Mutation Notes

Linkage relationships of spontaneous mutations in *Drosophila willistoni.*

Soler, Ana María, and Beatriz Goñi. Sección Genética Evolutiva, Facultad de Ciencias, Instituto de Biología, Universidad de la República, Iguá 4225, Montevideo 11400, Uruguay. E-mail: bgoni@fcien.edu.uy.

Abstract

New mutations of *Drosophila willistoni* are reported. Of 80 visible spontaneous mutants, mostly isolated from natural or laboratory populations of *D. willistoni*, 42 genes have been assigned to chromosomes. Twenty-one mutants map on chromosome 2, fifteen on chromosome 3, and six on the X chromosome. The isolation of mutants with a particular phenotype and data on the genetic interaction observed in eye color mutants were used to propose the linkage groups of *D. willistoni* in relation to *D. melanogaster*.

Introduction

The *willistoni* group comprises a group of cryptic species that inhabits the Neotropical region and has been the subject of evolutionary research studies for the past century (Ehrman and Powell, 1982; Cordeiro and Winge, 1995). *D. willistoni* is a member of the *willistoni* species subgroup, which inhabits domestic and natural environments of Uruguay (Goñi *et al.*, 1997, 1998).

The karyotype of *D. willistoni* is characterized by two pairs of autosomes (chromosomes 2 and 3) and a pair of heteromorphic sex chromosomes, the X chromosome and the Y chromosome. The earliest information on *D. willistoni* mutants and linkage maps was reported by several authors in the early 1920's. Lancefiled and Metz (1922) and Ferry *et al.* (1923) described 34 X-linked and 19 autosomal mutants (11 in chromosome 2, and 8 in chromosome 3) isolated from strains brought from Cuba in 1915. Later, Spassky and Dobzhansky (1950) described 21 X-linked mutants, 22 mutants on chromosome 2, and 11 on chromosome 3, some of them of spontaneous in origin from Belem, Pará, Brazil and others, which were X-ray-induced. The authors named these mutants by virtue of their phenotypic similarities with the classical mutants of *D. melanogaster*, as well as to those mutants described by Lancefield and Metz (1922). Subsequently, Poulson and Counce (1960) described additional mutants of *D. willistoni*. Unfortunately all of the mutant strains reported by these authors are no longer available.

Müller (1940) proposed that the ancestral genome of *Drosophila* species was composed of five pairs of acrocentric chromosomes and a pair of dot chromosomes. Using *D. melanogaster* as reference, he also proposed the letters A-F to designate each of the five chromosome arms and mini or "dot" chromosome, and used that nomenclature to identify homologous linkage groups within different species of of the genus *Drosophila*. Subsequently, a homology relationship between the chromosome arms of *D. willistoni* and *D. melanogaster* was proposed (Sturtevant and Novitsky, 1941). According to these authors, the X chromosome of *D. willistoni* is the result of the fusion of Müller elements A and D (chromosome X and 3L of *D. melanogaster*), chromosome 2 is the result of

the fusion of Müller elements B and C (arms 2L and 2R of *D. melanogaster*), and chromosome 3 is composed by elements E and F (chromosome 4 and 3R of *D. melanogaster*). This proposal was recently reevaluated by Schaeffer *et al*. (2008) using physical and genetic markers to anchor the genome assembly scaffolds to the polytene chromosome maps of 12 *Drosophila* species that have sequenced genomes. In that analysis, the scaffolds are oriented and joined on the basis of the conserved synteny at the ends of the scaffolds using the location of a single locus or the order of genetic marker(s) on the genetic map. In spite of using new markers on most of the chromosome arms of *D. willistoni*, Schaeffer *et al*. (2008) point out the paucity of genetic and physical markers available in this species resulting in a provisional orientation of the scaffolds. In addition to the aforementioned global analysis, Papaceit and John (1998), using molecular techniques and *in situ* hybridization, mapped several markers on chromosome 3 of *D. willistoni* to characterize the E-F Müller element fusion.

