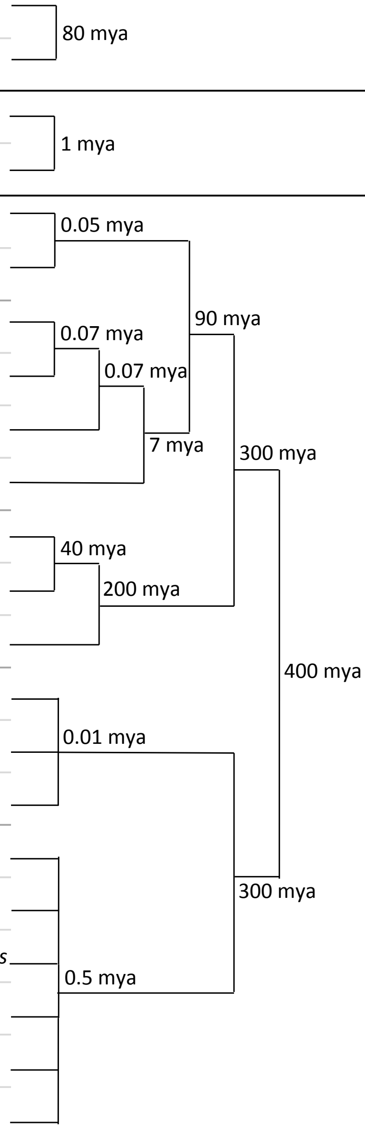
Table S1. Summary of cases detected by our literature search. Listed node ages are the means of all available estimates, rounded to the nearest highest significant figure. Node ages are only shown between taxa that evolved a similar phenotype (individual taxa with ancestral phenotypes are not shown). Initial genetic methods: m = genome-wide mapping; ct = complementation test; mcg = mapping of a candidate gene; cg = candidate gene. The column "Informative Candidate Genes Confirmed" refers to those candidate genes confirmed to contribute to the repeatedly evolved phenotype in the taxa specified in the same row, for which there is also evidence to draw upon regarding its contribution in the other taxa that evolved the same phenotype. A candidate gene was considered to have no effect if the assay used produced no evidence that the gene contributed to the trait. We recognize though, that assays were not always exhaustive and could not completely rule out an effect of the gene on the trait. Candidate genes considered to have no effect are listed (as "not ___") only when nothing more is known about the genetic basis of the phenotype.

Phenotype	Independent Origins In	Mean Estimated Node Ages (rounded to the nearest highest significant figure)	Initial Genetic Method	Estimated Relative Contrbution of Genes or QTL	Informative Candidate Gene(s) Confirmed	References
Larval trichome loss	*Drosophila montana*	2 mya	cg	--	*svb*	Dickinson et al. 1993[3]; Sucena and Stern 2000[3]; Sucena et al. 2003[1]; Tamura et al. 2004[2]; Morales-Hojas et al. 2011[2]
	Drosophila borealis	60 mya	cg	--	*svb*	
	Drosophila sechellia		m	*svb*: 1	--	
Skin toxin - caerulein	*Xenopus laevis*	200 mya	cg	--	*xlcae3p*	Hedges et al. 2006[2]; Roelants et al. 2010[1]; Roelants et al. 2011[3]
	Litoria splendida		cg	--	*lscae1p*	
Tetrodotoxin resistance	*Thamnophis couchii*	0.5 mya	cg	--	*Nav1.4*	de Queiroz et al. 2002[2]; Wüster et al. 2008[2]; Wood et al. 2011[2]; Feldman et al. 2012[1]
	Thamnophis atratus	2 mya	cg	--	*Nav1.4*	
	Thamnophis sirtalis	30 mya	cg	--	*Nav1.4*	
	Amphiesma pryeri	60 mya	cg	--	*Nav1.4*	
	Rhabdophis tigrinus	60 mya	cg	--	*Nav1.4*	
	Liophis epinephelus		cg	--	*Nav1.4*	
Lactase persistance	European *Homo sapiens*	0.05 mya	m	*LCT*: 1	--	Tishkoff et al. 2007[1]; Enattah et al. 2008[3]; Ingram et al. 2009[3]
	Saudi Arabian *H. sapiens*	0.1 mya	cg	--	*LCT*	
	Kenyan and Tanzanian *H. sapiens*		cg	--	*LCT*	
Reduction in lateral plate number	Paxton benthic *Gasterosteus aculeatus*		m	*Eda*: 0.83; *LG7*: 0.04; *LG10*: 0.08; *LG21*: 0.05	--	Orti et al. 1994[2]; Hatfield 1997[3]; Colosimo et al. 2004[3]; Cresko et al. 2004[1]; Schluter et al. 2004[3]; Colosimo et al. 2005[1]; Cano et al. 2006[3]; Kitano et al. 2008[3]; Bell et al. 2009[2]; Shapiro et al. 2009[1]; Le Rouzic et al. 2011[3]; Rogers et al. 2012[3]; Rogers pers. comm.[3]
	Cranby *G. aculeatus*		m	*Eda*: 0.98; LG7: 0.02	--	
	Paq; Graham; Bear Paw *G. aculeatus*	0.01 mya	m	*Eda*: 1	--	
	Boot Lake; Whale Lake *G. aculeatus*		ct	*Eda*: 1	--	
	Nakagawa Creek *G. aculeatus*	0.8 mya	ct	*Eda*: 1	--	
	6 Pacific freshwater populations of *G. aculeatus*		cg	--	*Eda*	
	5 Atlantic populations of *G. aculeatus*	10 mya	cg	--	*Eda*	
	5 Scandinavian populations of *G. aculeatus*	0.01 mya	cg	--	*Eda*	
	Fox Hole *Pungitius pungitius*		m	LG12: 1	--	

