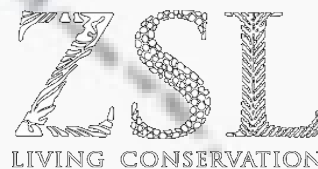
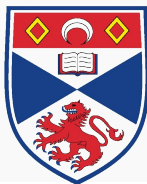


# CHEMOPERCEPTION IN THE FRUIT FLY

## THE GENOME'S STORY

***Gardiner, D. Barker, W. Jordan, R. Butlin, M. Ritchie***

fruit Fly



The  
University  
Of  
Sheffield.

# GENETICS

## *Genomes*

Chemoreceptor  
Gene  
Superfamily:

*Olfactory  
Receptors*

*Gustatory  
Receptors*



# ECOLOGY

*Volatile*

*Soluble*

Chemical Cues of

host plants, food,  
oviposition sites,

toxins,

mates (pheromones)



***~120 Olfactory and Gustatory receptors***

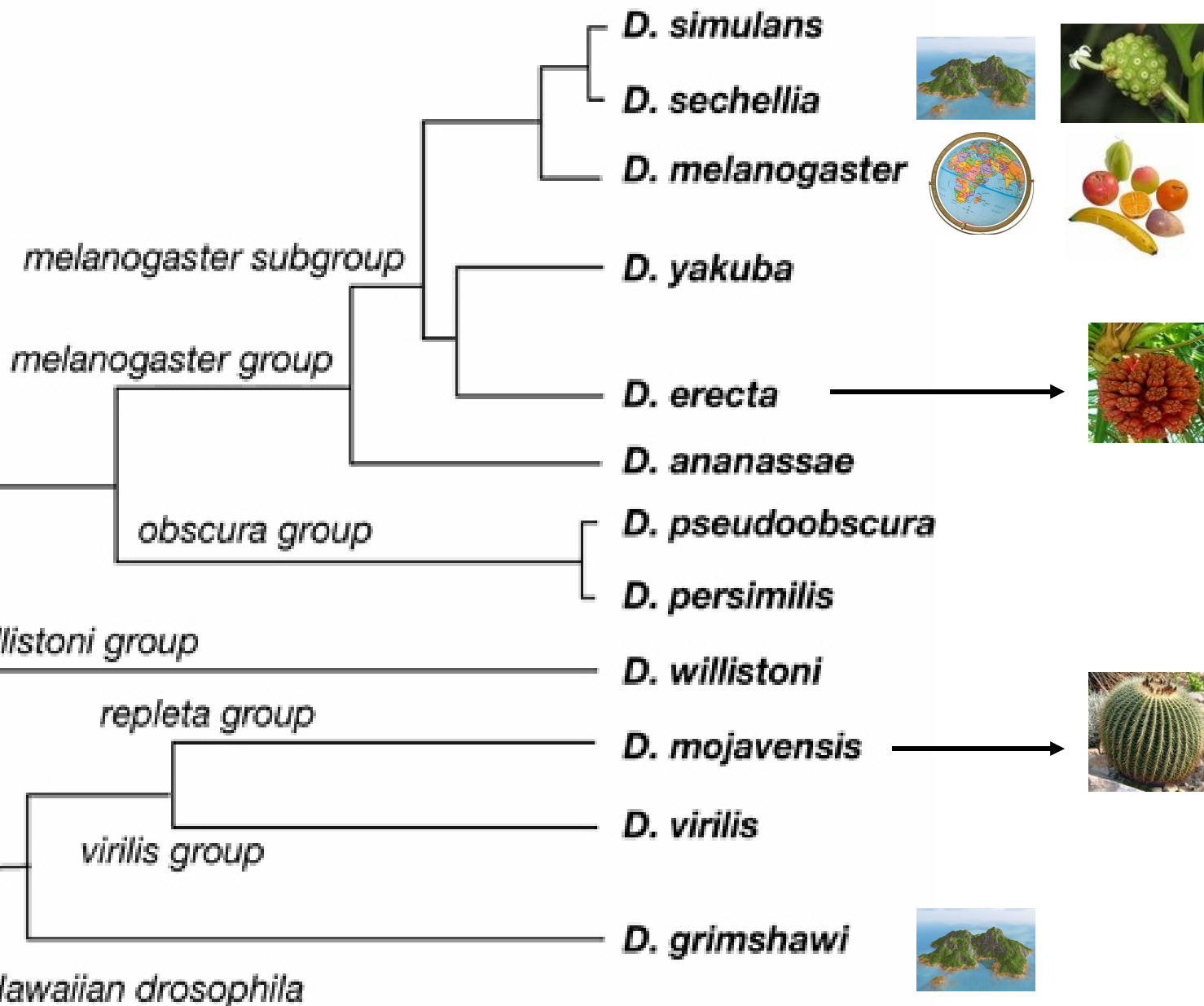


***~150 Olfactory and Gustatory receptors***

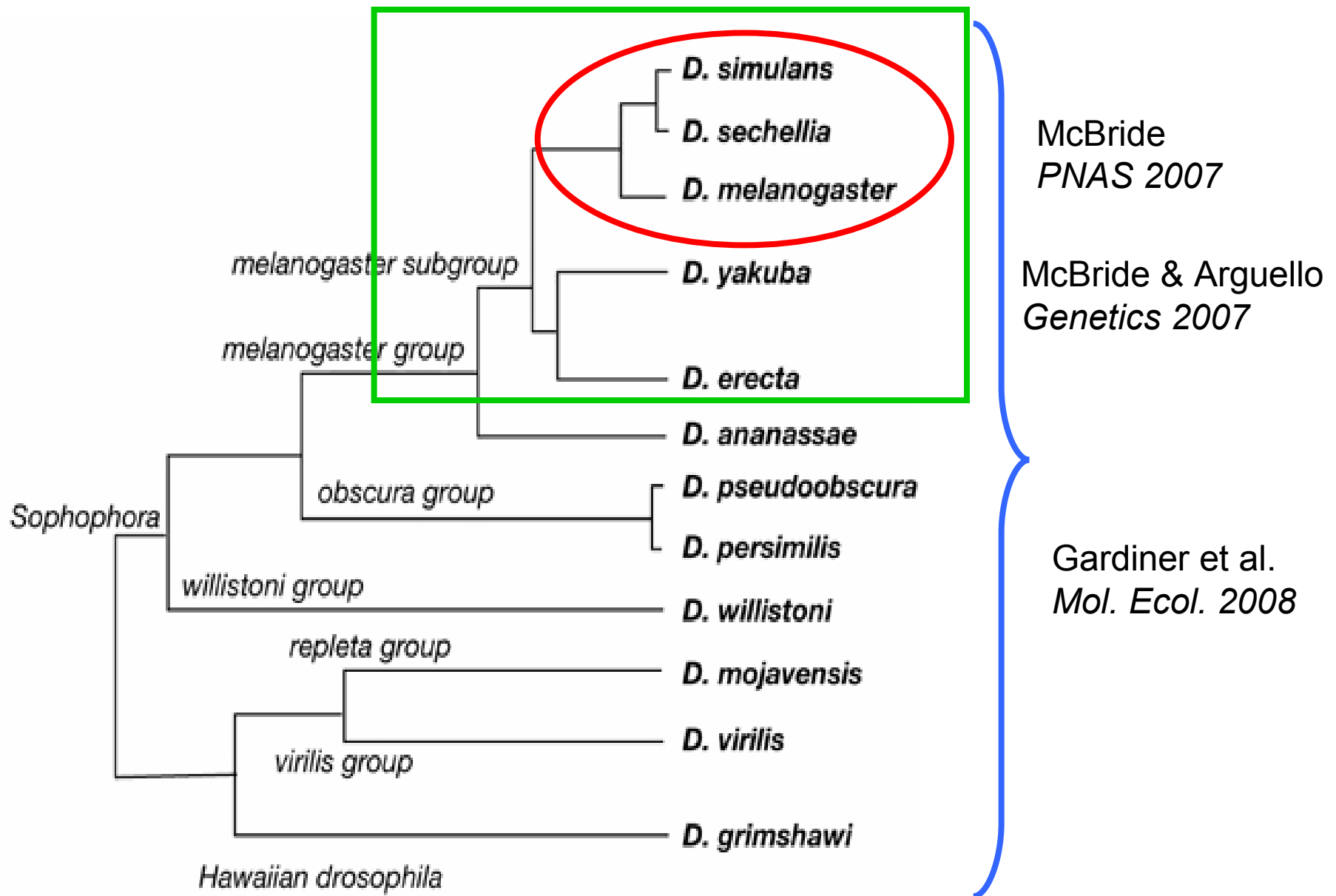


***~170 Olfactory and Gustatory receptors***

# 12 DROSOPHILA GENOMES



# Comparison of the Olfactory and Gustatory receptor gene families



McBride  
*PNAS* 2007

McBride & Arguello  
*Genetics* 2007

Gardiner et al.  
*Mol. Ecol.* 2008

# METHODS

Dmel-ORs and GRs

tBLASTn (aa/nt)

12 Drosophila genomes

GeneWise + manual curation

Verification of orthology: reciprocal BLAST, phylogeny, Inparanoid

**Test the orthologues genes for positive selection: PAML**

- b) rates of Ka (amino acid mutations) and Ks (mutations do not lead to amino acid change)
- c)  $\omega = K_a/K_s$  – indicate selective constrains on gene
- d)  $\omega < 1$  – purifying selection against Ka;  $\omega > 1$  – positive selection for Ka (adaptive evolution)