Since 1998, the laboratory of *Drosophila*, Evolutionary Genetics Section has been working in the isolation of spontaneous mutations in *D. willistoni*, which were reported in Goñi *et al.*, (2002) and Parada and Goñi (2003). More recently, Soler (Bachelor Thesis, 2012) presented new mutants along with relevant linkage data for autosomal mutations of *D. willistoni*. We report here a study of the formal genetics of *D. willistoni*: the collection of a broad spectrum of spontaneous mutations, mostly isolated from natural populations, and their linkage relationships.

Material and Methods

Flies

Eighty spontaneous mutants of *D. willistoni* were analyzed. The majority of these were isolated from isofemale lines or mass mating cultures from natural or laboratory populations collected in several localities of Argentina, Brazil, and Uruguay, since 1998. Wild type strains used: WIP-4, from Ilha das Cobras, Bahia, Brazil, 1970, which has been kept in culture for many years, and GDH (Guadalupe), a monomorphic strain used in the recent citomap revision and genomic studies (Schaeffer *et al.*, 2008) (obtained by courtesy of Dr. V.L.S. Valente).

Mutant descriptions

The phenotypes of mutants of *D. willistoni* (Ferry *et al.*, 1923; Lancefield and Metz, 1922; Poulson and Counce, 1960; Spassky and Dobzhansky, 1950), *D. paulistorum* (Malogolowkin and Ehrman, 1960, see the revised genetic map of *D. willistoni* proposed by Dobzhansky and Powell, 1975), and the classical mutant descriptions of *D. melanogaster* (Lindsley and Zimm, 1992; The FlyBase Consortium, 2012) were used as a reference for a comparison and aid in the description of the new mutants of *D. willistoni* reported here.

Allelism test

Genetic crosses between individuals of mutant strains with similar phenotype were done to test for complementation in the F_1 progeny. In each experiment, two replicas of each reciprocal cross were performed. In some cases, individuals from wild strains were used in crosses with mutant strains to test for the recessive/dominance character of the mutation, or the segregation of more than one mutant phenotype from a mutant strain.

Linkage test

Mutant phenotype criteria affecting adult morphology (wing shape, eye color, eye shape, body color, or others) allowed us to select some strains as reference mutations for linkage analysis.

Crosses were performed between individuals from reference mutations to unmapped mutations. For each cross the F_1 progeny was examined. Male mutants appearing in the F_1 progeny of mutant females indicated an X-linked mutation. If the F_1 progeny were all wild type, an $F_1 \times F_1$ cross was performed, and the F_2 progeny analyzed. The presence of four different phenotypic classes indicated that the mutant genes are unlinked and thus located on different autosomal chromosomes. The data obtained allowed us to identify the linkage groups of mutants.

Eye color mutant genetic interaction test

Crosses between individuals with eye color mutations were performed. The F_1 progeny was analyzed. If the F_1 was wild type, $F_1 \times F_1$ cross was done. The presence of a new eye color in F_2 progeny was interpreted as the occurrence of eye color genetic interaction between the tested mutations. When testing for genetic interactions between eye color mutations that are linked on the same chromosome, the presence of a novel eye color in individuals in the F_3 progeny was interpreted as resulting from crossing over in the previous generation. In *D. melanogaster* crossing over is restricted to females; however, two observations suggest the existence of crossing over in males of *D. willistoni*. França *et al*. (1968) reported 0.4% recombination between heterozygous inversions in males and females of *D. willistoni*. More recently, Colares Dos Santos *et al*. (2004) reported a meiotic configuration in spermatocytes, that they interpreted as the result of exchange within the 2LH inversion loop in larvae from the wild type (G3) strain collected in the State of Santa Catarina, Brazil.