Trait	Taxon	Divergence	Type	Mapping	Candidate gene	References
Pelvic spine and girdle reduction	Paxton benthic *G. aculeatus*		m	*Pitx1*: 0.731; *LG1*: 0.073; *LG2*: 0.122; *LG4*: 0.074	--	Orti et al. 1994[2]; Cresko et al. 2004[3]; Shapiro et al. 2004[3]; Marks 2006[3]; Shapiro et al. 2006[1]; Coyle et al. 2007[3]; Bell et al. 2009[2]; Shapiro et al. 2009[1]; Chan et al. 2010[3]
	Boulton *G. aculeatus*	0.01 mya	m	LG4: 1	--	
	7 Alaska populations of *G. aculeatus*		cg	--	*Pitx1*	
	Dolomite; Orphia *G. aculeatus*	0.8 mya	cg	--	not *Pitx1*	
	Loch Fada *G. aculeatus*		m	*Pitx1*: 1	--	
	Loch Vifilsstadavat *G. aculeatus*		ct	*Pitx1*: 1	--	
	Loch Scadavay *G. aculeatus*	0.01 mya; 10 mya	cg	--	not *Pitx1*	
	Fox Hole *Pungitius pungitius*		m	LG4: 1	--	
Inability to use galactose	West African strains *Saccharomyces cerevisiae*	2 mya	m	*GAL3*: 1	--	Cliften et al. 2003[2]; Hittinger et al. 2004[1]; Beltrao and Serrano 2005[2]; Warringer et al. 2011[3]
	27361N strain *S. cerevisiae*	50 mya	ct	*GAL1*: 1	--	
	Saccharomyces kudriavzevii	300 mya	cg	--	*Gal 1 - Gal 7*	
	Candida glabrata	400 mya	cg	--	*Gal 1 - Gal 7*	
	Eremothecium gossypi and Kluyveromyces waltii		cg	--	*Gal 1 - Gal 7*	
Red floral pigmentation (system 1)	*Mimulus l. variegatus*	2 mya	mcg	*Pla2:* 1	--	Nie et al. 2006[2]; Cooley & Willis 2009[1]; Cooley et al. 2011[1]; Grossenbacher and Whittall 2011[2]
	Mimulus naiandinus	3 mya	ct	*Pla2:* 0	--	
	Mimulus cupreus		mcg	*Pla1:* 1	--	
Red floral pigmentation (system 2)	*Ipomoea Mina* clade	80 mya; 4 mya	cg	--	*F3'h*	Stefanovic et al. 2002[2]; Hedges et al. 2006[2]; Streisfeld & Rausher 2009[1]; Des Marais et al. 2010[3]; Smith & Rausher 2011[1]
	Ipomoea horsfalliae		cg	--	*F3'h*	
	Iochroma gesnerioides	70 mya	cg	--	*Dfr*	
Electrical activity of myogenic electric organ	*Mormyroids*	300 mya	cg	--	*Scn4aa*	Hedges et al. 2006[2]; Zakon et al. 2006[1]; Arnegard et al. 2010[3]; Lavoué et al. 2012[2]
	Gymnotiforms		cg	--	*Scn4aa*	
Red wing patterns	*Heliconius melpomene*	20 mya	m	*optix*: 1	--	Baxter et al. 2008[3]; Papa et al. 2008[3]; Pohl et al. 2009[2]; Quek et al. 2010[3]; Reed et al. 2011[1]
	Heliconius erato		m	*optix*: 1	--	
Digestion of foregut-fermenting bacteria	*Pygathrix nemaeus*	10 mya	cg	--	*RNase1B*	Zhang et al. 2002[3]; Zhang 2003[1]; Hedges et al. 2006[2]; Sterner et al. 2006[2]; Zhang 2006[3]; Fabre et al. 2009[2]
	Colobus guereza	90 mya	cg	--	*RNase1beta; RNase1gamma*	
	ruminant artiodactyls		cg	--	*bovine pancreatic RNase gene*	
Life history (latitudinal clines*)	Australian *D. melanogaster*	0.0003mya	cg	--	*InR*	David and Capy 1988[2]; Paaby et al. 2010[1];
	North American *D. melanogaster*		cg	--	*InR*	



