of African origin, including elephants, hyraxes, dugongs and manatees, elephant shrews, and aardvarks. Initially greeted with deep skepticism, if not outright disbelief, this assemblage — named Afrotheria — and its shared evolutionary history is now widely accepted, and an overwhelming amount of genomic data as well as numerous other lines of supportive evidence have since been adduced. Long regarded as unmodified primitive holdovers from an ancestral mammal stock, tenrecs are now regarded as the successful result of millions of years of evolutionary experimentation.

Is there anywhere I can I see a tenrec? Tenrecs, particularly tail-less and hedgehog tenrecs, can be found in many zoos. But the best place to see a tenrec is in Madagascar. A number of national parks and other protected areas staffed by trained Malagasy naturalists provide ecotourists with unprecedented opportunities to experience Madagascar's remarkable biodiversity.

Where can I learn more about tenrecs?

The Animal Diversity Web (http://animaldiversity.ummz.umich.edu/).
BBC Nature Wildlife (http://www.bbc.co.uk/nature/life/Tenrecidae).
Benstead, J.P. and Olson, L.E. (2003). *Limnogale mergulus*. In The Natural History of Madagascar, S.M. Goodman and J.P. Benstead, eds. (Chicago: University of Chicago Press), pp 1267–1273.
Eisenberg, J.F. and Gould, E. (1970). The Tenrecs: A Study in Mammalian Behavior and Evolution. (Washington, D.C.: Smithsonian Institution Press).
Goodman, S.M. (2003). *Oryzorictes*, mole tenrec or rice tenrec. In The Natural History of Madagascar, S.M. Goodman and J.P. Benstead, eds. (Chicago: University of Chicago Press), pp 1278–1281.
Jenkins, P.D. (2003). *Microgale*, shrew tenrecs. In The Natural History of Madagascar, S.M. Goodman and J.P. Benstead, eds. (Chicago: University of Chicago Press), pp 1273–1278.
Olson, L.E., and Goodman, S.M. (2003). Phylogeny and biogeography of the tenrecs. In The Natural History of Madagascar, S.M. Goodman and J.P. Benstead, eds. (Chicago: University of Chicago Press), pp 1235–1240.
Olson, L.E., Goodman, S.M., and Yoder, A.D. (2004). Illumination of cryptic species boundaries in long-tailed shrew tenrecs (Mammalia: Tenrecidae; *Microgale*): New insights into geographic variation and distributional constraints. Biol. J. Linn. Soc. *83*, 1–22.
Poux C., Madsen, O., Glos, J., de Jong, W.W., and Vences, M. (2008). Molecular phylogeny and divergence times of Malagasy tenrecs: influence of data partitioning and taxon sampling on dating analyses. BMC Evol. Biol. *8*, 102.

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Drosophila suzukii

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What is* Drosophila suzukii*? Not just another *Drosophila* species. *D. suzukii* is an invasive, destructive crop pest that originated in South East Asia. The species is also known as Spotted Wing *Drosophila*, because, as in many other *Drosophila* species, males have one dark spot on each wing and two sex combs (Figure 1A). *D. suzukii* recently invaded western countries and is threatening both European and American fruit industries.

Why is* D. suzukii *a menace? Because it is extremely fond of otherwise undamaged, ripening fruits, unlike most other *Drosophila* species which attack only decaying or rotten fruits. *D. suzukii* uses a simple evolutionary advantage, a serrated ovipositor (Figure 1B), to pierce the relatively hard skin of fruits and lay eggs in them. The damage is caused by larvae feeding within the fruits, making them quite protein rich but useless for the market. What is worse is that *D. suzukii* is fond of virtually every small fruit: it will quite happily feast on grapes, pears, apples, tomatoes, peaches, apricots, and plums, although its favourites are cherries and berries. Direct crop loss is the major problem in the first year of invasion, with peaks of 80% reduction in yield. After the pest has become established, eradication is virtually impossible and costs of production rise permanently because of the requirement for monitoring, management, increased chemical inputs, and secondary selection of fruits. The fly is also a potential threat for the biodiversity and the ecology of the invaded areas.