Experimental conditions

For mating experiments virgin flies were collected every three hours and mated to young males. In general, virgin females and young males used in the genetic crosses were selected with the help of an aspirator. The progeny were anethesized with triethylamine vapors (Fresia *et al.*, 2002). Progeny were scored only up to the 21st day post crossing to avoid overlapping generations. Wild and mutant strains and experimental crosses were maintained at 23-25ºC with standard cornmeal-yeast-agar media.

Results and Discussion

The detailed list of (new) mutants and alleles is presented below. It includes relevant information concerning genetic interaction of eye color mutants, *e.g*., the observed interaction between *brown* and *cardinal* mutations, and others (Table 1, Figure 1) that were evaluated, among other genetic data to construct the linkage groups.

This list includes data on 42 mutations: twenty-one map on chromosome 2, fifteen on chromosome 3, and only six map on the X chromosome. The X linked loci include new *white* mutants and *yellow* alleles. Chromosome 2 linked mutants include some mutations that were previously mapped by Spassky and Dobzhansky (1950), *brown* and *plexus*, and new mutations with good homology with *D. melanogaster*: *blistered*, *cinnabar*, *eye absent*, *jaunty*, *orange*, *purple* and *speck*. Chromosome 3 linked mutants include several new mutations: *blistery*, *claret*, *ebony*, *glass*, *hedgehog*, *kayak*, *rough*, *rosy*, and *spineless*. Some of these mutants are shown in Figure 2. At present, the genome sequence of *D. willistoni* and the sequence annotation in *D. melanogaster* (see FlyBase, Dmel annotation version 4.3) provide information of orthologous genes for most of these autosomal mutations. In the case of *cinnabar*, the only information available is the annotated transcript of *D. melanogaster*. The linkage data of new mutants reported here along with the availability of new mutant strains provide an opportunity to review the genetic and physical map of *D. willistoni*.

X Linked Mutants:

cm: carmine

phenotype: Eye color: almost wild type in young flies to dull carmine in old flies. Pseudopupil less evident than wild type.

$cm^{FA30.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2005.

cv: crossveinless

phenotype: Anterior and posterior crossvein absent or traces only present. Similar to *crossveinless* of *D. melanogaster.*

$cv^{EM1.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.
references: Parada and Goñi (2003).

g: garnet

phenotype: Eye color: translucent brownish, darkening with age. No pseudopupil.

$g^{EM1.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.
references: Referred as *pink* mutation in Goñi *et al.* (2002); Parada and Goñi (2003).

l-1: lobe-1

phenotype: Variable reduction in eye size. Eyes slightly smaller with a nick in the anterior edge. The lower part of eye is more reduced than upper part. Overlaps wild type. Similar to *Lobe* of *D. melanogaster.*

$l\text{-}1^{EM1.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.
references: Parada and Goñi (2003).

w: white

phenotype: Eye color: white. Colorless ocelli. Eye color: dull light red with *cinnabar* at eclosion, colorless ocelli (Table 1). Similar to *white* of *D. willistoni* (Spassky and Dobzhansky, 1950).

$w^{EM1.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000. Segregates a second linked mutant, referred as *dull red* mutation in Goñi *et al.* (2002).
references: Goñi *et al.* (2002); Parada and Goñi (2003); Ludwig *et al.* (2003).

$w^{TB44.02}$

origin: Segregates from the *eye absent* [$eya^{TB44.02}$] mutant strain. Low fertility.

$w^{a\,Q14F11}$

phenotype: Eye color: yellow-orange. Pale ocelli. Similar to *white apricot* of *D. melanogaster.*
origin: Buenos Aires City, Argentina, 2006.

$w^{cf\,Ey10.00}$

phenotype: Eye color: pinkish-red, darkening to sepia-like in old flies. Similar to *white coffee* of *D. melanogaster.*
origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.
references: Ludwig *et al.* (2003).

y: yellow

phenotype: Wings and body cuticle yellow. Puparia much lighter than wild type. Similar to *yellow* of *D. melanogaster.*

$y^{EM1.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.
references: Goñi *et al.* (2002); Parada and Goñi (2003); Ludwig *et al.* (2003).