Ultrahigh-frequency hearing for echolocation	Yangochiroptera and Yinpterochiroptera◆	cg	--	*Prestin, Tmc1, Pjvk, Cdh23, Pcdh15, Otof*	Hedges et al. 2006[2], Liu et al. 2010[3], Davies et al. 2012[1], Shen et al. 2012[3]
	Tursiops truncatus	cg	--	*Prestin, Tmc1, Pjvk, Cdh23, Pcdh15, Otof*	
Rapid development rate	Clearwater *Oncorhynchus mykiss*	m	OC8: 0.80; OC9: 0.03 ;OC10: 0.02; OC14: 0.04; OC24: 0.04; Ocb: 0.07	--	McCusker et al. 2000[2]; Robison et al. 2001[3]; Sundin et al. 2005[3]; Nichols et al. 2007[3]; Miller et al. 2012[1]
	Swanson *O. mykiss*	m	tthR13 (same as OC8 above): 0.60; tthR9: 0.19; tthR6:0.21	--	
Reduced pigmentation (system 1)	European *H. sapiens*	m	✧*Kitlg*: 0.23; *SLC45A2*: 0.0175; *SLC45A5*: 0.315; *TYR*: 0.14; *Oca2*: 0.14	--	Shriver et al. 2003[3]; Graf et al. 2005[3]; Lamason et al. 2005[3]; Soejima et al. 2006[3]; Miller et al. 2007[1]; Norton et al. 2007[3]
	East Asian *H. sapiens*	cg	--	not *SLC45A2;* not *SLC45A5*	
Reduced pigmentation (system 2)	Gulf-coast *Peromyscus polionotus*	m	✚*Agouti*: 0.64; *Mc1r*: 0.33; *LG14*: 0.03	--	Hedges et al. 2006[2]; Hoekstra et al. 2006[3]; Degner et al. 2007[2]; Steiner et al. 2007[3]; Linnen et al. 2009[3]; Steiner et al. 2009[1]; Manceau et al. 2011[3]
	Atlantic coast Anastasia Island *P. polionotus*	cg	--	not *Mc1r*	
	Atlantic coast Sotheastern *P. polionotus*	cg	--	not *Mc1r*	
	Sand Hill *Peromyscus maniculatus*	mcg	*Agouti*: 1	__	
Reduced pigmentation (system 3)	White sands *Sceloporus undulatus*	cg	--	*Mc1r*	Schulte et al. 2000[2]; 2003[2]; Vidal and Hedges 2009[3]; Rosenblum et al. 2010[1]
	White sands *Aspidoscelis inornata*	cg	--	*Mc1r*	
	White sands *Holbrookia maculata*	cg	--	*Mc1r*	
Reduced pigmentation (system 4)	Paxton benthic *G. aculeatus*	m	*Kitlg*: 1	--	Miller et al. 2007[1]
	Fishtrap Creek *G. aculeatus*	cg	--	*Kitlg*	
	Gasterosteus williamsoni	cg	--	*Kitlg*	
Reduced pigmentation (system 5)■	Pachón cavefish *Astyanax mexicanus*	m	*Oca2*: 0.57; *Mc1r*: 0.43	--	Sadoglu and McKee 1969[3]; Jeffrey 2001[2]; Wilkens and Strecker 2003[3]; Protas et al. 2006[1]; Gross et al. 2009[1]
	Molino *A. mexicanus*	m	*Oca2*: 1	--	
	Yerbaniz/Japonés *A. mexicanus*	ct	*Oca2*: 1	--	
	Curva *A.mexicanus*	ct	*Mc1r*: 1	--	
	Chica *A. mexicanus*	ct	*Mc1r*: 1	--	
	Piedras *A.mexicanus*	ct	*Mc1r*: 1	--	