Statistical tests: standard regression, t-tests, the general linear model

Phylogenetical correction of the statistical tests with CONTINUOUS1.0d13

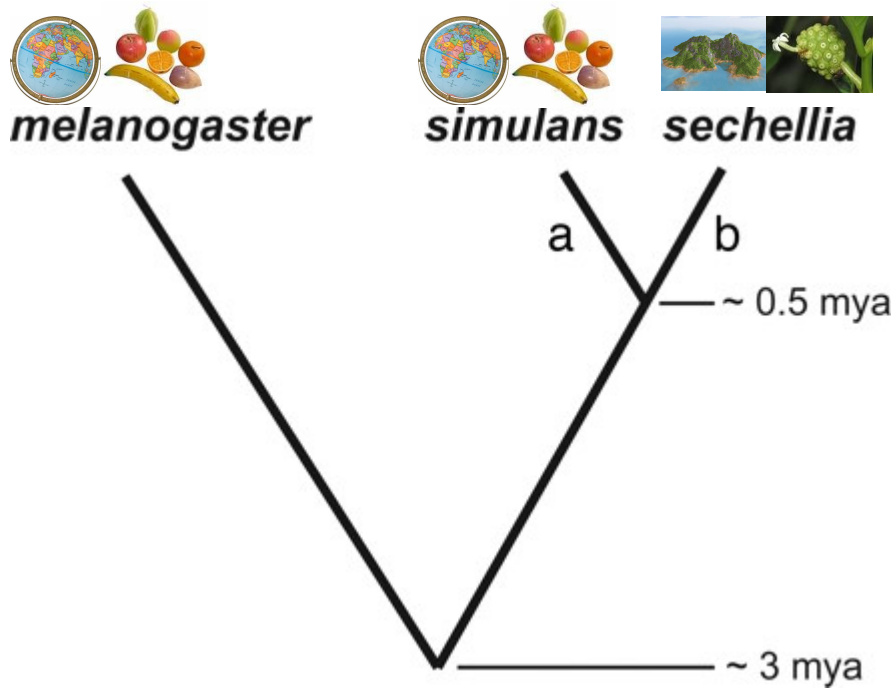


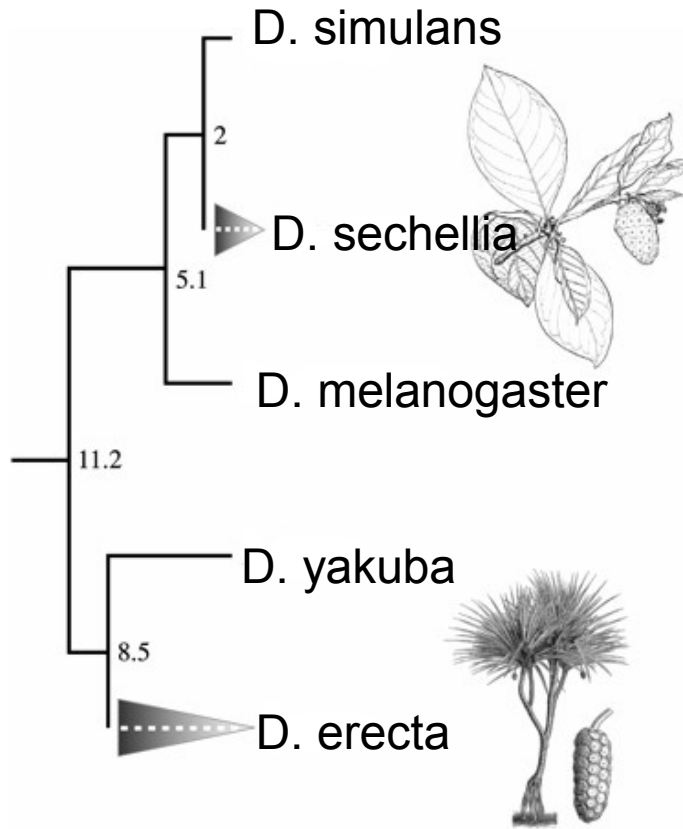
Table 1. The number of receptor and control genes that became pseudogenes along the *sechellia* and *simulans* lineages

Genes	Status	<i>D. sechellia</i> , n	<i>D. simulans</i> , n	P value*
Or	Pseudo	6	0	0.012
	Intact	57	63	
Gr	Pseudo	13	2	0.003
	Intact	60	71	
Ors + Grs	Pseudo	19	2	0.0001
	Intact	117	134	
Controls†	Pseudo	9	2	0.03
	Intact	181	188	

*D. sechellia* is losing Or and Gr nearly 10 times faster than generalist *D. simulans* (this trend is also significant for 190 randomly selected genes – Table 1)

*D. sechellia* intact receptors have fixed amino acid replacement mutations at a higher rate relative to silent mutations than have their *D. simulans* orthologs (this trend is also significant for 190 randomly selected genes).