$y^{TB46.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.
references: Parada and Goñi (2003).

y^{Q14F1}

origin: Buenos Aires City, Argentina, 2006.

Chromosome 2 Linked Mutants

amy: amethyst

phenotype: Eye color: dull light purplish in young flies, darkening to purple with age. Pseudopupil less evident than wild type. Eye color: light reddish with *cardinal* in young flies (Table 1).

$amy^{RLN1.00}$

origin: Laguna Negra, Rocha, Uruguay, 2000.

$amy^{SG3.03}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2003.

bs: blistered

phenotype: Wings inflated with hemolymph to produce blisters and vesicles. Venation weak. Texture discolored and muddy in appearance. Poor viability at low temperature. Similar to *balloon* of *D. willistoni* (Ferry *et al.*, 1923) and to *blistered* of *D. melanogaster.*

$bs^{D14.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999.

bur: burgundy

phenotype: Eye color: dull brownish red in young and old flies. Pseudopupil less evident than wild type. Similar to *burgundy* of *D. melanogaster.*

$bur^{SMV28.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.

bw: brown

phenotype: Eye color: light brownish in young flies to light reddish-brown color in old ones. No pseudopupil. Eye color: white with *cardinal* in young flies to blotchy brownish in old flies. Eye color: white with *cinnabar*, colorless ocelli (Table 1). Similar to *brown* of *D. willistoni* (Spassky and Dobzhansky 1950) and to *brown* of *D. melanogaster*.

$bw^{SG23.00}$, $bw^{Sy11.03}$, bw^{Q51F13}

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000, 2003 and 2009, respectively.

Cl: Clipped

phenotype: Wing margins notched, most often along marginal vein. Similar to *Clipped* of *D. willistoni* (Ferry *et al.,* 1923).

$Cl^{ES13.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999.
references: Parada and Goñi (2003); Ludwig *et al.* (2003).

cn: cinnabar

phenotype: Eye color: bright red, approaching to wild type with age. Colorless ocelli. Eye color: white with *brown*, colorless ocelli. Eye color: apricot with *claret*. Eye color: light apricot with *maroon*. Eye color: dull apricot with *purple* at eclosion, colorless ocelli. Eye color: Light creamy-apricot with *rosy*. Eye color: dull light red with *white* at eclosion, colorless ocelli (Table 1). Similar to *orange* of *D. willistoni* (Spassky and Dobzhansky, 1950), *orange* of *D. paulistorum* (Malogolowkin and Ehrman, 1960) and *cinnabar* of *D. melanogaster*.

$cn^{REB1.00}$

origin: Laguna Negra, Rocha, Uruguay, 2000.
references: Parada and Goñi (2003).

$cn^{SM35.00}$, $cn^{SL7.01}$, $cn^{FA2.05}$, $cn^{FA22.05}$, cn^{Q51F13}

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000, 2001, 2005 (cn^{FA2}, cn^{FA22}) and 2009, respectively.

$cn^{TB26.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

cn^{Q46F32}

origin: San Pablo City, Brazil, 2007.

cp-2: clipped-2

phenotype: Wing margins notched, most often along marginal vein. Similar to *clipped* of *D. melanogaster*.