Notes:

*Clines are bidirectional.

◆Yinpterochiroptera includes all members except the family Pteropodidae, as they do not exhibit high-frequency hearing. Yangochiroptera and Yinpterochiroptera are conservatively grouped together here, as it is not yet known whether high frequency hearing evolved independently in each lineage or only once and then was lost in Pteropodidae.

✧Light pigmentation alleles at *Kitlg* are shared between European and East Asian humans. For *Kitlg* and *SLC45A2* effect size in melanin units was converted to an estimated PVE using a linear conversion factor based on the these values for *SLC45A5*. After doing so, the remaining unexplained variance was split evenly for *Tyr* and *Oca2*.

✚Average relative contributions for all body regions phenotyped.

■Both albino and brown phenotypes were considered "reduced pigmentation". The Pachón population is polymorphic for these phenotypes, but individuals are either one or the other. Therefore, we set the relative contributions of the underlying genes to the frequency with which each gene would underlie "reduced pigmentation" in a hypothetical cross between heterozygotes at both loci. The Japonés population is fixed for the albino phenotype, but also harbors a "brown mutation". Since this mutation is not the current cause of reduced pigmentation, it was assigned a relative contribution of 0.

[1]Reference found by objective literature search; [2]Additional reference used to estimate node age; [3]Additional reference for genetics underlying trait