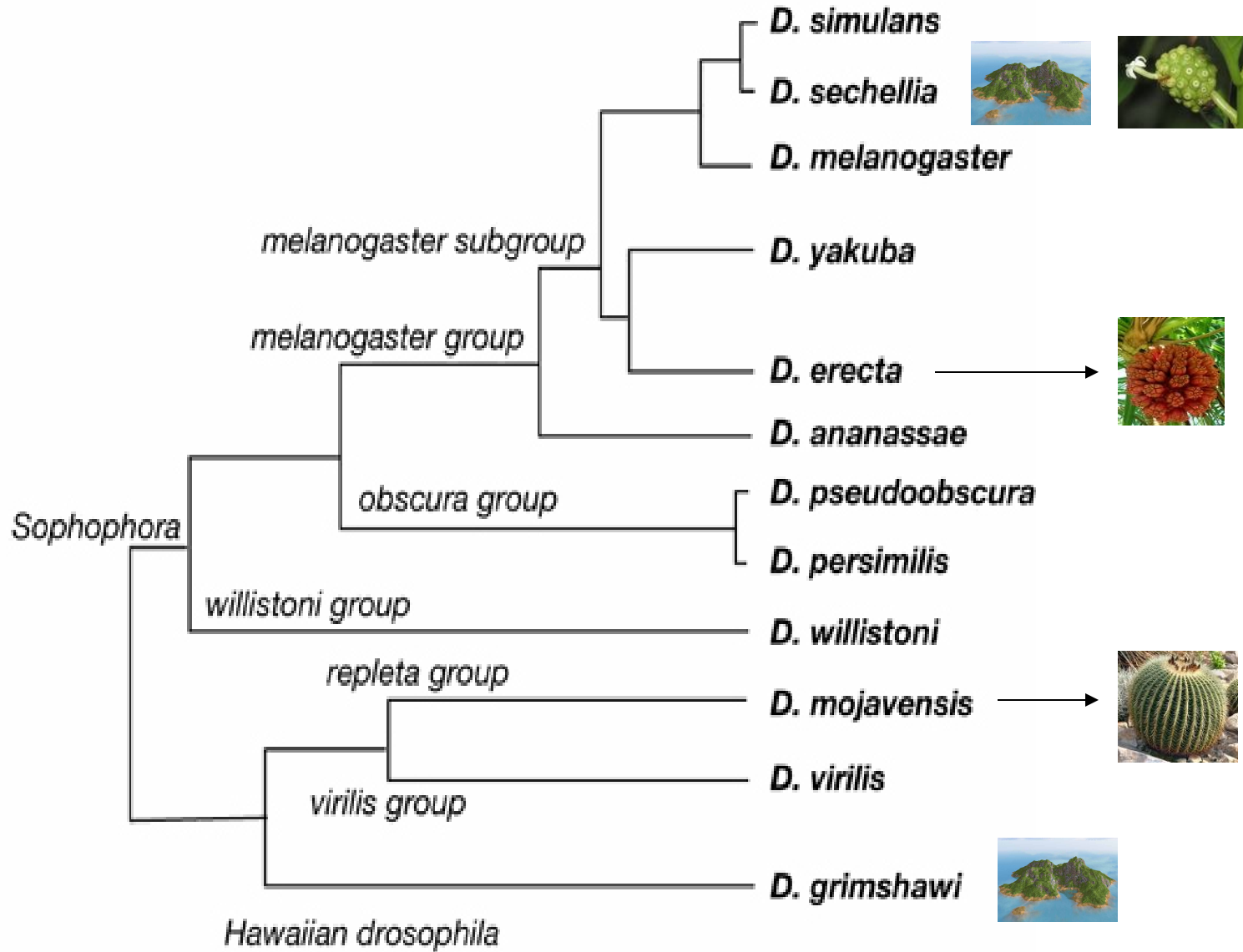
# Host Specialization!