When and how did it arrive in western countries? *D. suzukii* is endemic to Asia, where it is widely distributed in temperate climates from Japan to Pakistan. Its western invasion started in 2008 with three synchronous outbreaks in California, Spain, and Italy (Figure 1C). These first records were close to ports, suggesting that the first individuals arrived as eggs or larvae in fruits sea-traded from Asia. By the end of 2010, the outbreak had spread to the American East coast, Canada, and most of the Mediterranean basin. Latest reports show that the outbreak is escalating with new records announced monthly. The UK has been recently added to the list, and *D. suzukii* is now at the borders of Scandinavia. Few records are available from developing countries, though it is expected that the pest has also colonised additional territories. From an ecological point of view, this invasion has few precedents, and *D. suzukii* is quickly becoming a model for research on invasion biology and pest management (Dreves 2011, Cini *et al*. 2012).

***Why has* D. suzukii *been able to invade so quickly*?** There are several compelling reasons. The first is niche-filling: *D. suzukii* fits the western agricultural environment where there are virtually no competitors for fresh fruits, nor natural predators or parasitoids. Second, *D. suzukii* shows a series of adaptations to temperate climates, which allow it to overwinter, even high in the Alps or Canada where it regularly freezes. A third is the species' dispersal mode: *D. suzukii* can move quickly from a region to another, either flying or being passively introduced by the fruit trade. Last, *D. suzukii* has a high reproductive output: a single female can lay hundreds of eggs during her life, which develop through three larval instars into adults in just 10 days at room temperature. As there may be up to 10 generations a year, a single colonising female can generate billions of descendants by the end of her reproductive season.

What is being done to tackle* D. suzukii*? The first action was in the Americas: since 2010, a number of West coast Universities and Institutions have run a consortium funded by the US Department of Agriculture to monitor and control the spread of the fly. In Europe, various national institutions are monitoring the fly, and within the EU there are proposals to monitor and study *D. suzukii* at the continental level. To provide growers with immediate help, front-line monitoring and surveys have focused on traps and frequent pesticide application, in some cases hazardously close to

