Supp. Table 1 - Sex differences in recombination landscapes summarized across taxa.

Species	Sex chromosomes	Greater overall recombination	Greater recombination at telomeres	Greater recombination at centromeres / chromosome centers (*)	Notes	Sources
Eutherian Mammals						
Bos taurus (cattle)	XY	M	M	N.S.		Ma et al. (2015), Wang et al. (2016b)
Canis familiaris (domestic dog)	XY	F	M	F		Wong et al. (2010), Campbell et al. (2016)
Cervus elaphus (red deer)	XY	F	M	F	Male recombination marginally elevated near telomeres.	Johnston et al. (2017)
Homo sapiens (human)	XY	F	M	F		Broman et al. (1998), Kong et al. (2002)
Mus musculus (house mouse)	XY	F	M	F	No recombination near centromeres in males. Elevated near centromeres in females.	Shifman et al. (2006), Paigen et al. (2008), Cox et al. (2009)
Ovis aries (Soay sheep)	XY	M	M	N.S.	Elevated near telomeres in males unless near centromere (i.e., acrocentric chromosomes). Reduced near telomere in females.	Johnston et al. (2016)
Pan troglodytes (chimpanzee)	XY	F	M	F	Elevated near telomeres in males. Relatively uniform in females.	Venn et al. (2014)
Sus scrofa (domestic pig)	XY	F	F	N.S.	Elevated near telomeres regardless of centromere position in both sexes, somewhat more strongly in females.	Tortereau et al. (2012)

Marsupials						
Monodelphis domestica (gray short-tailed opossum)	XY	M	F	M*	Chiasmata cluster near telomeres in females. Majority are interstitial in males.	Hayman et al. (1988)
Sminthopsis crassicaudata (fat-tailed dunnart)	XY	M	F	M*	Chiasmata cluster near telomeres in females. Majority are interstitial in males.	Bennett et al. (1986)
Birds						
Anser anser (gray goose)	ZW	F	M	N.S.	Subtelomeric peaks more pronounced in males.	Torgasheva and Borodin (2017)
Columba livia (rock dove)	ZW	N.S.	N.S.	N.S.	Distribution of recombination nodules similar between sexes.	Pigozzi and Solari (1999)
Coturnix japonica (Japanese quail)	ZW	N.S.	N.S.	N.S.	COs evenly distributed in both sexes.	Calderon and Pigozzi (2006)
Ficedula albicollis (collared flycatcher)	ZW	M	M	N.S.	Elevated near telomeres in males. Very low at extreme terminal ends in females.	Smeds et al. (2016)
Parus major (great tit)	ZW	N.S.	N.S.	M*	Varies by chromosome. Most commonly male-biased in chromosome centers.	Van Oers et al. (2014)
Taeniopygia guttata (zebra finch)	ZW	N.S.	N.S.	N.S.	Elevated near telomeres in males and females.	Backström et al. (2010)
Reptiles						
Crocodylus porosus (saltwater crocodile)	ESD	F	M?	F	Elevated near telomeres in males. Relatively uniform in females. Did not provide direct comparison of male and female recombination rate at telomeres.	Miles et al. (2009)
Amphibians						
Hyla arborea (European tree frog)	XY	F	M	F*	Limited to telomeres in males. Relatively uniform in females.	Brelsford et al. (2016a)
Rana temporaria (common frog)	XY	F	M	F*	Limited to telomeres in males. Relatively uniform in females.	Brelsford et al. (2016b)

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Xenopus borealis (Marsabit clawed frog)	ZW	F	M	F*	Elevated at ends in males. Elevated in chromosome centers in females.	Furman and Evans (2018)
Xenopus laevis (African clawed frog)	ZW	F	M	F*	Elevated at ends in males. Elevated in chromosome centers in females.	Furman and Evans (2018)
Triturus cristatus (northern crested newt)	XY / ESD	M	M	F*	Chiasmata relatively uniform in males. Localized near center of chromosomes in females.	Watson and Callan (1963)
Triturus helveticus (palmate newt)	XY / ESD	?	M	F*	Chiasmata localized near telomeres in males. Relatively uniform in females.	Watson and Callan (1963)
Teleost Fish						
Danio rerio (zebrafish)	Polygenic	F	M	F		Singer et al. (2002)
Gasterosteus spp. (stickleback)	XY	F	M	F	Decreases with distance from telomere and increases with distance from centromeres in males. More uniform in females.	Sardell et al. (2018)
Notothenia coriiceps (Bullhead notothen)	?	N.S.	M	F	Elevated near telomeres in males. Elevated near centromeres in females.	Amores et al. (2017)
Hippoglossus hippoglossus (Atlantic halibut)	XY	F	M	F*	Male-biased in telomeric half, female-biased in centromeric half.	Reid et al. (2007)
Oncorhynchus mykiss (rainbow trout)	XY	F	M	F*	Male-biased near telomeres, female-biased in middle of chromosome.	Sakamoto et al. (2000)
Oreochromis spp. (tilapia)	Polygenic / ESD	N.S.	M	F*	Male-biased near telomeres, female-biased in middle of chromosome.	Lee et al. (2005)
Oreochromis niloticus (Nile tilapia)	Polygenic / ESD	F	N.S.	N.S.	Suppressed near telomeres and elevated in middles in both sexes.	Conte et al. (2018)
Paralichthys olivaceus (Japanese flounder)	XY / ESD	M	M	F	Elevated near telomeres in males. Elevated near centromeres in females.	Castaño-Sánchez et al. (2010)

