Gene drives

Proof of concept

Kyrou et al., 2018

- The doublesex locus in *Anopheles gambiae*
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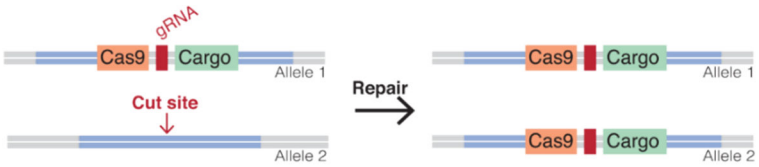

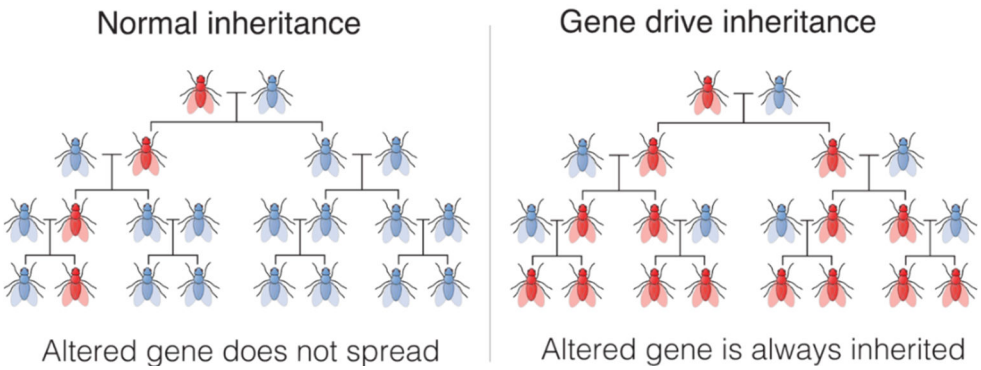

Figure 1. Wikipedia commons

Uses

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Big questions around gene drives

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Types

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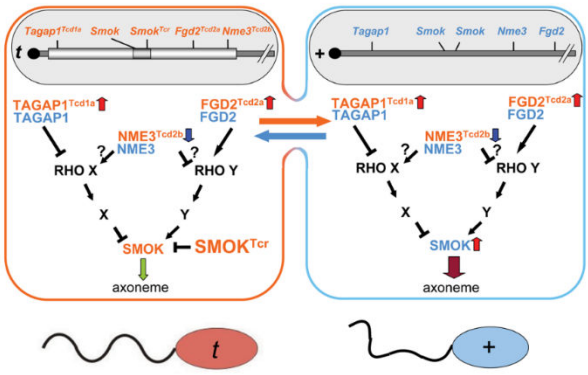
Figure 2. Bauer et al., 2012



How widespread are gene drives?

- Animals
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- Fungi
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- Plants
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- B chromosomes
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Maize abnormal chromosome 10

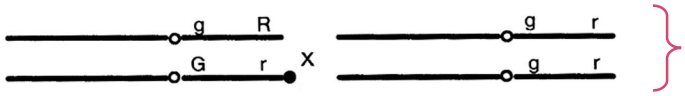
Longley, 1938

FIGURE 11.—Chromosome X: *A*, Normal type; *B*, one of the abnormal types. × 1,500.

Discovery of meiotic drive in plants

Rhoades, 1942

- Tried to map distance from R:



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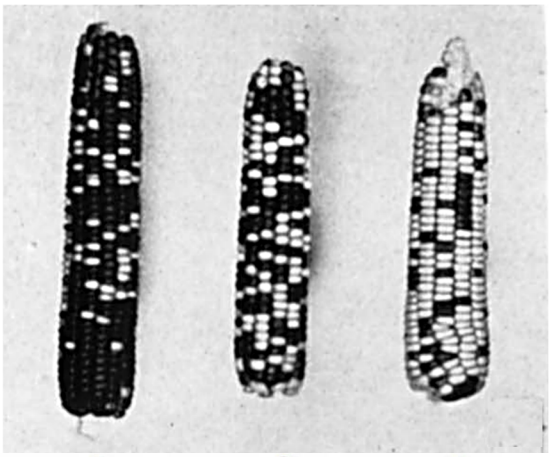
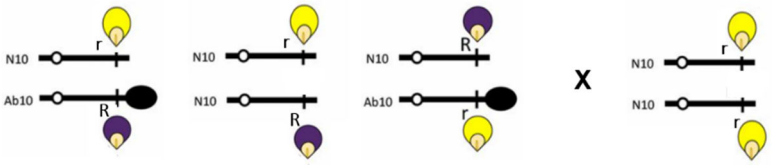


Ears from testcrosses with R^kr, Rr, and Rr^k, respectively. Note the excess recovery of the knobbed allele.



Rhoades & Vilkomerson, 1942

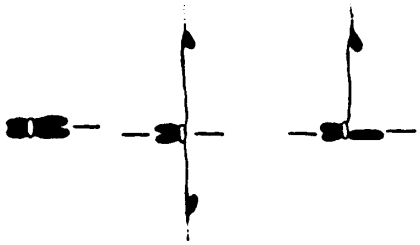


Figure 4. Three Met II chromosomes, with 3 chromatids showing neocentric activity.

Figure 3. When K10 is present, chromosomes with knobs move precociously towards the poles.

Figure 5. Two Ana II chromosomes, with the one on the right showing neocentric activity.

The Rhoades model

Dawe et al., 2018

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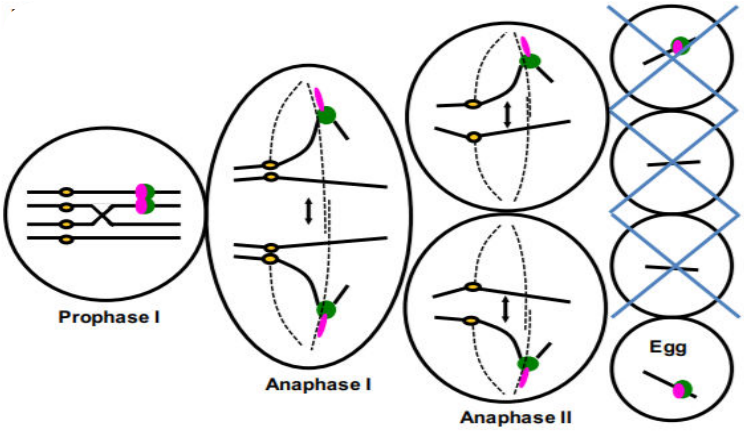
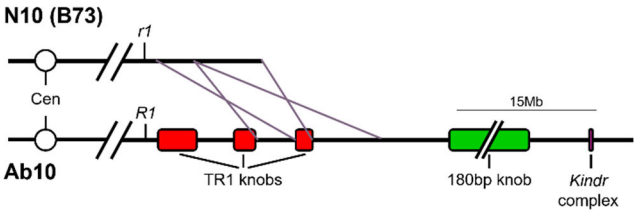
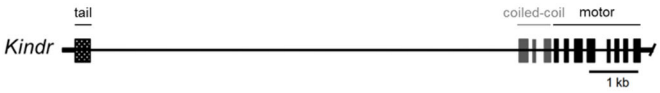
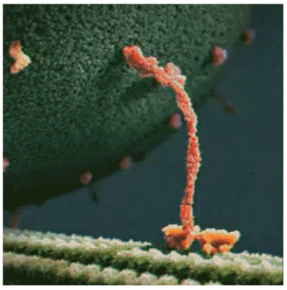


