number, and are most effective on reasonably sized, well-infested lily plots. Parasitoids are also likely to establish more easily on wild lilies (in Europe, parasitism levels are higher on wild lily populations). Wild lilies in the invaded range stand a good chance of harbouring parasitoid populations, which could reduce damage and contain outbreaks better, and this would be good news for North America's threatened and endangered lily species.

Modelling suggests that much of the North American continent is suitable and therefore under threat from the lily leaf beetle. Establishment of a suite of three biocontrol agents while the invasion is still in its early stages could be a key factor in slowing the pest's spread and limiting the impact of the invasion in new areas. This early research will also be invaluable in guiding release strategies as the parasitoids are redistributed in North America to counter the invasion.

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Towards Successful Establishment of Exotic Parasitoids Attacking the Pod Borer *Maruca vitrata* in West Africa

The legume pod borer, *Maruca vitrata* (Lep., Crambidae; syn. *M. testulalis*), remains the single most important insect pest attacking cowpea (*Vigna unguiculata*) and other leguminous crops and wild species in Africa. The damage caused by *M. vitrata* caterpillars feeding on flowers and pods of cowpea is estimated at 20–80%, depending on agro-ecological zone and climatic factors.[1]

For many years, this pest was tacitly categorized as 'indigenous' in Africa, and hence most control approaches were targeting pesticide applications and improving host plant resistance.[1] However, as previously speculated from comparing natural enemy diversity in tropical Asia[2], and recently confirmed by phylogenetic studies comparing worldwide populations of *M. vitrata*[3], it appears now quite clear that this insect originated in Southeast Asia. This hypothesis is also supported by the fact that none of the natural enemies observed in West Africa are specific to *M. vitrata*.[4,5] Earlier biodiversity studies in Asia had identified the parasitic wasp *Apanteles taragamae* (Hym., Braconidae) from Taiwan as a possible biocontrol candidate for testing in West Africa.[6] Although initial results from lab studies were promising, thorough ecological assessment of its real potential in West Africa revealed that it was only marginally adapted to the legume host range present in this region.[7]

In the meantime, more detailed biodiversity studies targeting hymenopteran parasitoids of *M. vitrata* in Southeast Asia revealed two more interesting braconid species, *Phanerotoma syleptae* (an egg–larval parasitoid) and *Therophilus javanus* (a larval parasitoid), with field parasitism rates of up to 60%.[8] Both parasitoids were introduced from the World Vegetable Center (WorldVeg) to the rearing labs of the International Institute of Tropical Agriculture (IITA), Benin Station, for two years' confined testing. An interesting aspect worth mentioning is that, by the time we introduced the parasitoids in our labs, we had just switched from rearing *M. vitrata* larvae on artificial substrate to the use of sprouted cowpea grains as a natural substrate. As we found out later, we would never have been able to establish a rearing colony for one of the parasitoids, *T. javanus*, if we had tried to rear it on *M. vitrata* larvae originating from artificial diet, possibly because of a lack of essential elements, or because of the presence of some anti-nutritional factors affecting the development and survival of the parasitoid.

Once we had obtained release permits from the respective national authorities, a total of 101,600 adult parasitoids – 60,100 in Benin (30,300 *T. javanus* and 29,800 *P. syleptae*) and 41,500 in Burkina Faso (23,000 *T. javanus* and 18,500 *P. syleptae*) – were released, starting in January 2016. Based on ecological observations in their native area in Southeast Asia, our release strategy targeted different agro-ecologies and host plant habitats depending on the parasitoid species. For *P. syleptae*, we released on flowering legume trees and shrubs such as *Pterocarpus santalinoides*, *Lonchocarpus sericeus*, *Philenoptera cyanescens* (syn. *L. cyanescens*) and *Milletia thonningii*, all belonging to the family Leguminosae–Papilionaceae. These plants are major hosts for *Maruca vitrata* populations during the off-season, when no cowpea is planted.[9] In contrast, *T. javanus* was released on cowpea crops and patches of herbaceous legumes including *Sesbania rostrata*, *Tephrosia platycarpa* and *Pueraria phaseoloides*, all Leguminosae–Papilionaceae, as well. Releases were carried out with the active participation of local communities and were preceded by a sensitization campaign explaining in simple terms the concepts of biological control. The two main messages voiced by the campaign were (i) not to apply chemical pesticides where the releases were made, and (ii) to preserve the legume tree species in the environment. In fact, one of these trees, *L. sericeus*, is unfortunately the object of indiscriminate cutting because of its value in artisanal charcoal processing, hence the urgent need for advocating its preservation.

In Benin, only a few months after the initial releases in early 2016, *Phanerotoma syleptae* was recovered from parasitized pod borer larvae on the target host plants, particularly *L. sericeus*, while *Therophilus javanus* was recovered later in the season, mostly from cowpea and *Tephrosia* spp. Both parasitoids were also recovered from cowpea and from wild host plants in Burkina Faso during the 2016 cropping season. Furthermore, surveys carried out in Benin in February–April 2017 indicate with certitude and unambiguously that both species have successfully survived the long dry season (particularly harsh this year) on alternative host plants in the absence of cowpea, nearly one year after initial experimental releases (first author's unpublished data).

While it is too early to be able to give a proper quantitative assessment of the impact of the released parasitoids on *Maruca vitrata* populations, it is noteworthy that during the recent post-dry season surveys we were able to recover parasitized *M. vitrata* larvae from very low pod borer populations, indicating a good ecological adaptation of both parasitoids, and maybe also an early sign of parasitoid efficacy.

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Biocontrol Agents Break New Ground in the Cook Islands

International collaboration and funding from New Zealand have facilitated the introduction and release of biocontrol agents against two invasive plants that have not previously been targeted anywhere else. The introductions are part of a larger project to implement biological control of invasive weeds in the Cook Islands.

Seven invasive plant species in the Cook Islands were identified for biological control during consultation in 2009 between Landcare Research New Zealand scientists and experts in agriculture, biodiversity conservation and biosecurity in the Cook Islands. Using a method developed by Landcare Research, the process took into account the importance of each weed and the feasibility and relative cost of implementing biological control. A five-year plan was mapped out for a partnership project between Landcare Research and the Cook Islands Ministry of Agriculture (MoA), funded by the New Zealand Ministry of Foreign Affairs and Trade. Biocontrol agents have so far been released on Rarotonga, the largest island of the Cook Islands archipelago, against five of the invasive plant species, including the two novel targets. In addition, a genetic study is being conducted on peltate morning glory (*Merremia peltata*) because the dominance of this smothering vine over native species had led to its native status in Rarotonga being questioned, with suspicions that it could actually be a Polynesian introduction. If it is a recent introduction, that potentially opens the door to its biological control.

Red passionfruit

Red passionfruit (*Passiflora rubra*) was potentially a difficult target, because it had not been targeted before and because of the need to avoid non-target attack on the related edible passionfruit (*P. edulis*). Traditionally, such a project begins with surveys in the area of origin of the target plant. But evolutionary biologists have long been interested in coevolution between *Passiflora* species and Neotropical *Heliconius* butterflies as a model system. Research on them has been extensive, and has revealed a high degree of host specificity in the but-