Species						
Poecilia reticulata (Trinidadian guppy)	XY	F	M	F	Limited to telomeres in males. Relatively uniform in females.	Bergero et al. (2019)
Salmo salar (Atlantic salmon)	XY	F	M	F	Elevated near telomeres and reduced near centromeres in males. More uniform in females.	Moen et al. (2008), Lien et al. (2011)
Salmo trutta (brown trout)	XY	F	M	F*	Elevated near telomeres in males but not females.	Gharbi et al. (2006)
Salvelinus alpinus (Arctic char)	XY	F	M	F*	Elevated near telomeres and reduced near putative centromeres in males.	Woram et al. (2004)
Salvelinus fontinalis (Brook char)	XY	F	M	F*	Elevated near telomeres in males. Elevated toward center of chromosomes in females.	Sutherland et al. (2017)
Sparus aurata (gilthead sea bream)	Hermaphrodite	F	Variable	Variable	Variable: some chromosomes male-biased near telomeres, others female-biased in telomeres.	Franch et al. (2006)
Invertebrates						
Crassostrea spp. (oysters)	Hermaphrodite	F	M	F	Elevated near telomeres in males. Elevated near centromeres in females.	Wang et al. (2016a)
Pinctada maxima (silver-lipped pearl oyster)	Hermaphrodite	F	M	F		Jones et al. (2013)
Chorthippus jucundus (large green grasshopper)	XO	N.S.	M*	M	Higher in males across whole chromosome, but biased more towards telomeres and away from centromeres in females relative to males.	Cano and Santos (1990)
Chorthippus parallelus (meadow grasshopper)	XO	M	M*	M	Higher in males across whole chromosome, but biased more towards telomeres and away from centromeres in females relative to males.	Cano and Santos (1990)

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Species	System				Description	Reference
Chorthippus vagans (steppe grasshopper)	XO	M	M*	M	Higher in males across whole chromosome, but biased more towards telomeres in females relative to males.	Cano and Santos (1990)
Euchorthippus chopardi (Iberian straw grasshopper)	XO	M	M*	M	Higher in males across whole chromosome, but biased much more towards telomeres and away from centromeres in females.	Cano and Santos (1990)
Euchorthippus pulvinatus (eastern straw grasshopper)	XO	M	M*	M	Higher in males across whole chromosome, but biased more towards telomeres in females.	Cano and Santos (1990)
Omocestus panteli (Pantel's grasshopper)	XO	M	M*	M	Higher in males across whole chromosome, but biased more towards telomeres in females.	Cano and Santos (1990)
Litopenaeus vannamei (Pacific white shrimp)	ZW	N.S.	N.S.	N.S.	No significant difference between sexes.	Jones et al. (2017)
Plants						
Arabidopsis thaliana (thale cress)	Monoecious	M	M	N.S.	Elevated near telomeres in males. No difference in middles of chromosomes.	Giraut et al. (2011)
Brassica nigra (black mustard)	Monoecious	M	M	F	Elevated near telomeres in males. Elevated near centromeres in females.	Lagercrantz and Lydiate (1995)
Hordeum bulbosum (barley)	Monoecious	M	M	N.S.	Elevated near telomeres in males.	Devaux et al. (1995), Phillips et al. (2015)
Solanum spp. (tomato)	Monoecious	F	F	F	Reduced chromosome-wide in males.	de Vicente and Tanksley (1991)
Zea mays (maize)	Monoecious	N.S.	N.S.	N.S.	Fine-scale, but no broad-scale sex differences in recombination.	Kianian et al. (2018)

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787   Table Notes - "M" = males, "F" = females, "N.S." = no significant sex difference, "ESD" = environmental sex determination

788 **Supp. Figure 1** – The standard definition for a recombination hotspot fails to identify some sex-

789 specific recombination peaks, and confounds effects that are sex specific with those that are not.