Dawe Lab, unpublished



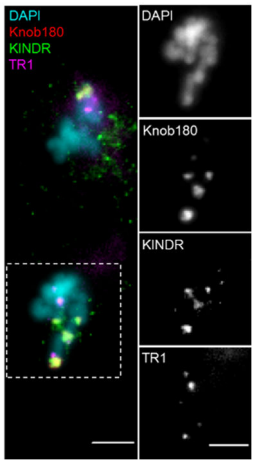
Dawe et al., 2018





KINDR localizes to 180-bp knobs

Dawe et al., 2018



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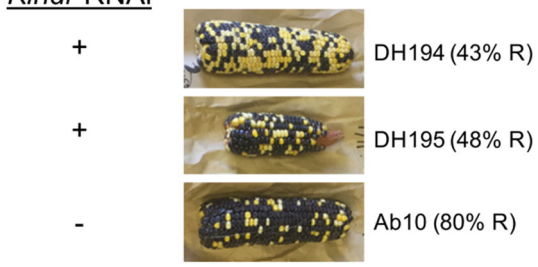
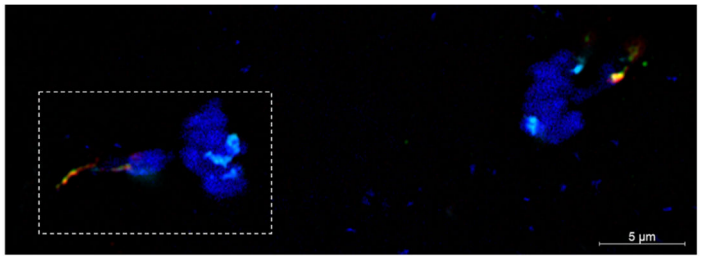
- Note hybridization to the 180-kp knobs but not the TR1 repeats
  - (green + red overlay = yellow)

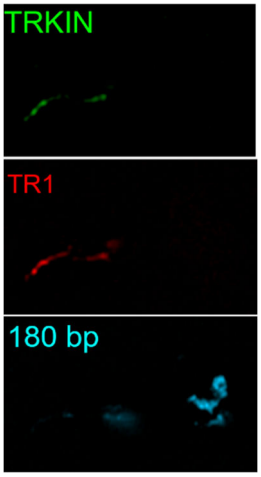
- Knocking out Kindr removes drive



TRKIN localizes to TR1 knobs

Dawe lab, unpublished





Increased transmission of alleles linked to knobs

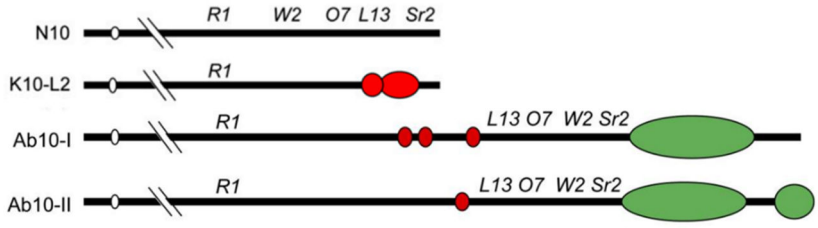
Rhoades & Dempsey, 1957

10 Haplotype	3 Haplotype	% GI	% Lg	% A
Ab10 / N10	K3L / k3L	51.7	72.5	63.6
Ab10 / N10	k3L / k3L	50.6	50.8	52.3
N10 / N10	K3L / k3L	50.0	50.9	51.7
N10 / N10	k3L / k3L	53.1	50.4	51.5