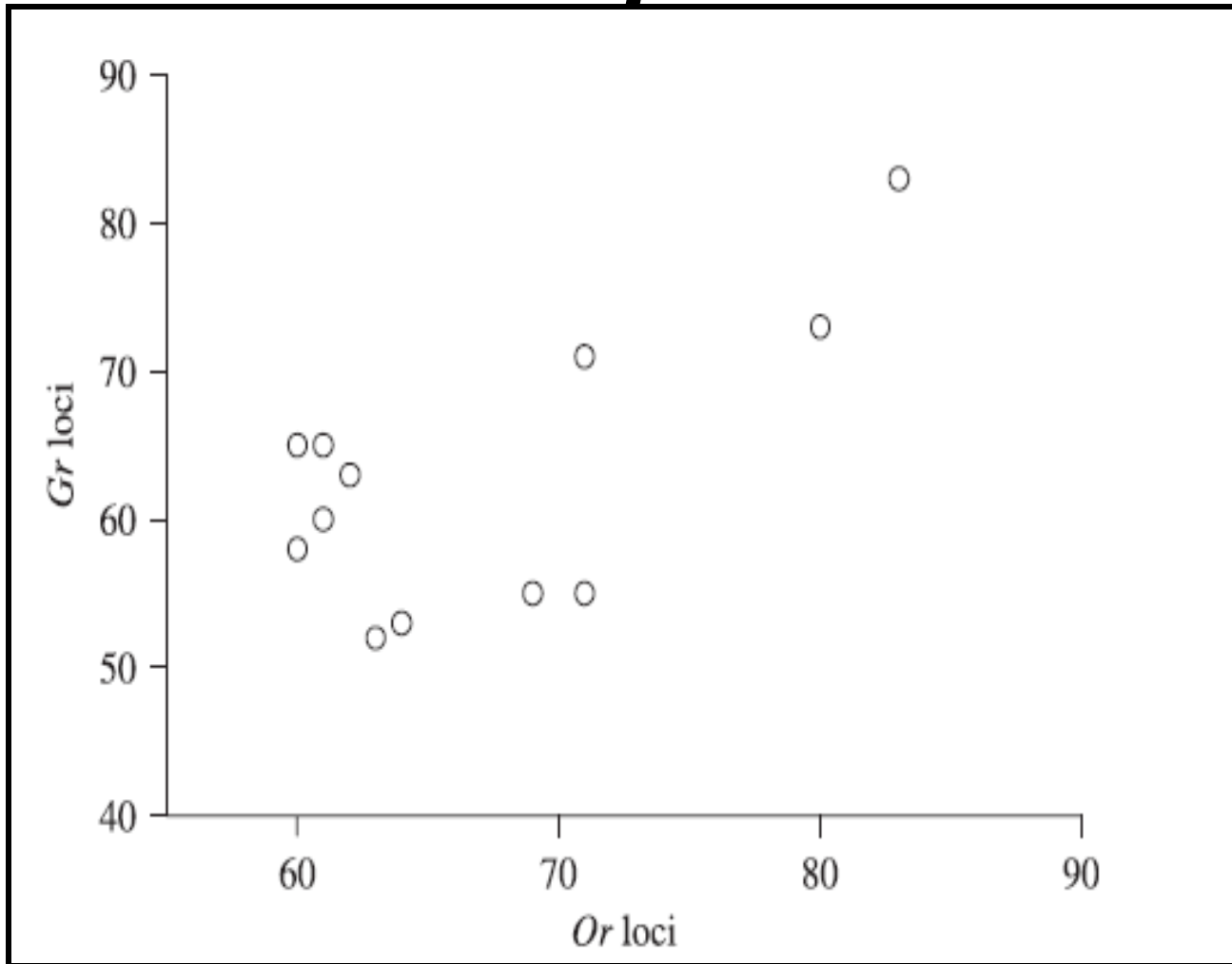
Rapid OR loss is not a general characteristic of host specialization in flies, but 2 specialist species lost bitter GRs at faster rate than generalist species.

Specialist lineages have higher  $K_a/K_s$  rates in ORs and GRs, but it is also a genome wide phenomena.

