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Evolutionary Biology

A newly evolved W(olbachia) sex chromosome in pillbug!

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Submitted: 13 January 2017, Recommended: 24 January 2017

Cite this recommendation as:

Published: 24 January 2017

In some taxa such as fish and arthropods, closely related species can have different mechanisms of sex determination and in particular different sex chromosomes, which implies that new sex chromosomes are constantly evolving [1]. Several models have been developed to explain this pattern but empirical data are lacking and the causes of the fast sex chromosome turn over remain mysterious [2-4]. Leclerq *et al.* [5] in a paper that just came out in PNAS have focused on one possible explanation: *Wolbachia*. This widespread intracellular symbiont of arthropods can manipulate its host reproduction in a number of ways, often by biasing the allocation of resources toward females, the transmitting sex. Perhaps the most spectacular example is seen in pillbugs, where *Wolbachia* commonly turns infected males into females, thus doubling its effective transmission to grandchildren. Extensive investigations on this phenomenon were initiated 30 years ago in the host species *Armadillidium vulgare*. The recent paper by Leclerq et al. beautifully validates an hypothesis formulated in these pioneer studies [6], namely, that a nuclear insertion of the Wolbachia genome caused the emergence of new female determining chromosome, that is, a new sex chromosome. Many populations of *A. vulgare* are infected by the feminising *Wolbachia* strain *w*VulC, where the spread of the bacterium has also induced the loss of the ancestral female determining W chromosome (because feminized ZZ individuals produce females without transmitting any W). In these populations, all individuals carry two Z chromosomes, so that the bacterium is effectively the new sex-determining factor: specimens that received *Wolbachia* from their mother become females, while the occasional loss of *Wolbachia* from mothers to eggs allows the production of males. Intriguingly, studies from natural populations also report that some females are devoid both of *Wolbachia* and the ancestral W chromosome, suggesting the existence of new female determining nuclear factor, the hypothetical "*f* element". Leclerq *et al.* [5] found the *f* element and decrypted its origin.

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By sequencing the genome of a strain carrying the putative *f* element, they found that a nearly complete *w*VulC genome got inserted in the nuclear genome and that the chromosome carrying the insertion has effectively become a new W chromosome. The insertion is indeed found only in females, PCRs and pedigree analysis tell. Although the *Wolbachia*-derived gene(s) that became sex-determining gene(s) remain to be identified among many possible candidates, the genomic and genetic evidence are clear that this *Wolbachia* insertion is determining sex in this pillbug strain. Leclerq *et al.* [5] also found that although this insertion is quite recent, many structural changes (rearrangements, duplications) have occurred compared to the *w*VulC genome, which study will probably help understand which bacterial gene(s) have retained a function in the nucleus of the pillbug. Also, in the future, it will be interesting to understand how and why exactly the nuclear inserted *Wolbachia* rose in frequency in the pillbug population and how the cytoplasmic *Wolbachia* was lost, and to tease apart the roles of selection and drift in this event. We highly recommend this paper, which provides clear evidence that *Wolbachia* has caused sex chromosome turn over in one species, opening the conjecture that it might have done so in many others.

References:

[1] Bachtrog D, Mank JE, Peichel CL, Kirkpatrick M, Otto SP, Ashman TL, Hahn MW, Kitano J, Mayrose I, Ming R, Perrin N, Ross L, Valenzuela N, Vamosi JC. 2014. Tree of Sex Consortium. Sex determination: why so many ways of doing it? PLoS Biology 12: e1001899. doi: [10.1371/journal.pbio.1001899](https://doi.org/10.1371/journal.pbio.1001899)

[2] van Doorn GS, Kirkpatrick M. 2007. Turnover of sex chromosomes induced by sexual conflict. Nature 449: 909-912. doi: [10.1038/nature06178](https://doi.org/10.1038/nature06178)

[3] Cordaux R, Bouchon D, Grève P. 2011. The impact of endosymbionts on the evolution of host sex-determination mechanisms. Trends in Genetics 27: 332-341. doi: [10.1016/j.tig.2011.05.002](https://doi.org/10.1016/j.tig.2011.05.002)

[4] Blaser O, Neuenschwander S, Perrin N. 2014. Sex-chromosome turnovers: the hot-potato model. American Naturalist 183: 140-146. doi: [10.1086/674026](https://doi.org/10.1086/674026)

[5] Leclercq S, Thézé J, Chebbi MA, Giraud I, Moumen B, Ernenwein L, Grève P, Gilbert C, Cordaux R. 2016. Birth of a W sex chromosome by horizontal transfer of *Wolbachia* bacterial symbiont genome. Proceeding of the National Academy of Science USA 113: 15036-15041. doi: [10.1073/pnas.1608979113](https://doi.org/10.1073/pnas.1608979113)

[6] Legrand JJ, Juchault P. 1984. Nouvelles données sur le déterminisme génétique et épigénétique de la monogénie chez le crustacé isopode terrestre *Armadillidium vulgare* Latr. Génétique Sélection Evolution 16: 57–84. doi: [10.1186/1297-9686-16-1-57](http://dx.doi.org/10.1186/1297-9686-16-1-57)

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