Intragenomic conflict

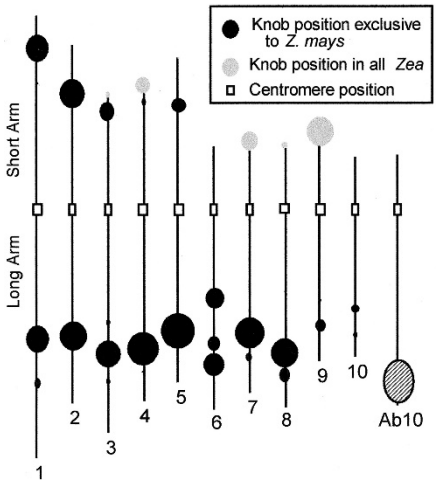
Kanizay et al., 2013

Neocentric activity



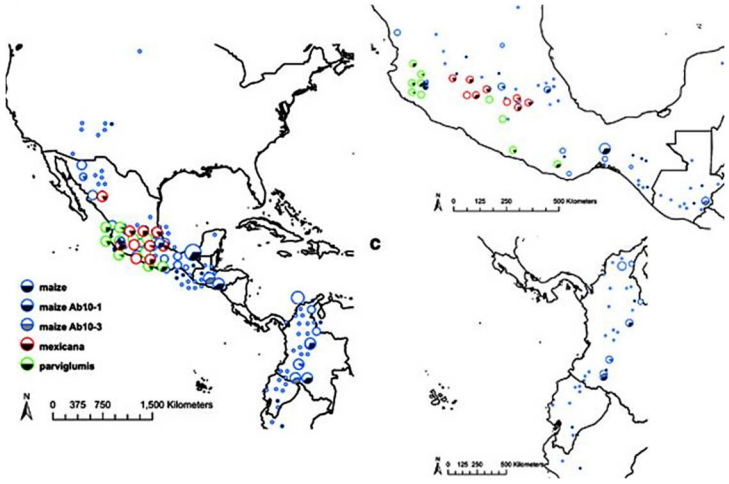
Knobs in maize & teosinte are in gene-rich areas

Buckler et al., 1999



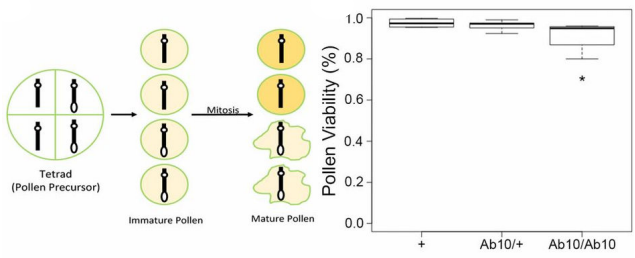
How common is gene drive?

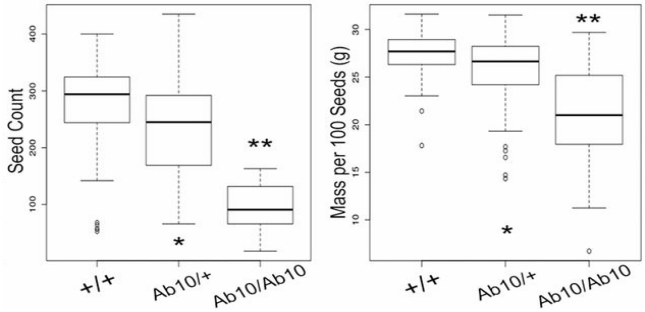
Kanizay et al, 2013



Why haven't gene drive systems achieved fixation?

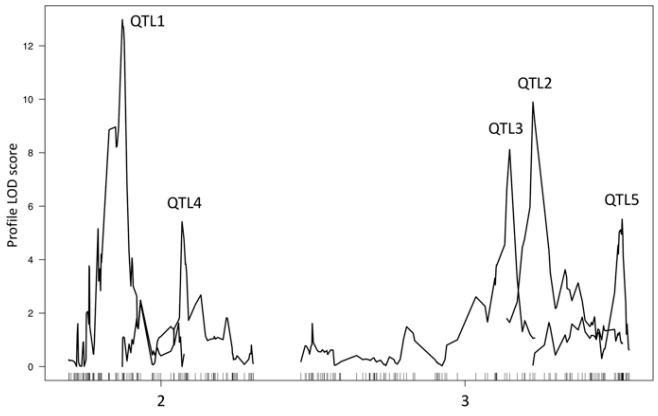
Rhoades, 1942; Higgins et al., 2017





- Drosophila sex-ratio drive system

Courret et al., 2018



Champer et al., 2017

Price et al., 2019