# Evolution of the ORs and GRs in 12 *Drosophila* species

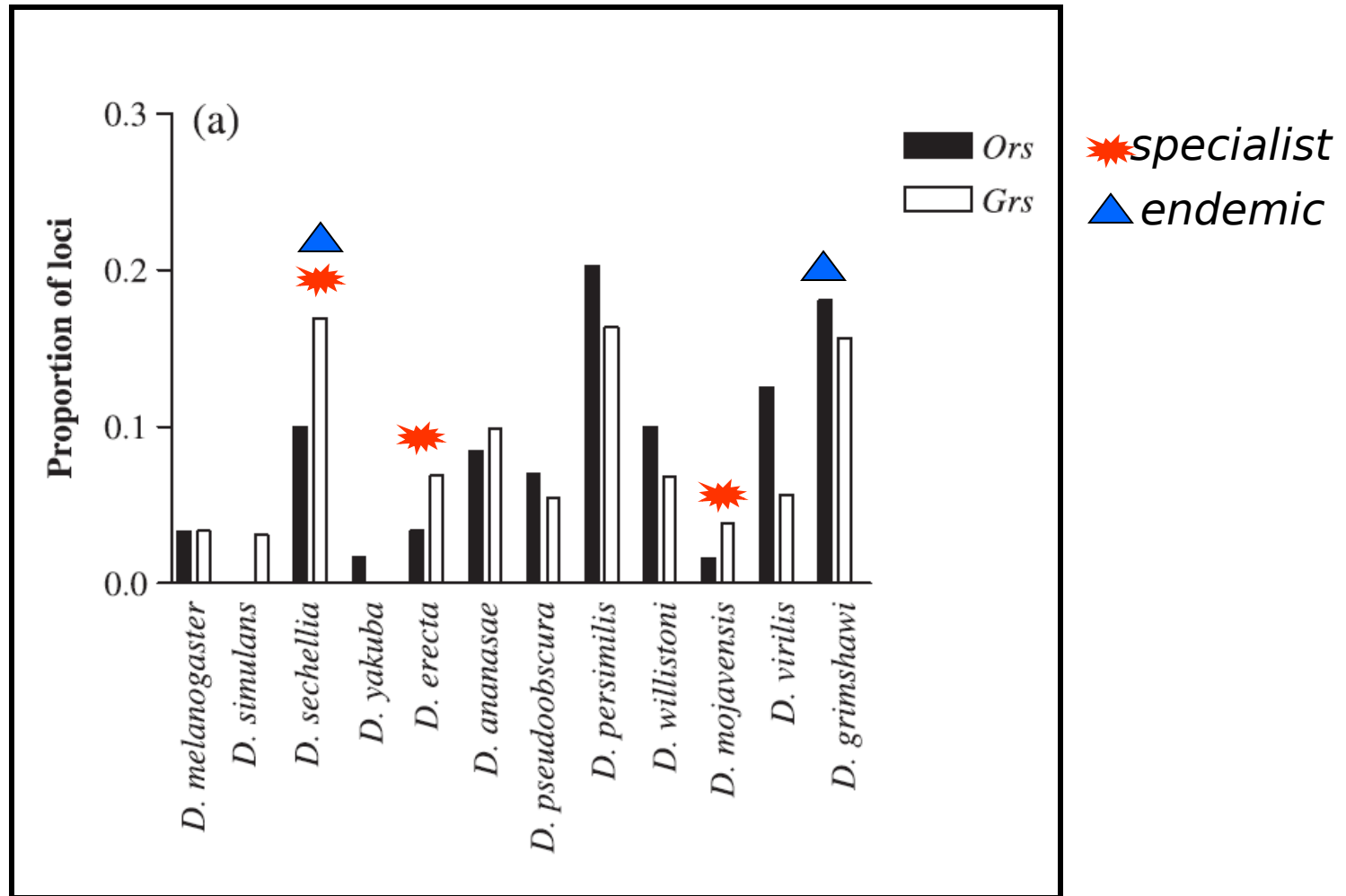


# ***The sizes of GR/OR repertoires in Drosophila***



$(r = 0.664, P = 0.019)$

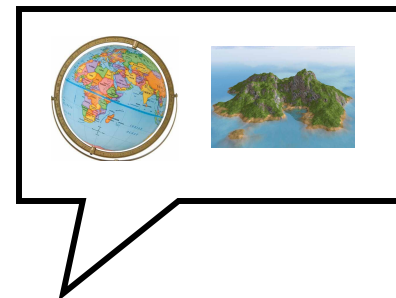
# The Proportion Of Pseudogenes



The proportion of pseudogenes classified by species and receptor type shows that the proportion of pseudogenes varies significantly among species [ $P < 0.001$ ].

