Rampant gene duplication facilitates Y-linked gene evolution in the *Drosophila simulans* clade

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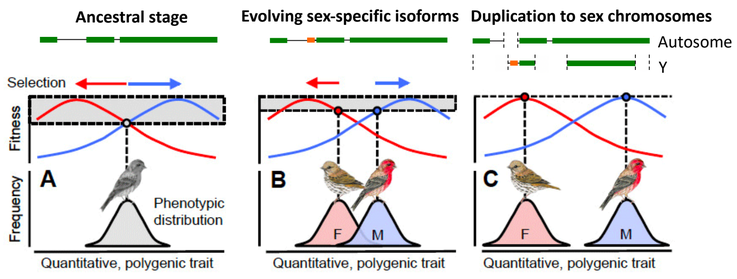
Summary

I. Long sequencing and *de novo* assembly of the Y chromosomes in *D. melanogaster* and *simulans* clade species
II. Rapid evolution of structure and gene content on Y chromosomes
III. Intralocus genetic conflicts and gene duplication

Conflicts and Y chromosomes

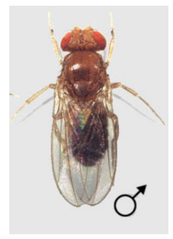
Resolving intralocus sexual antagonism

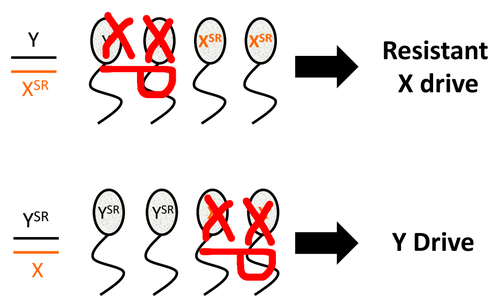


Accumulating male-specific genes

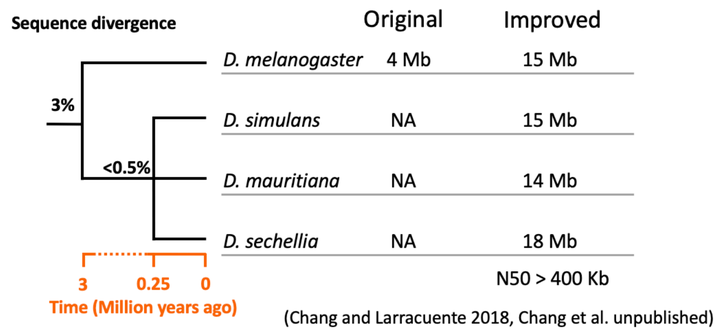
(Figure adapted from https://www.coxlabuva.org)

Sex-linked meiotic drive (sperm killer)





Improving Y assemblies

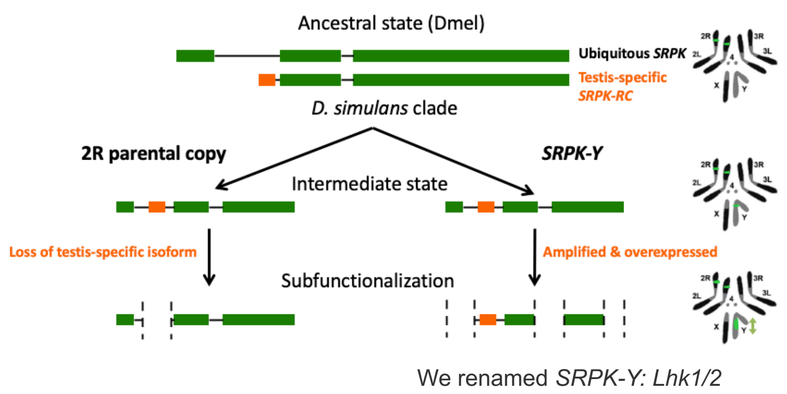


(Chang and Larracuente 2018, Chang et al. unpublished)

Y Chromosome Assembly	# of Contigs	Total size	Contig N50
D. melanogaster	80	14,578,684	416,887
D. simulans	38	13,717,056	1,031,383
D. sechellia	63	14,899,148	555,130
D. mauritiana	55	17,880,069	1,628,994

Y-linked ampliconic genes specific to the *simulans* clade

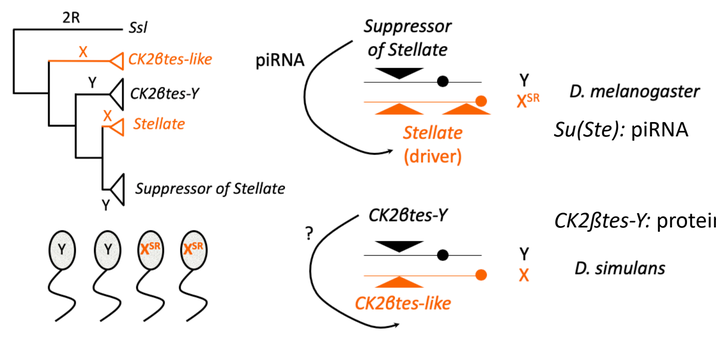
Translocation of a testis-specific isoform