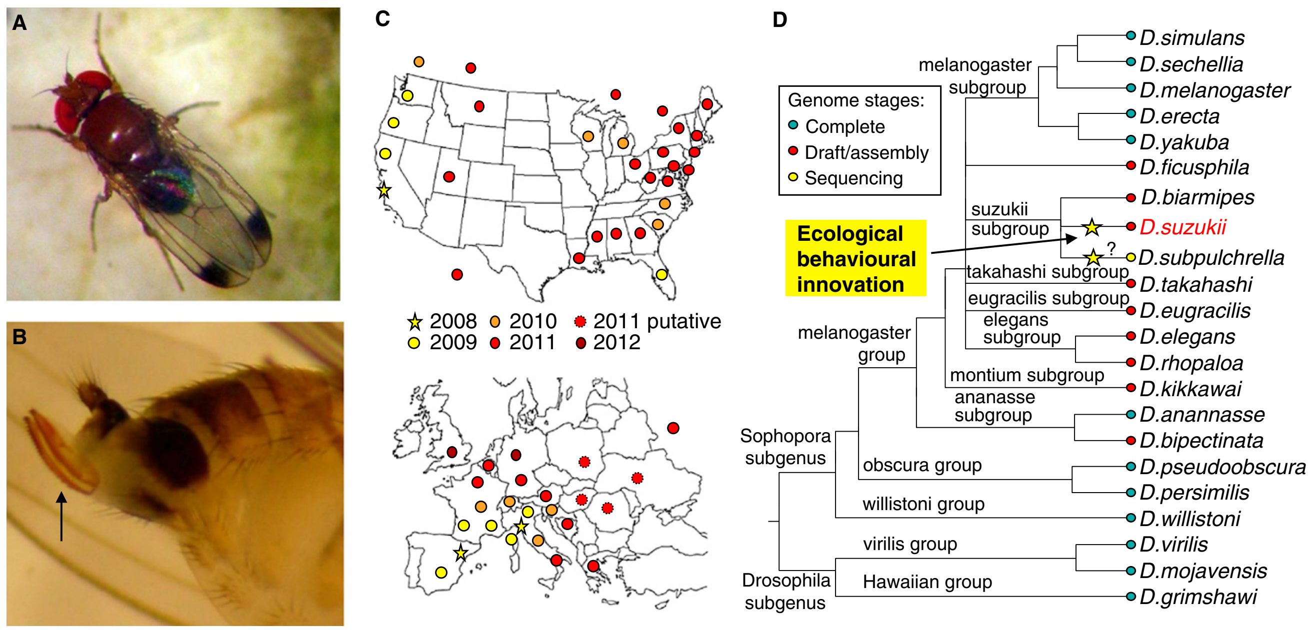

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Figure 1. *Drosophila suzukii*.
A *D. suzukii* male (A) is characterised by its spotted wings, while females (B) possess a saw-like ovipositor which enables them to break the relatively hard skin of fresh ripening fruits and lay eggs in it. The developing larvae accelerate fruit decay and provide a food source for the adult. (C) Originally a native of Asia, *D. suzukii* was first reported in America and Europe in 2008, and subsequently has shown an unprecedented rate of invasion with severe consequences for the fruit industry. (D) *D. suzukii* is closely related to *D. melanogaster* and to other *Drosophila* for which extensive genetic, genomic and physiological data are available. (Photos: Foundation Edmund Mach)

harvest. Because this approach poses serious concerns for residual insecticide and pollinator protection, other practices such as specific mass trapping, interruption of the lifecycle with semiochemicals, and biological control using imported native parasitoids are likely to be crucial for future sustainable integrated management. Finally, the wealth of genetic information accumulated in *D. melanoagster* is being exploited to find alternative genetic-based control strategies.

***How is* D. suzukii *related to the other* Drosophila?** Within *Drosophila*, *D. suzukii* belongs to the 'suzukii' subgroup of the 'melanogaster' group of the genus Sophopora (Figure 1D). It is closely related to the 'takahashi' subgroup, also native to Asia (Ometto *et al*., unpublished). Affinities within the 'suzukii' subgroup are still unclear, but its closest sister species is likely to be *D. biarmipes* (Yang *et al*. 2012), for which a complete genome sequence is available. Other widely studied *Drosophila*, such those from the 'obscura', 'willinstoni', and 'virilis' groups, are sisters to the melanogaster group, and thus *D. suzukii* is nested within existing *Drosophila* genetic models. This placement will ease interpretation of comparative behavioural, genetic and genomic studies.

***Are there other reasons to study* D. suzukii?** Together with the closely related species *D. subpulchrella*, *D. suzukii* is one of the few *Drosophila* that lays eggs on fresh fruits. This remarkable innovation is interesting from many biological points of view. The saw-like ovipositor is one key adaptation, but other traits, such as fruit recognition mediated by the olfactory system, are also implicated. Recent studies indicate that suzukii has a complex antennal response to the odorant spectrum of fruits, and comparison with other *Drosophila*, which are instead attracted mostly by vinegar and fermentation odours, will provide an interesting neuroethological model of trait evolution.

***What genomic resources are available for* D. suzukii?** To assist both basic and applied research, we have recently determined the genome sequence of Italian *D. suzukii*. These data provide the complete repertoire of genes involved in processes such as olfaction (food and mate location), stress response (diapause and overwintering) and neurobiology (novel behaviours, and insecticide targets). In the context of the rich genomic data available for many *Drosophila* species, the *D. suzukii* genome will be a key tool in tracking the origins and dynamics of population spread, adaptations to new environments, and the effects of control measures.

Where can I find out more?

http://horticulture.oregonstate.edu/group/spotted-wing-drosophila, http://capra.eppo.org/files/examples/1/Drosophila_suzukii.pdf, http://genomics.research.iasma.it/ds/twiki/bin/view
Cini, A., Ioriatti, C., and Anfora, G. (2012). A review of the invasion of *Drosophila suzukii* in Europe and a draft research agenda for integrated pest management. Bull. Insectol. *65*, 149–160.
Dreves, A.J. (2011). IPM program development for an invasive pest: coordination, outreach and evaluation. Pest Manag. Sci. *67*, 1403–1410.
Yang, Y., Hou, Z.-C., Qian, Y.-H., Kang, H., and Zeng, Q.-T. (2012). Increasing the data size to accurately reconstruct the phylogenetic relationships between nine subgroups of the *Drosophila melanogaster* species group (*Drosophilidae*, *Diptera*). Mol. Phylogenet. Evol. *62*, 214–223.

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