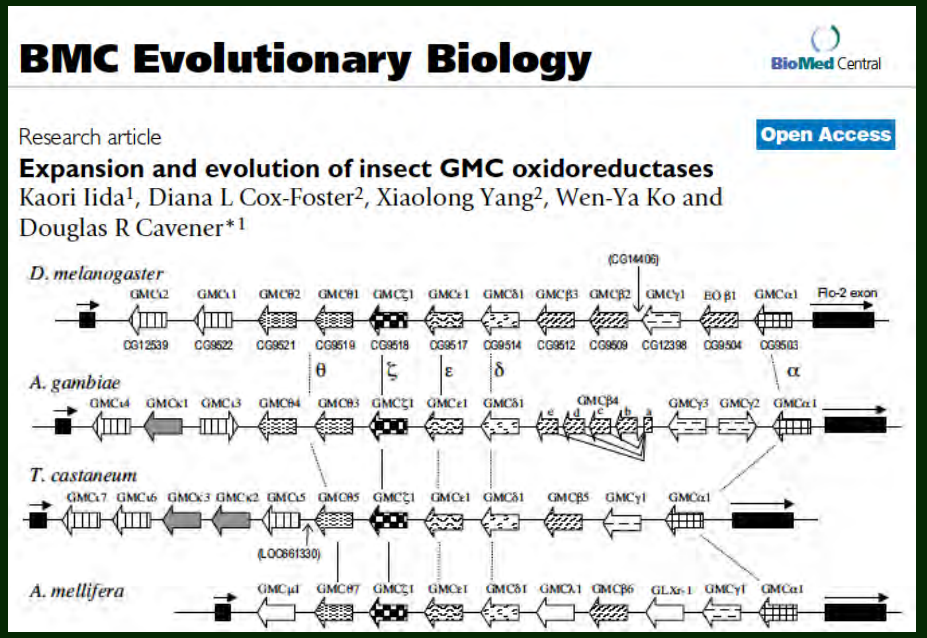
Candidate region 1: *gce*

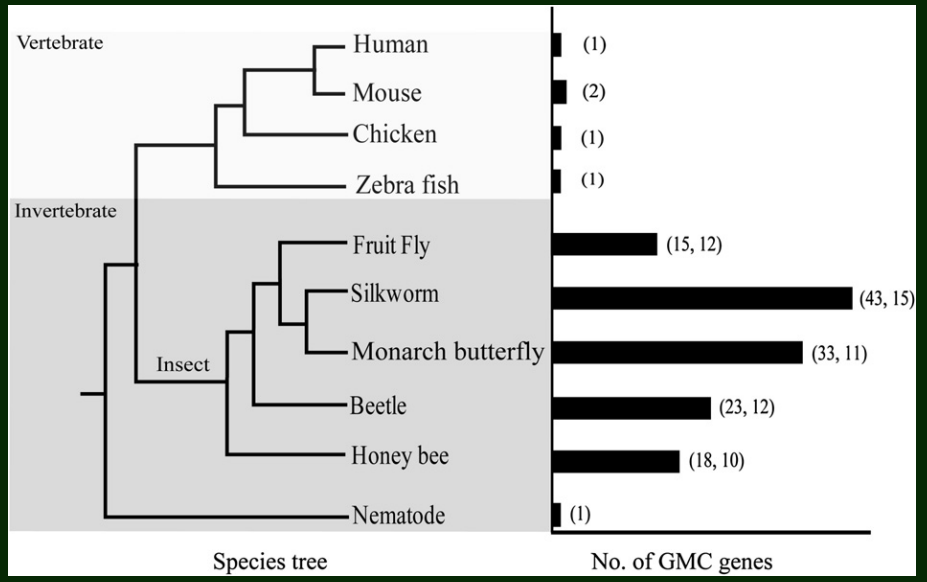




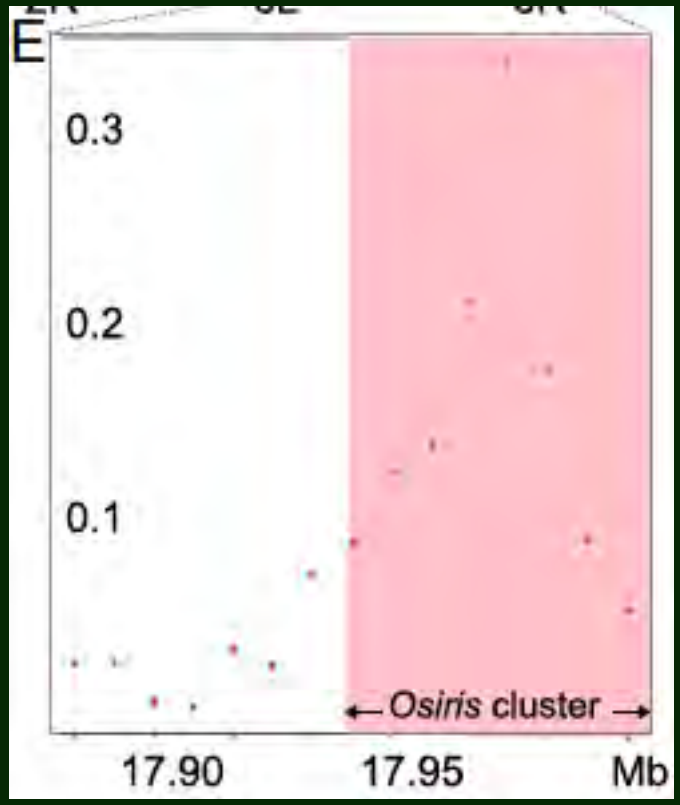
Candidate region 2: GMC, *Flo2*







Candidate region 3: *Osiris*



A Locus in *Drosophila sechellia* Affecting Tolerance of a Host Plant Toxin

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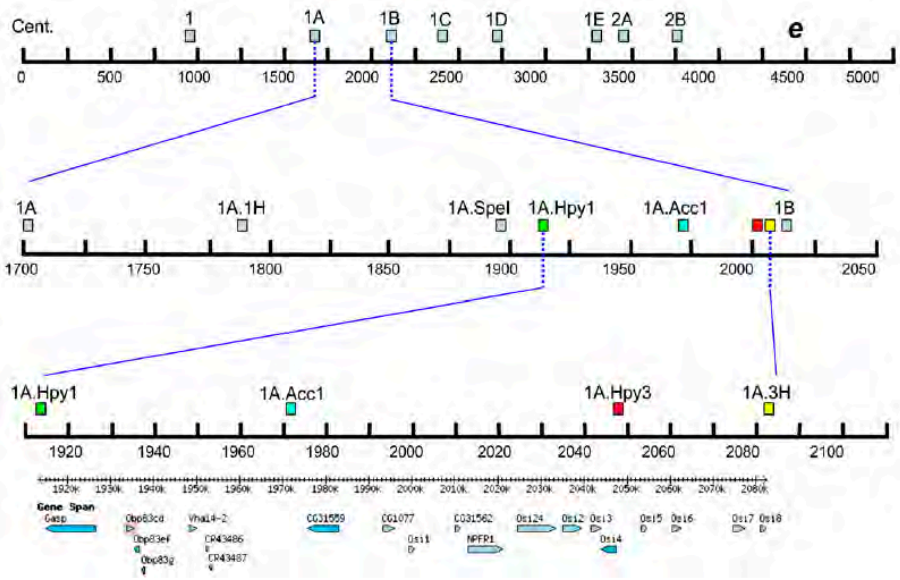
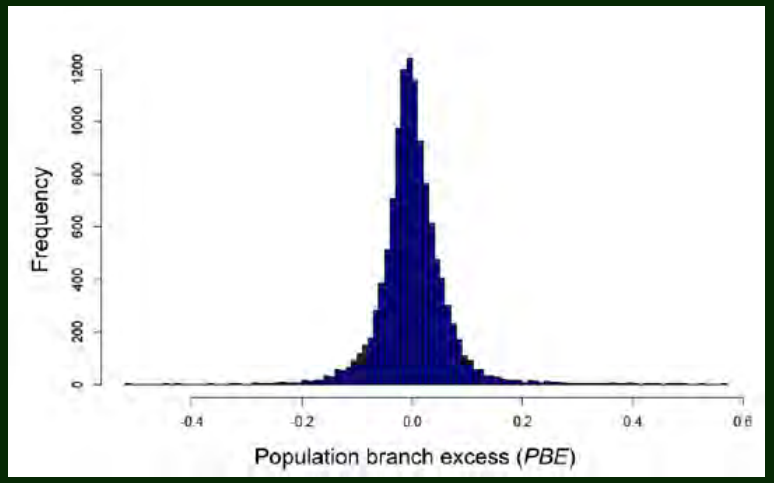


Tolerance region harbors several candidate loci

Of the 18 genes in this region, two gene families represented two-thirds of the total and only three remain unnamed. A cluster of nine *Osiris* genes was present, along with three *Obps*. None of these 18 genes, however, showed a strong signature of positive selection that may be expected for a gene contributing to *D. sechellia* adaptation to its host.

Genomic parallelism with *D. sechellia*



- Larval tolerance to octanoic acid (Huang & Erezyilmaz 2015 *G3*)
  - 4 of 9 QTLs (*P* = 0.013)
- Adult tolerance to octanoic acid (Hungate et al. 2013 *Genetics*)
  - 1 of 1 QTL (*P* = 0.008)
- Adult attraction to noni volatiles (Earley & Jones 2011 *Genetics*, C. B. Jones, pers.)
  - 3 of 13 QTLs (*P* = 0.200)

Conclusions: an 'ecological speciation continuum'

- Specialization on noni occurred twice on independent islands:
  - *D. sechellia*, 250000 ya, large QTLs (~2 Mb), pre- and post-zygotic isolation
  - *D. yakuba*, 29000 ya, small windows (~20 kb), pre-zygotic isolation
- Similar detoxification genes strongly selected for
- Different genes or weak selection on preference genes
- Similar pathways may involved other *Drosophila* and herbivorous species

Acknowledgements

Jean R. David
(CNRS, Gif-sur-Yvette)

John E. Pool
Héloïse Bastide
(University of Wisconsin-Madison, Madison)

Vincent Debat
Nelly Gidaszewski
(MNHN, Paris)