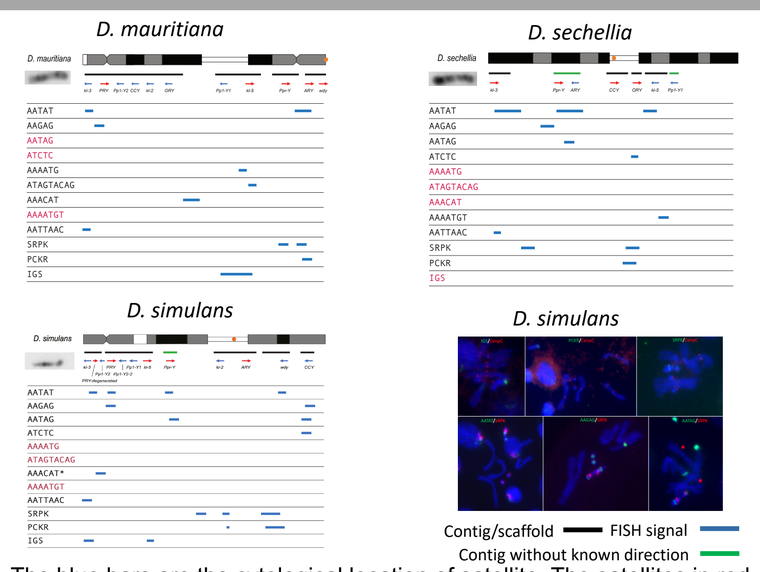
We renamed *SRPK-Y: Lhk1/2*

Co-amplification of a potential driver

Stellate (casein kinase) is an X-linked driver in *D. melanogaster*
Su(Ste) is a Y-linked suppressor of drive
Stellate and *Su(Ste)* genes are amplified. (Palumbo et al. 1994)