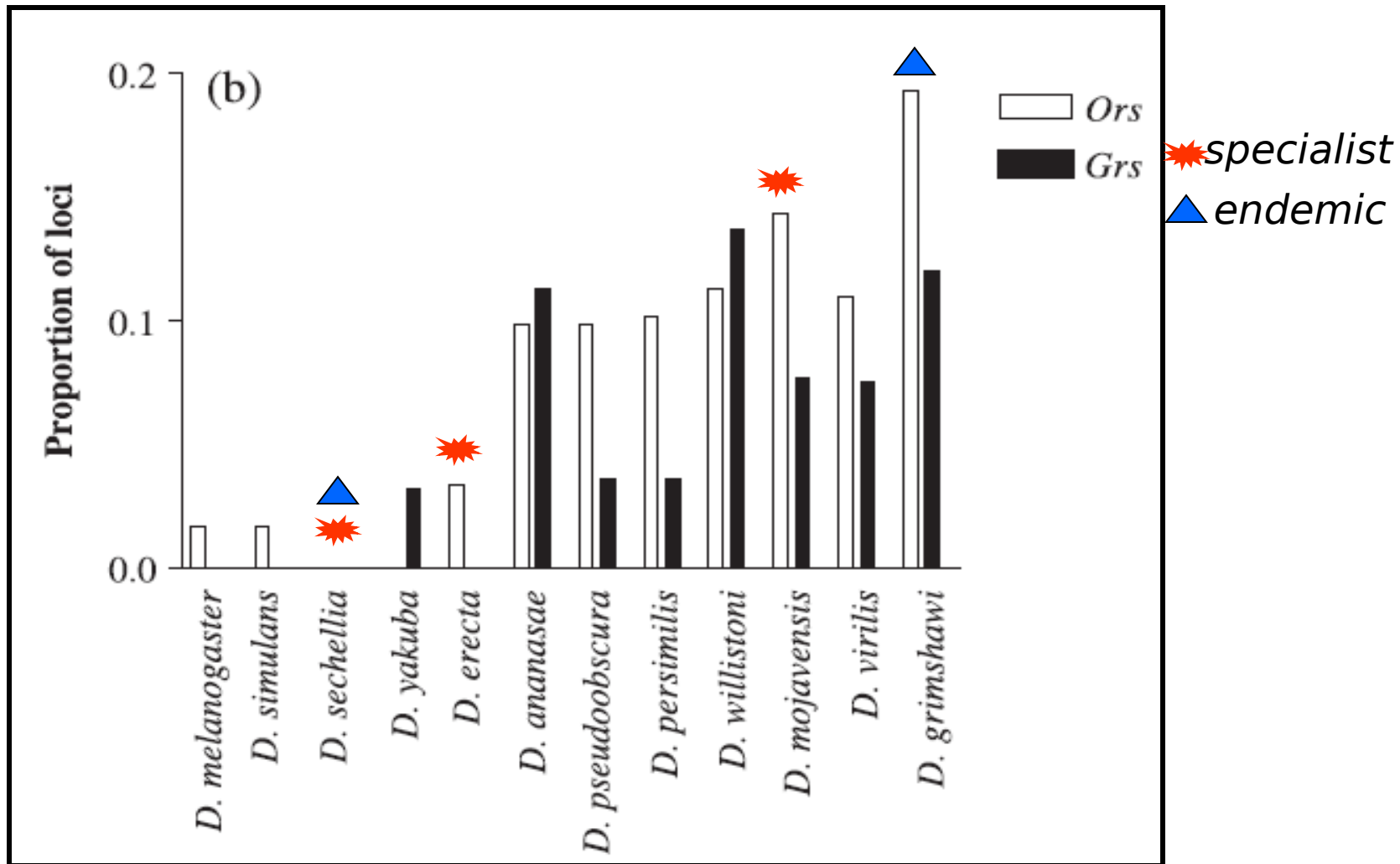
# ***Predictors of gene family size***

**The proportion of pseudogenized loci across both families did not differ between the specialist vs. generalist species ( $t = 0.30$ , d.f. = 3,  $P = 0.78$ ).**



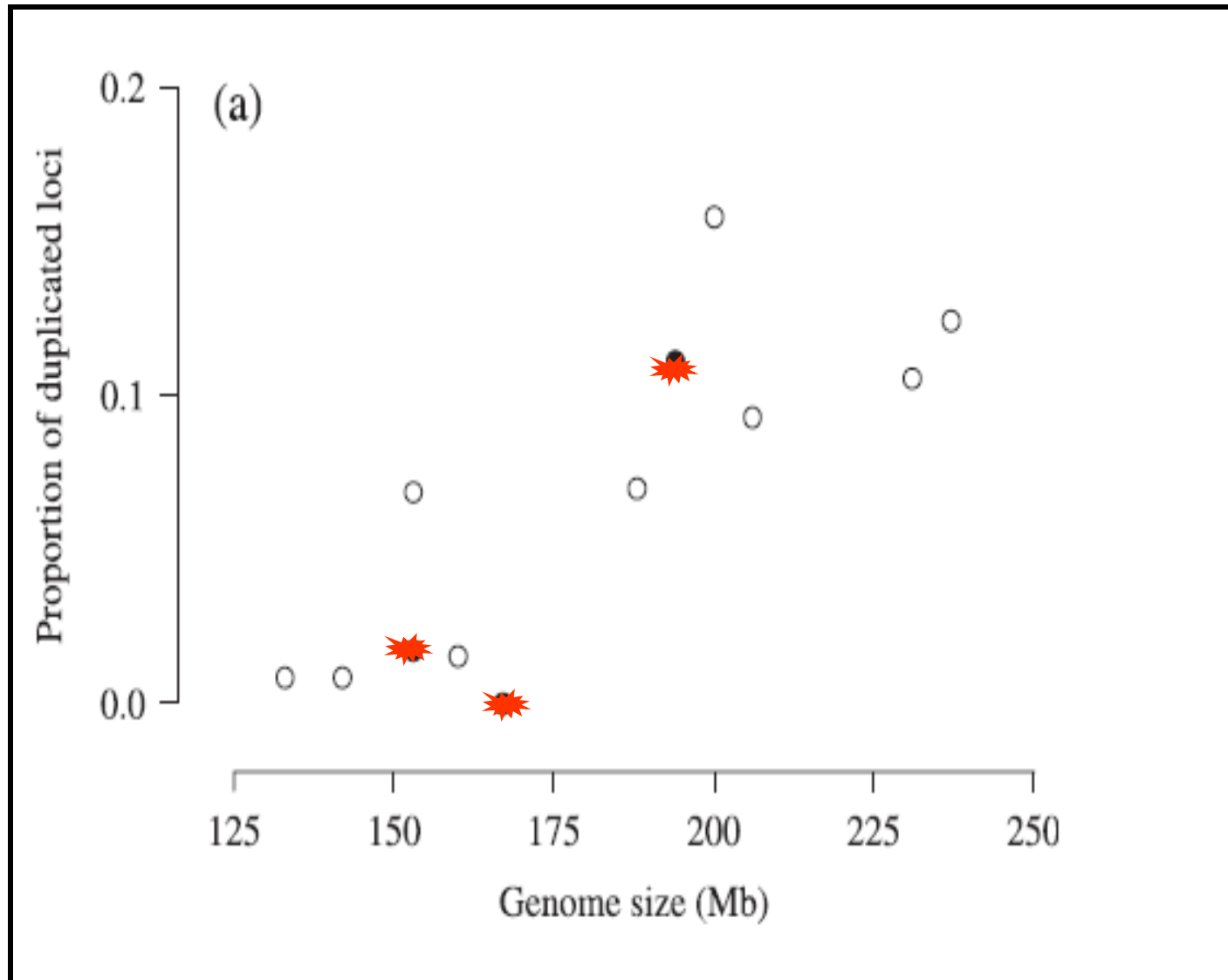
**The proportion of pseudogenized loci did differ between island vs. mainland species ( $t = 3.75$ , d.f. = 3,  $P = 0.033$ , mean 0.07 and 0.15 for mainland and island species, respectively).**