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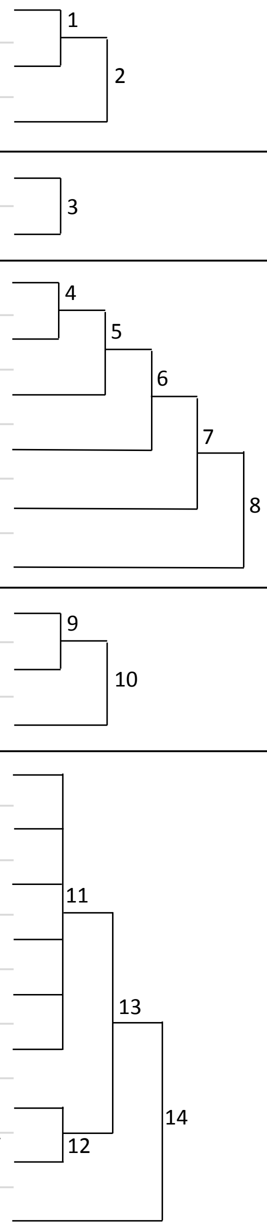
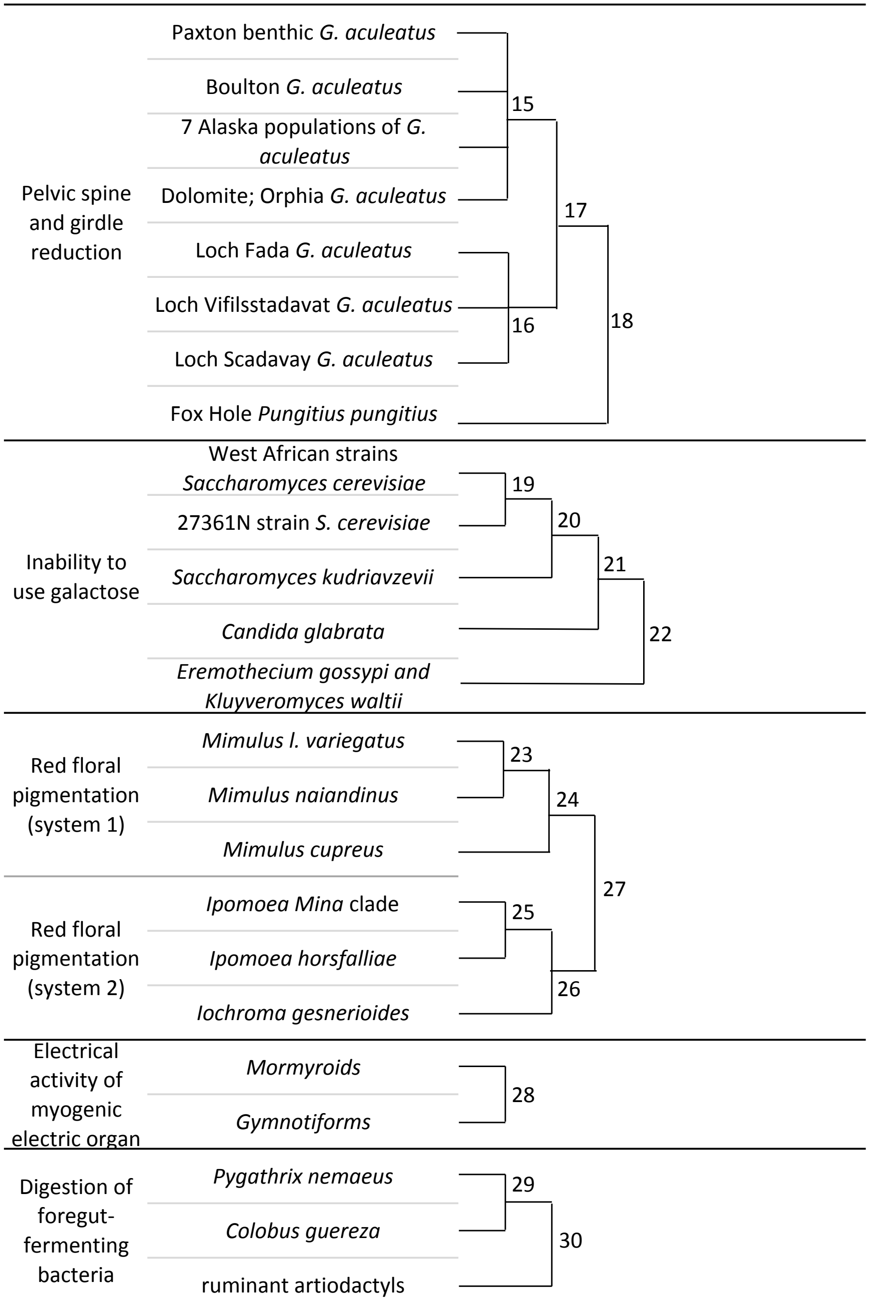
Table S2. Numbered nodes corresponding to data in Table S3. Node ages are given in Table S1.

