Quick guide

Nasonia

Leo Beukeboom[1] and Claude Desplan[2]

What is* Nasonia*? A small (2–3 mm) parasitoid wasp that oviposits in the pupae of flies (but not those of *Drosophila*!). This hymenopteran occurs naturally in bird nests and at carcasses. Three species are known: the cosmopolitan *N. vitripennis* and two endemic North American species, *N. girault*i and *N. longicornis*. *Nasonia* is extremely easy to culture on commercially available host pupae, it has a short generation time (15 days at 25°C) and can be maintained in diapause for over one year.

What is so special about* Nasonia*? *Nasonia* has haplodiploid reproduction; haploid males develop from unfertilized eggs and diploid females from fertilized eggs. Thus, all recessive traits are expressed directly in the male: this is the case for X chromosome genes in *Drosophila*, but with *Nasonia* it is true of the entire genome. An extensive forward genetic screen for developmental mutants has already been accomplished and the identification of candidate genes is under way. Unlike the honey bee and many other hymenopterans, *Nasonia* has no single locus complementary sex determination, which allows fully homozygous strains to be kept without inbreeding problems. Another major advantage of *Nasonia* is that the three species, which exhibit considerable morphological and behavioral differences, can produce viable and fertile hybrids in the laboratory. The genetic basis for these differences can thus be easily identified through QTL analysis. *Nasonia* is also very favorable for cell biology, with its very clear yolk and slow early development which allow easy imaging.

A useful species for studying the evolution of development then? Yes. General patterns in development and evolution can only come from comparison of multiple organisms. *Nasonia* has a long germband mode of development, which facilitates comparison of expression patterns with *Drosophila*; in contrast the beetle *Tribolium*, also much used for studies of the evolution of development, exhibits short germband development. Transgenic and RNAi tools are also being developed for *Nasonia*. With respect to sex determination, it will be exciting to figure out how ploidy differences lead to determination of the two sexes.

What aspects of evolutionary genetics might* Nasonia *illuminate? *Nasonia* is extensively used to study the evolution of sex ratios and speciation. Females vary the sex of their offspring by controlling whether eggs are fertilized. A number of non-Mendelian elements, including the 'selfish' paternal sex-ratio chromosome and cytoplasmic sex-ratio distorters illustrate genetic conflict over sex determination. *Nasonia* is one of the primary organisms used to investigate the evolution and mechanisms of action of *Wolbachia*, an intracellular bacterium which infects many arthropods. Finally, exciting work is being done, using the three cross-fertile species, on the genetic basis of hybrid incompatibilities and interspecies differences in morphology and behaviour (wingsize and courtship, for example). This takes advantage of exchange of genes or genomic regions between species and the construction of introgression lines in which a gene for a particular trait from one species is bred into another species' genetic background.

Mating pair of *Nasonia vitripennis*. The mutant red-eyed male courts on top of the female.

Are there genomic tools available for* Nasonia*? Efforts are already underway to develop genetic and genomic tools for *Nasonia*. Visible genetic markers are known from all five chromosomes. Dense linkage maps containing RAPD, AFLP and microsatellite markers are available with a resolution of approximately 1cM, making possible whole genome screens for mutations and fine-scale mapping of genes. The total genome size is ~335 Mb and 1 cM corresponds to ~100 Kb of genomic DNA. An embryonic cDNA library and a BAC library funded by NSF have been constructed, and the first attempts at positional cloning are underway, focusing on a major gene for wingsize.

Where can I find out more?

Bordenstein, R.S., O'Hara, F.P., Werren, J.H. (2001). Wolbachia-induced incompatibility precedes other hybrid incompatibilities in Nasonia. Nature *409*, 707-710.

Nasonia web http://fire.biol.wwu.edu/leaf/Nasonia/nas.html

Nasonia http://www.rochester.edu/College/BIO/labs/WerrenLab/nasonia

Pultz, M.A. and Leaf, D.S. (2003). The Jewel Wasp *Nasonia*: Querying the genome with haplo-diploid genetics. Genesis *35*, 185-191.

Shuker, D., Lynch, J. and Peire Morais, A. (2003). Moving from model to non-model organisms? Lessons from *Nasonia* wasps. BioEssays, in press.

[1]Evolutionary Genetics Group, Centre for Ecological and Evolutionary Studies, University of Groningen, P.O. Box 14, NL-9750 AA Haren, The Netherlands.
E-mail: l.w.beukeboom@biol.rug.nl
[2]Department of Biology, New York University, 100 Washington Square East, New York, New York 10003-6688, USA.
E-mail: cd38@nyu.edu