$cp\text{-}2^{TB46.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.
references: Parada and Goñi (2003).

cui: curvi

phenotype: Distal half of wings curved upward. Temperature sensitive expression. Curl is strong if wings unfolds at 24ºC but weakened or overlap wild type if wings unfold at 17ºC. At low temperature females do overlap wild type more than males. Very good viability. Similar to *curvi* of *D. melanogaster.*

cui^{Q46M6}

origin: San Pablo City, Brazil, 2007.

dke: dark eye

phenotype: Eye color: dull dark red in young flies to brownish red in old flies. Less evident pseudopupil than wild type. Eye color: bright reddish with *cardinal* at eclosion (Table 1). Similar to *dark eye* of *D. melanogaster*.

dke$^{SL13.01}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2001.

dke$^{TB28.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

dl-2: delta-2

phenotype: Wing's second vein widened at their junctions with the margin to form delta-like structure. Mutant phenotype stronger in females than males. Similar to *Delta* of *D. willistoni* (Spassky and Dobzhansky, 1950) and *Delta* of *D. melanogaster*.

dl-2^{Q46F9}

origin: San Pablo City, Brazil, 2007.

dre: dark red

phenotype: Eye color: dark red in young flies, darkening with age, but lighter than the *dark eye* mutation. Similar to *dark red* of *D. melanogaster*.

dre$^{SGV8.00}$

origin: Santa Lucia, Canelones, Uruguay, 2000.

dre$^{SL8.02}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2002.

eya: eye absent

phenotype: Eye facets almost or completely absent, from flies with no eyes to those having few ommatidia. Head development normal; antennae and ocelli present. The aristae of the antennae is thinner and shorter than wild type. Similar to *eye absent* of *D. melanogaster*.

eya$^{TB44.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.
references: Mistakenly referred as the *eyeless* mutation in Ludwig *et al.* (2003).

j: jaunty

phenotype: Wings curved upward throughout their length but less twisted than the classical *Curly* mutation of *D. melanogaster*. The wings are thick and with opaque texture. In general, the wings do not entirely unfold. Similar to *jaunty* of *D. willistoni* (Ferry *et al.*, 1923) and *jaunty* of *D. melanogaster*.

j$^{ST12.01}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2001.

j$^{TB38.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

or: orange

phenotype: Eye color: bright yellowish orange, browner with age. No pseudopupil. Colorless ocelli. Eye color: dull apricot with *claret*, colorless ocelli. Eye color: yellowish apricot with *pink* (Table 1). Similar to *orange* of *D. melanogaster*.

or$^{FA7.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2005.

pab: pale body

phenotype: Whitish body color. Similar to *Pale body* of *D. melanogaster*.

pab$^{S46.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999.

po: pale ocelli

phenotype: Ocelli colorless. Similar to *pale ocelli* of *D. melanogaster*.

po$^{Riv1.03}$

origin: Rivera City, Uruguay, 2003.

pr: purple

phenotype: Eye color: purple at eclosion, darkening to purplish ruby with age. No pseudopupil. Eye color: dull apricot with *cinnabar* at eclosion, colorless ocelli (Table 1). Similar to *purple* of *D. willistoni* (Spassky and Dobzhansky, 1950) and to *purple* of *D. melanogaster*.

pr$^{Ey3.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999.

pu: punch

phenotype: Eye color: translucent purplish at eclosion darkening with age. Similar to *Punch* of *D. melanogaster*.

$pu^{REM2.00}$

origin: Laguna Negra, Rocha, Uruguay, 2000.

px: plexus

phenotype: Wings have network extra veins, specially towards tips and margins. First posterior cell between L3 and L4 widen toward tip. Similar to *plexus* of *D. melanogaster*.

$px^{SGV1.00}$

origin: Santa Lucia, Canelones, Uruguay, 2000.

$px^{SG1.01}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2001.

sp: speck

phenotype: Axils of wings have black specks. Similar to *speck* of *D. melanogaster*.

$sp^{98e3.98}$

origin: Segregate from the *claret* $[ca^{98e3.98}]$ mutant strain. Females have poor fertility.

wr: wrinkle

phenotype: Wings wrinkled, blistered and curved upward. Temperature sensitive expression. Overlaps wild type. At low temperature poor viability. Similar to *wrinkle* of *D. melanogaster*.

$wr^{TB46.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.
references: Parada and Goñi (2003).