# The Proportion Of Duplicated Loci



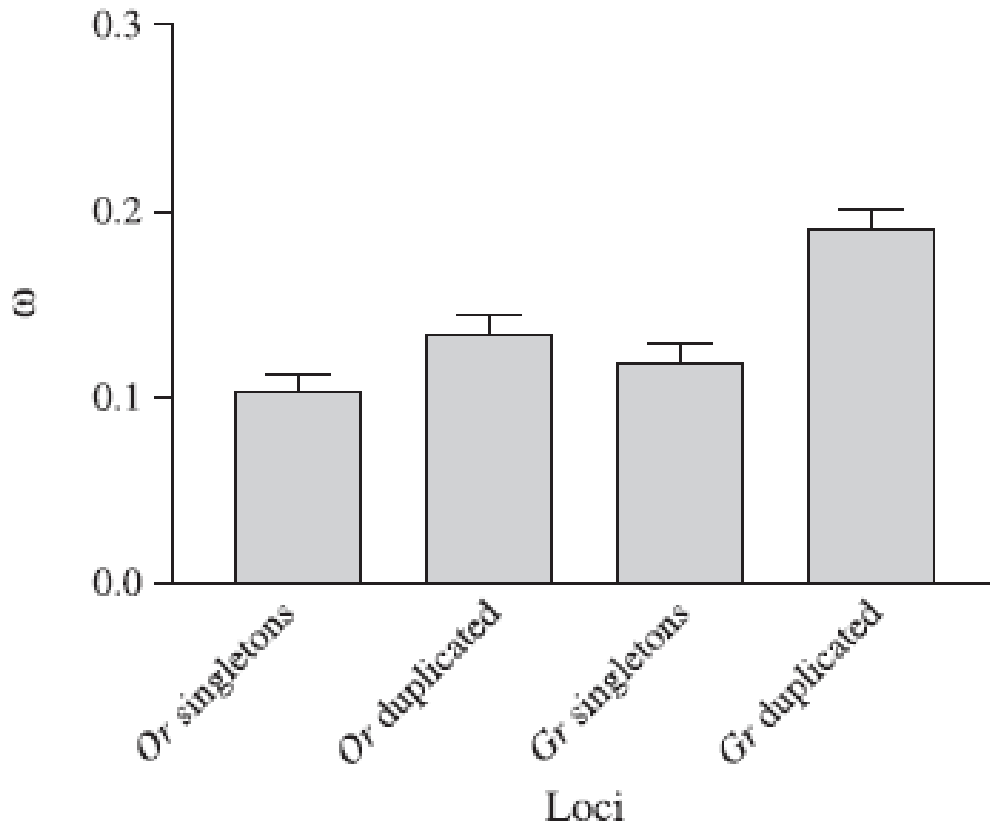
The proportion of duplicated loci varies significantly between species

# The Proportion Of Duplicated Loci vs. Genomes Size



# ***Selection analysis*** $\omega = Ka/Ks$

$\omega < 1$ , purifying selection



$\omega$  was smaller for

1) OR than GR loci ( $P < 0.001$ )

2) singletons than duplicated loci

( $P < 0.001$ )

There was a slight interaction so that  $\omega$  was weakest for duplicated **GR** loci

# *Conclusions*

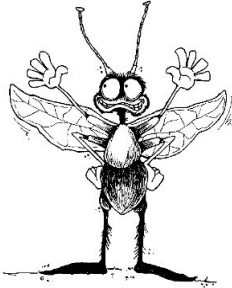
1. Or/Gr gene families evolve through gene duplication, pseudogenization, gene loss.
2. The best predictor of the extent of gene duplication is total genome size.
3. Genes which are prone to duplication show evidence of relaxed constraints, which will facilitate evolutionary divergence in receptor function between these loci.
4. We find a significant effect of endemism rather than specialization on the proportion of pseudogenes.



# OUR GROUP:



**M. Ritchi**



**D. Barker R. Butlin**



**W. Jordan**

**e**  
A. Gardiner



J. Lu  
D. Wengraff



The  
University  
Of  
Sheffield.

J. Nielsen