790 Feature (1) is identified as male-specific hotspot because its peak is above the chromosome

791 average (dashed gray line). Feature (2) is not because its peak lies below the average. Feature

792 (3), which has identical effects in males and females, is only recognized as a hotspot in females.
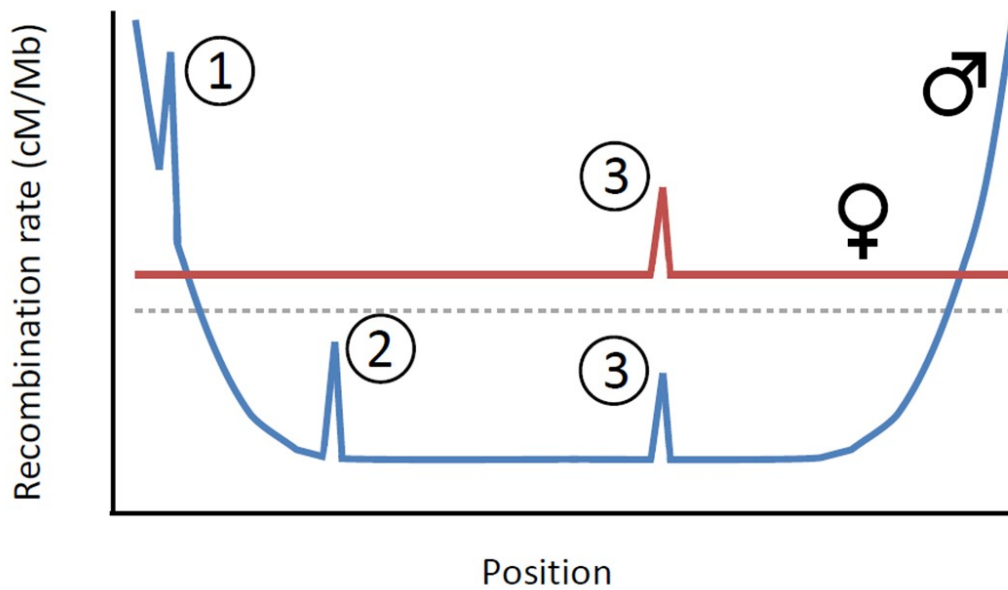
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794

795   **Supp. Material**: A model of sexually antagonistic *cis*-acting epistasis

796   We developed a simple model for the evolution of sex differences in recombination resulting from

797   sexually antagonistic *cis* epistasis (SACE). As explained in the text, the model is motivated by Equation

798   (32) of Lenormand (2003).

799   The model is of three loci. Loci R and C experience frequency-dependent selection which

800   maintains them polymorphic at a specified allele frequency. In the results shown here, we simply assumed

801   both loci have allele frequencies fixed at 0.5. In males, the loci interact epistatically such that haplotypes

802   R_0-C_0 and R_1-C_1 have fitness $(1 + \varepsilon)$ relative to the other two haplotypes. We assume fitnesses are

803   multiplicative across chromosomes, so the fitness of a diploid is the product of the fitnesses of its

804   haplotypes. Epistatic selection is absent from females.

805   The third locus, M, is a neutral recombination modifier. Initially the ancestral allele M_0 is fixed,

806   and recombination rates are equal in males and females. The linkage map is R-C-M, and the

807   recombination rates between adjacent loci are r_{RC} and r_{CM}. We study the fate of a rare mutation M_1 that

808   modifies the recombination rates. In males, the modifier multiplies both recombination rates by a factor K

809   (where $K < 1$ corresponds to decreased recombination). In females, recombination is increased by the

810   same amount, and so the sex-averaged recombination rate is unchanged.

811   We introduce the mutation at a very low frequency (10^{-6}) and simulate the dynamic equations to

812   determine how the mutation's frequency changes. After a few generations of initial transients, the

813   frequency increases or decreases by a constant proportion that represents the system's dominant

814   eigenvalue. This eigenvalue can be interpreted as the modifier's "effective selection coefficient", s_{eff},

815   which is the selection coefficient acting on a nonneutral locus that would produce the same rate of

816   change.

817   The model described here does not strictly speaking involve sexually antagonistic epistasis, but

818   rather sex-limited epistasis. We show that case here for the sake of simplicity. Because we are assuming

819   no epistasis in females, the effect of the modifier on recombination in females has no impact on the

820   outcome. Qualitatively similar outcomes do result with sexually antagonistic epistasis (that is, when

821   epistasis in females opposes that in males) so long as epistatic selection is stronger in males than females.

822   In that case, a modifier that decreases recombination in males and increases it in females will spread, as

823   predicted by Lenormand (2003).

824   Results from several representative simulations are shown below. The simulation code is

825   available from the authors on request.

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827

ε	r_{RC}	r_{CM}	K	s_{eff}
0	0.005	0.1	1.00	0
0.01	0.005	0.1	0.5	2.6×10^{-7}
0.01	0.005	0.1	0.25	4.1×10^{-7}
0.05	0.005	0.1	0.25	9.6×10^{-6}
0.05	0.005	0.2	0.25	7.6×10^{-6}

828   829   830   831   832   833

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