What doesn’t kill me, makes me stronger

Multicolored Asian lady beetles are advancing round the globe, often driving out native species in many of the countries they invade, and their methods amount to no less than biological warfare: they infect their opponents with deadly parasites against which they themselves are immune.

This was revealed in a study conducted by Fraunhofer IME, published in the current edition of Science Magazine, the academic journal of the American Association for the Advancement of Science. From the human point of view, ladybugs are harmless creatures that are not only pretty to look at, but that also serve a useful purpose, as their diet includes aphids and other botanical pests. The multicolored Asian lady beetle or Harlequin ladybird (also known as the Japanese ladybug, the Halloween ladybug or the Harlequin ladybird) is an especially voracious eater; this little glutton can munch its way through up to 200 aphids a day. Its sizeable appetite led resourceful organic farmers to import Harlequin ladybird decades ago as a natural method of biological pest control. They initially introduced the insect onto fields and into greenhouses in North America before bringing it over to Europe – but from the 1990s onward, these little helpers started to become a problem in their own right. The beetle has reproduced uncontrollably, and is now considered a primary example of an invasive species.

The alien invaders also gained a foothold in Germany, where they are making life difficult for the 80 or so native ladybug species. This could have worrying consequences, as Professor Andreas Vilcinskas, biologist and joint head of the Institute for Phytopathology and Applied Zoology at Justus Liebig University Giessen, explains: “If things continue at this rate, many of these species will disappear.” Professor Vilcinskas also set up the Bioresources project group at the Fraunhofer Institute for Molecular Biology and Applied Ecology IME in 2010, an initiative that is funded to the tune of 4.5 million euros by the Land Hesse through the LOEWE research promotion program (“State offensive for the development of scientific and economic excellence”). “Our aim is to utilize the enormous potential that the insect world holds for us. Insects are an incredibly diverse species in possession of many bio- molecules that could have all manner of medicinal and biotechnological applications,” Vilcinskas adds.

Fraunhofer research scientists consider invasive species such as the multicolored Asian lady beetles to be very promising. “If a species is able to successfully spread across the planet, then it must have a very strong immune system, else it would not be able to withstand the various pathogens it encounters every time it enters a new habitat.” Com- paring the invading beetle with two native species, the seven-spotted ladybug (Coccinella septempunctata) and the two-spotted ladybug (Adalia bipunctata), gives credence to the biolodist’s argument: laboratory tests indicate that the blood of the foreign insects has much greater activity against bacteria than the blood of both European species. Vilcinska’s team identified the active agent as harmonin, a substance that is exclusively produced by Harmonia. This substance proved to be an effective antibiotic that is capable of combatting tuberculosis and malaria pathogens, among others.

But harmonin is just one of many chemical weapons the multicolored Asian lady beetle uses to defend itself against microorganisms. Its armory also contains over 50 types of peptides with which it can fight off massive bacterial attacks, as revealed by Dr. Heiko Vogel’s in-depth molecular biological analyses conducted at the Max Planck Institute for Chemical Ecology in Jena. “This makes Harmonia a record breaker. We know of no other animal that produces so many antimicrobial peptides,” says Vilcinskas. This gives the interlopers a distinct competitive advantage over their seven-spotted rivals and other ladybugs. But having a strong immune system still doesn’t explain their incredible assertiveness – for these little fighters invariably come out on top when they go head-to-head with their local relatives, too.

A startling observation made by the Fraunhofer team led them to discover the real secret to Harmonia’s success. When competing for food and space in their natural habitat, it’s not unusual for ladybugs to eat their rivals’ larvae and eggs. If a seven-spotted ladybug tucks into the young of its exotic opponent, then it’s a deadly meal: the hungry native dies. When a multicolored Asian lady beetle gobbles up the offspring of its local relation, however, it suffers no ill side-effects whatsoever. The answer to the mystery is contained within the invaders’ blood, which is filled with spore-like parasites. Some 18 months of molecular biological detective work finally identified the organism as belonging to a group of fungi-like unicellular parasites called Nosema, a microsporidian.

“Since making the discovery, we have examined multicolored Asian lady beetles from all over the world. We found microsporidia in every single animal in every population, even in the eggs,” explains Vilcinskas. This means that whenever a seven-spotted ladybug eats a Harmonia egg, the insect is invariably infected with the pathogens the egg contains. The microsporadia multiply in their new host, and eventually kill it. Researchers at the IME do not yet know why the Asian ladybugs aren’t affected by the microsporidia they carry – but they’re hot on the heels of a promising lead, as Vilcinskas reveals: “Presumably the beetles protect themselves

using harmonin. We think that they use it to limit the rate of microsporidia reproduction, thus keeping levels harmlessly low.”

Countries

Austria, Belgium, Bulgaria, Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, United Kingdom

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