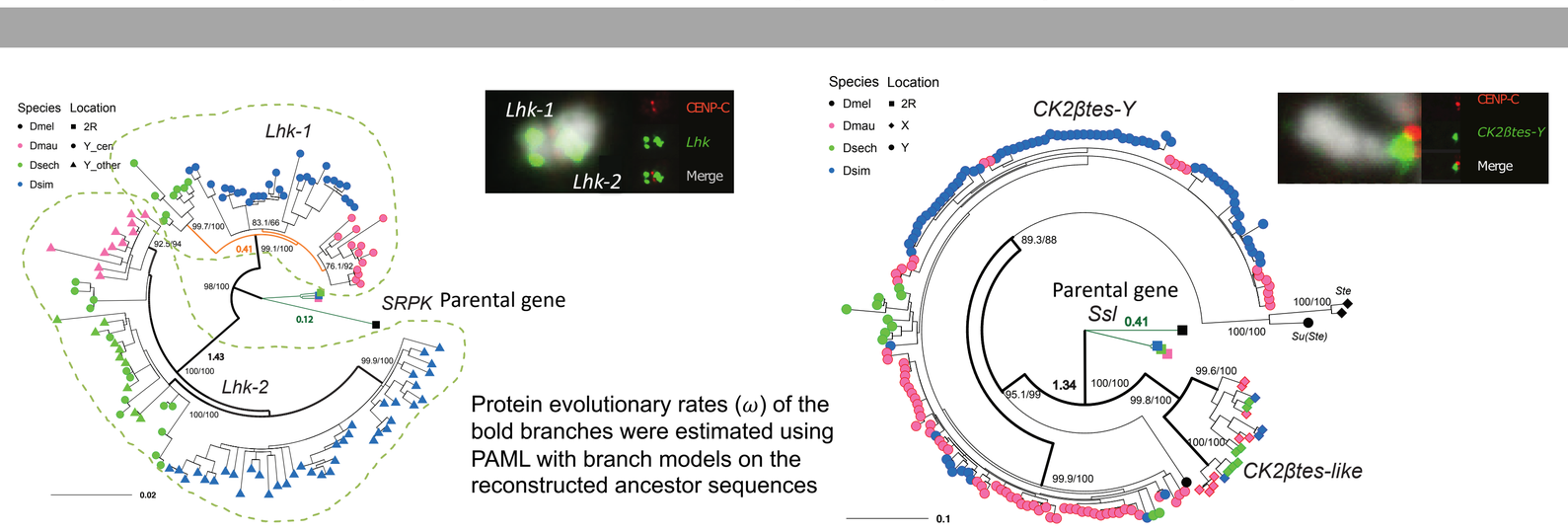


Placing contigs on the Y using FISH



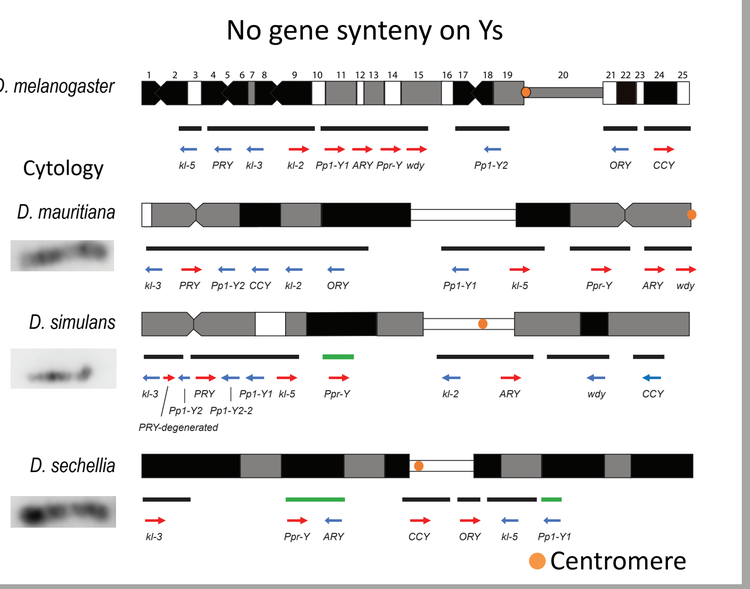
The blue bars are the cytological location of satellite. The satellites in red are sequences we cannot detect on Y chromosomes using FISH.

Strong positive selection on Y ampliconic genes ($\omega = 1.3–1.5$)



***Lo-han-kha (Lhk)* –** sleep in temples
The homeless male migrants that moved from the mainland China to Taiwan.

Extensive rearrangement of Y-linked genes



SRPK has different roles in each sex

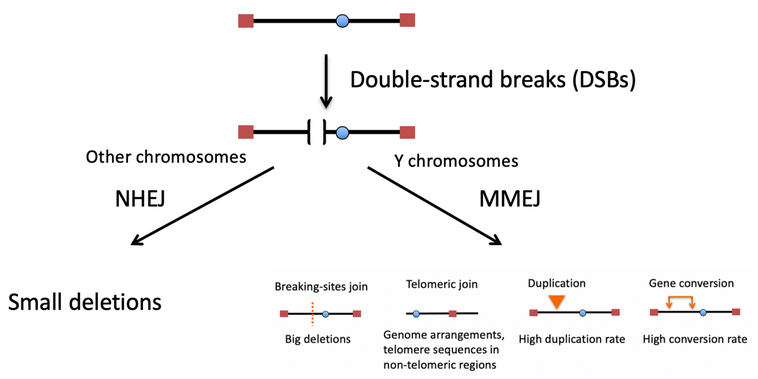
I. Testis-specific isoform, *SRPK-RC,* is recently acquired in melanogaster group
II. *SRPK* knockout is sterile in both sexes
III. Two *SRPK* mutants are only sterile in females
IV. Ubiquitous *SRPK* isoforms are expressed premeiotically and are localized to cytoplasm and nucleolus in testes
V. *SRPK-RC* is only expressed in primary spermatocytes

Common features of ampliconic Y genes

I. Positive selection after duplicating to the Y
II. Massive copies (>40) on Ys
III. High gene conversion between Y copies (10^{-4} to 10^{-6} event per bp/generation)
IV. Nuclear localization and function in serine phosphorylation

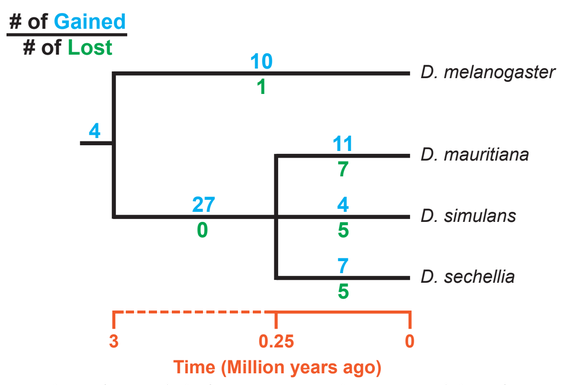
Y-specific mutation patterns?

Model: Microhomology-mediated end joining
I. NHEJ is rare in heterochromatin regions
II. No homologous recombination



Rapid turnover of duplicated genes on Ys

Many genes duplicated to Y from other chromosomes
>50% of new Y-linked genes are degenerated



*whole mitochondrial genome inserted in the ancestral *simulans* clade Y

Ongoing

I. Exploring functional divergence between *SRPK-RC, Lhk-1, and Lhk-2*
II. What drives positive selection and amplification of multicopy Y-linked genes?
III. Do the sequence and copy number divergences between species contribute to hybrid sterility in *D. simulans* clade?

References

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Acknowledgements

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