Larval trichome loss	*Drosophila montana*
	Drosophila borealis
	Drosophila sechellia
Skin toxin - caerulein	*Xenopus laevis*
	Litoria splendida
Tetrodotoxin resistance	*Thamnophis couchii*
	Thamnophis atratus
	Thamnophis sirtalis
	Amphiesma pryeri
	Rhabdophis tigrinus
	Liophis epinephelus
Lactase persistance	European *Homo sapiens*
	Saudi Arabian *H. sapiens*
	Kenyan and Tanzanian *H. sapiens*
Reduction in lateral plate number	Paxton benthic *Gasterosteus aculeatus*
	Cranby *G. aculeatus*
	Paq; Graham; Bear Paw *G. aculeatus*
	Boot Lake; Whale Lake *G. aculeatus*
	Nakagawa Creek *G. aculeatus*
	6 Pacific freshwater populations of *G. aculeatus*
	5 Atlantic populations of *G. aculeatus*
	5 Scandinavian populations of *G. aculeatus*
	Fox Hole *Pungitius pungitius*




Pelvic spine and girdle reduction
Paxton benthic G. aculeatus
Boulton G. aculeatus
7 Alaska populations of G. aculeatus
Dolomite; Orphia G. aculeatus
Loch Fada G. aculeatus
Loch Vifilsstadavat G. aculeatus
Loch Scadavay G. aculeatus
Fox Hole Pungitius pungitius
15
16
17
18
Inability to use galactose
West African strains Saccharomyces cerevisiae
27361N strain S. cerevisiae
Saccharomyces kudriavzevii
Candida glabrata
Eremothecium gossypi and Kluyveromyces waltii
19
20
21
22
Red floral pigmentation (system 1)
Mimulus l. variegatus
Mimulus naiandinus
Mimulus cupreus
Red floral pigmentation (system 2)
Ipomoea Mina clade
Ipomoea horsfalliae
Iochroma gesnerioides
23
24
25
26
27
Electrical activity of myogenic electric organ
Mormyroids
Gymnotiforms
28
Digestion of foregut-fermenting bacteria
Pygathrix nemaeus
Colobus guereza
ruminant artiodactyls
29
30

Trait	Taxa
Red wing patterns	*Heliconius melpomene*
	Heliconius erato
Life history (latitudinal clines)	Australian *D. melanogaster*
	North American *D. melanogaster*
Ultrahigh-frequency hearing for echolocation	Yangochiroptera and Yinpterochiroptera
	Tursiops truncatus
Rapid development rate	Clearwater *Oncorhynchus mykiss*
	Swanson *O. mykiss*
Reduced pigmentation (system 1)	European *H. sapiens*
	East Asian *H. sapiens*
Reduced pigmentation (system 2)	Gulf-coast *Peromyscus polionotus*
	Atlantic coast Anastasia Island *P. polionotus*
	Atlantic coast Sotheastern *P. polionotus*
	Sand Hill *Peromyscus maniculatus*
Reduced pigmentation (system 3)	White sands *Sceloporus undulatus*
	White sands *Aspidoscelis inornata*
	White sands *Holbrookia maculata*
Reduced pigmentation (system 4)	Paxton benthic *G. aculeatus*
	Fishtrap Creek *G. aculeatus*
	Gasterosteus williamsoni
Reduced pigmentation (system 5)	Pachón cavefish *Astyanax mexicanus*
	Molino *A. mexicanus*
	Yerbaniz/Japonés *A. mexicanus*
	Curva *A.mexicanus*
	Chica *A. mexicanus*
	Piedras *A.mexicanus*