Chromosome 3 Linked Mutants

by: blistery

phenotype: Wings with blisters in the proximal and medial regions. Wing surface dusky. Temperature sensitive expression. Females do overlap wild type more than males. Very good viability. Similar to *blistery* of *D. melanogaster*.

$by^{EB1.03}$, by^{Q52F56}

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2003 and 2009, respectively.

ca: claret

phenotype: Eye color: bright brownish scarlet in young flies, approaching sepia-like with age. No pseudopupil. Eye color: apricot with *cinnabar*. Eye color: dull apricot with *orange*, colorless ocelli (Table 1). Similar to *claret* of *D. willistoni* (Spassky and Dobzhansky, 1950) and to *claret* of *D. melanogaster*.

$ca^{98e3.98}$, $ca^{ES13.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1998 and 1999 (Parada and Goñi, 2003), respectively.

ca-l: claret-like

phenotype: Eye color: bright brownish scarlet, but lighter and translucent than the *claret* mutation of *D. willistoni* reported here. No pseudopupil.

$ca\text{-}l^{Q15F10}$

origin: Buenos Aires City, Argentina, 2006.

$ca\text{-}l^{Q52F63}$, $ca\text{-}l^{Q52F51}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2009.

cd: cardinal

phenotype: Eye color: bright yellowish vermilion at eclosion to dull red in old flies. No pseudopupil. Colorless ocelli. Eye color: light reddish with *amethyst* in young flies. Eye color: white with *brown* in young flies, to blotchy brownish in old flies. Eye color: bright reddish with *dark eye* at eclosion (Table 1). Similar to *cardinal* of *D. melanogaster*.

$cd^{SG12.00}$, $cd^{SG4.01}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000 and 2001, respectively.

$cd^{TB40.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

e: ebony

phenotype: Body color grayish-black. Puparia much lighter than wild type. Larvae show wild type color of spiracle sheaths. Good viability at 25°C. Similar to *ebony* of *D. paulistorum*

(Malogolowkin and Ehrman, 1960) and to *ebony* of *D. melanogaster*.

$e^{REB1.00}$

origin: Laguna Negra, Rocha, Uruguay, 2000.
references: Parada and Goñi (2003).

$e^{SB26.02}$

origin: Solis, Maldonado, Uruguay, 2002.
references: Parada and Goñi (2003).

e^{Q14F23}

origin: Buenos Aires City, Argentina, 2006.

gl: glass

phenotype: Eye color: blotchy with few patches of red, and creamy-white pigment. Eyes variable in size with a typically glassy surface. Few ommatidial bristles. Subtle anterior notch. Colorless ocelli. Reduced fertility. Similar to *glass* of *D. paulistorum* (Malogolowkin and Ehrman, 1960) and to *glass* of *D. melanogaster*.

$gl^{TB14.02}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2002.

hh: hedgehog

phenotype: Eye size reduced and rough, with irregular facets. Ommatidia unordered. Ommatidial bristles absent except on the posterior border. Fragmented pseudopupil. Variable expression in both sexes. Similar to the *hh[bar3]* allele of *D. melanogaster*.

hh^{Q02F7}, hh^{Q46M8}

origin: San Pablo City, Brazil, 2006 and 2007, respectively.

kay: kayak

phenotype: Mesothorax with a dorsal-antero-posterior cleft, which causes a gap in the bristle pattern. Temperature sensitive expression. Good viability and fertility. Similar to *kayak* of *D. melanogaster*.

$kay^{EB2.02}$, kay^{Q51F14}

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2002 (Parada and Goñi, 2003) and 2009, respectively.

ma: maroon

phenotype: Eye color: dull ruby, approaching to wild type with age. Eye color: light apricot with *cinnabar* (Table 1). Similar to *maroon* of *D. melanogaster*.

$ma^{SB27.02}$

origin: Solis, Maldonado, Uruguay, 2002.

$ma^{TB40.02}$, $ma^{TB77.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

$ma^{Riv9.03}$

origin: Rivera City, Uruguay, 2003.

$ma^{FA1.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2005.

p: pink

phenotype: Eye color: similar to wild type in young flies, approaching to dull ruby with purplish tint in old ones. No pseudopupil. Eye color yellowish apricot with *orange* (Table 1). Similar to *pink* of *D. melanogaster*.

$p^{FA33.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2005.

ro: rough

phenotype: Eyes rough with irregular facets and black specks. Similar to *rough* of *D. melanogaster*.

$ro^{FA11.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2005.

ry: rosy

phenotype: Eye color: purplish reddish brown in young flies, darkening with age. Eye color: Light creamy-apricot with *cinnabar* (Table 1). Similar to *rosy* of *D. melanogaster*.

$ry^{ES7.99}$, $ry^{SG24.00}$, $ry^{SS48.00}$, $ry^{SG1.03}$, $ry^{FA8.05}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999, 2000 (ry^{SG24}, ry^{SS48}), 2003 and 2005, respectively.

sh-5:

phenotype: Wings veins L5 and L2 short and do not reach wing margin. Variable expression. L2

may overlap wild type. Similar to *short-5* of *D. melanogaster*.

$sh\text{-}5^{SG11.00}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 2000.

ss: spineless

phenotype: Flies show a loss or reduction in number of scutellar, dorsocentral, coxal, ocellar, orbital, anterior notopleural, postvertical, tergital and sternal bristles. Variable expression. Similar to *aristapedia* (ss^a) of *D. willistoni* (Spassky and Dobzhansky, 1950) and *spineless* of *D. melanogaster*.

$sc^{TB37.02}$

origin: Laguna Negra, Rocha, Uruguay, 2002.

tx: taxi

phenotype: Wings held out at about 75° from body axis. Female sterile. Similar to *taxi* of *D. melanogaster*.

$tx^{ES13.99}$

origin: Faculty of Agronomy, Montevideo City, Uruguay, 1999.

Table 1. Genetic interaction of eye color mutations in *D. willistoni*.

Mutants / chromosome linkage	Eye color	Mutant alleles tested
Chromosome X ; 2		
w ; cn	Dull light red, colorless ocelli	*w EM1.00, cn SM35.00*
Chromosome 2 ; 3		
amy ; cd	Light reddish in young flies	*amy RNL1.00, cd SG12.00*
bw ; cd	White in young flies to blotchy brownish in old flies	*bw SG23.00, cd SG12.00*
cn ; ca	Apricot	*cn SM35.00, FA2.02, ca 98e3.98*
cn ; ma	Light apricot	*cn SM35.00, FA2.05, ma FA1.05*
cn ; ry	Light creamy-apricot	*cn FA22.05, ry SS48.00*
dke ; cd	Bright reddish at eclosion	*dke TB28.02, cd SG12.00*
or ; ca	Dull apricot, colorless ocelli	*or FA7.05, ca ES13.99, 98e3.98*
or ; p	Yellowish apricot	*or FA07.05, p FA33.05*
Chromosome 2		
bw cn	White, colorless ocelli	*bw SG23.00, Q51.F13, cn SM35.00, Q51.F13*
cn or	Dull yellowish orange at eclosion, light brownish in old flies, colorless ocelli	*cn FA2.05, or FA7.05*
cn pr	Dull apricot at eclosion, colorless ocelli.	*cn FA2.05, pr Ey3.99*

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Figure 1. Photomicrographs of the eye color interaction seen in crosses between *brown* (*bw* $^{SG23.00}$) and *cardinal* (*cd* $^{SG12.00}$). From left to right are F_2 individuals as follows: *cardinal*, white eye color (young fly), creamy-white eye color (older fly), and *brown.*