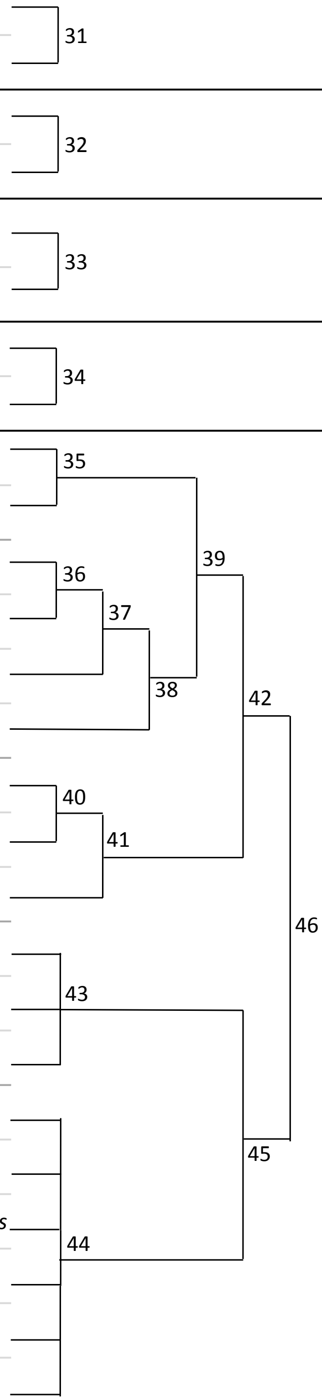


Table S3: Proportional similarity at each node in the data set. Methods: 'cross' = genetic cross, 'cg' = candidate gene. Node numbers are identified in Table S2. Some nodes are represented twice (once under method 'cross' and again with method 'cg'); in such cases there is no overlap between the populations used in the two analyses.

Phenotype	Node Number	Avg. Proportional Similarity	Rounded Average Estimate of Node Age	Species-level?	Method
Reduction in lateral plate number	11	0.95	10000	y	cross
Reduction in lateral plate number	14	0.00	10000000	n	cross
Pelvic spine and girdle reduction	17	0.37	800000	y	cross
Pelvic spine and girdle reduction	18	0.27	10000000	n	cross
Inability to use galactose	19	0.00	2000000	y	cross
Red floral pigmentation	23	0.00	2000000	n	cross
Red floral pigmentation	24	0.00	3000000	n	cross
Red wing patterns	31	1.00	20000000	n	cross
Rapid development rate	34	0.60	1000000	y	cross
Reduced pigmentation	38	0.64	7000000	n	cross
Reduced pigmentation	39	0.00	90000000	n	cross
Reduced pigmentation	44	0.43	500000	y	cross
Reduced pigmentation	45	0.00	300000000	n	cross
Reduced pigmentation	46	0.35	400000000	n	cross
Larval trichome loss	1	1.00	2000000	n	cg
Larval trichome loss	2	1.00	60000000	n	cg
Skin toxin - caerulein	3	0.00	200000000	n	cg
Tetrodotoxin resistance	4	1.00	500000	n	cg
Tetrodotoxin resistance	5	1.00	2000000	n	cg
Tetrodotoxin resistance	6	1.00	30000000	n	cg
Tetrodotoxin resistance	7	1.00	60000000	n	cg
Tetrodotoxin resistance	8	1.00	60000000	n	cg
Lactase persistance	9	1.00	50000	y	cg
Lactase persistance	10	1.00	100000	y	cg
Reduction in lateral plate number	13	1.00	800000	y	cg
Reduction in lateral plate number	14	0.00	10000000	n	cg
Pelvic spine and girdle reduction	17	0.34	800000	y	cg
Pelvic spine and girdle reduction	18	0.00	10000000	n	cg
Inability to use galactose	20	0.14	50000000	n	cg
Inability to use galactose	21	0.57	300000000	n	cg
Inability to use galactose	22	0.78	400000000	n	cg
Red floral pigmentation	25	1.00	4000000	n	cg
Red floral pigmentation	26	0.00	70000000	n	cg
Red floral pigmentation	27	0.00	80000000	n	cg
Electrical activity of myogenic electric organ	28	1.00	300000000	n	cg
Digestion of foregut-fermenting bacteria	29	0.00	10000000	n	cg
Digestion of foregut-fermenting bacteria	30	0.00	90000000	n	cg
Life history (latitudinal clines)	32	1.00	300	y	cg
Ultrahigh-frequency hearing for echolocation	33	1.00	80000000	n	cg
Reduced pigmentation	35	0.00	50000	y	cg
Reduced pigmentation	37	0.00	70000	y	cg
Reduced pigmentation	38	0.00	7000000	n	cg
Reduced pigmentation	39	0.00	90000000	n	cg
Reduced pigmentation	40	1.00	40000000	n	cg
Reduced pigmentation	41	1.00	200000000	n	cg
Reduced pigmentation	42	0.06	300000000	n	cg
Reduced pigmentation	43	1.00	10000	y	cg
Reduced pigmentation	45	0.00	300000000	n	cg
Reduced pigmentation	46	0.46	400000000	n	cg