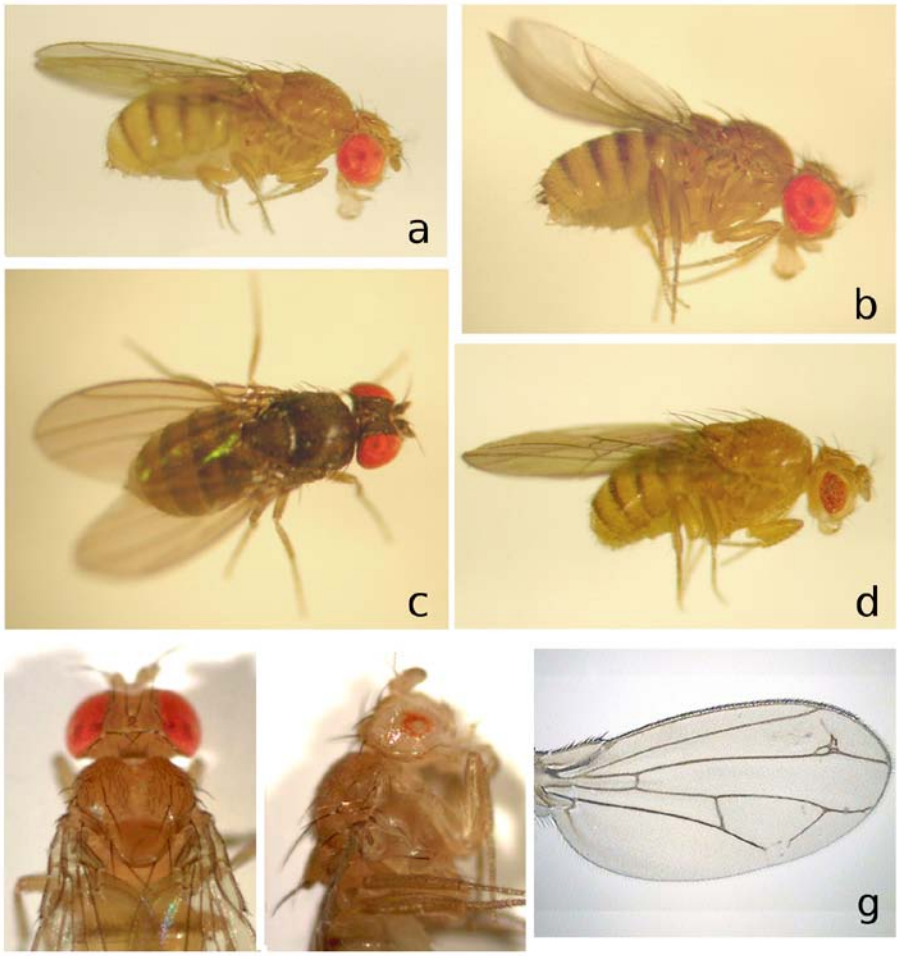

Figure 2. Photomicrographs of selected spontaneous mutations of *D. willistoni* described in this article: (a) wild type, (b) *jaunty*, (c) *ebony*, (d) *hedgehog*, (e) *kayak*, (f) *glass*, and (g) *plexus*.

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New mutants in *Drosophila simulans.*

Sousa-Neves[1], Rui, Emma Yang[2], and Youngmin Chu[2]. [1]Department of Genetics and Genome Science, School of Medicine, Case Western Reserve University, Cleveland, OH, 44106; [2]Department of Biology, Case Western Reserve University, Cleveland, OH, 44106, USA.

Here we describe 20 novel spontaneous mutations in *Drosophila simulans* and provide updates of mutations previously reported.

New Mutants

1- *jagged*[1] (*jgg*[1])
ORIGIN: Isolated in April 2012 from the stock Tabacón.
PHENOTYPE: recessive, wings divergent with severe notches along the wing margin or extremely reduced wings. Sometimes the longitudinal veins are interrupted.
LINKAGE: 1-95.5