OPINION

Neonicotinoids – friend or foe?

Dave Goulson debates the impact of neonicotinoids used in current crop farming practices on the UK and international ecosystem health, and in particular, the humble bee.

The impacts that neonicotinoids may or may not be having on bees, wildlife and ecosystem health has become one of the most hotly contested areas of environmental research and policy in recent years. Neonicotinoids are neurotoxins, synthetic variants of nicotine, and they have become the most widely used insecticides in the world since their introduction just over 20 years ago. Being insecticides they are of course highly toxic to insects, with the LD50 (the dose that kills 50 per cent of test organisms) being just 4 billionths of a gram for honeybees; meaning that 1 teaspoon would be sufficient to give an LD50 to 1.25 billion bees. They are systemic, water-soluble chemicals that are most commonly used as a seed dressing; farmers buy pre-dressed seeds and simply sow them. The pesticide is soluble within soil water and is taken up by the roots of the crop, spreading through the tissues and protecting all parts of the crop from insect pests. This all sounds like an efficient and effective means of pest control, but there are problems.

OPINION

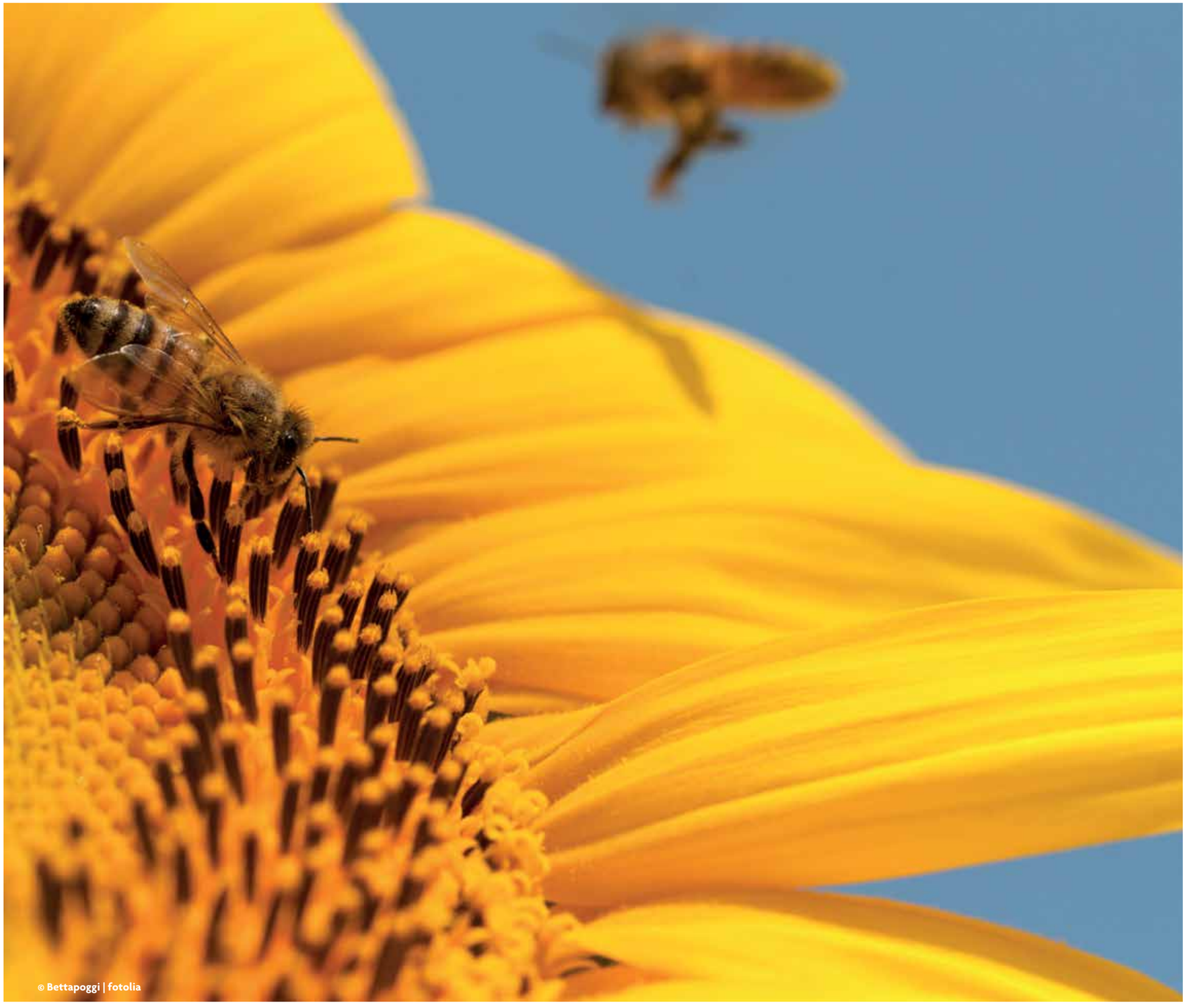
BEES AND NEONICOTINOIDS – WHAT'S THE PROBLEM?

The first to emerge was that, being systemic, the neonicotinoids are absorbed into the pollen and nectar of flowering crops such as oilseed rape and sunflowers, and thus are consumed by bees and other pollinators. French beekeepers raised the alarm as long ago as 1996 when they found that their honeybee hives were dying when near treated fields of sunflowers. This sparked considerable research, and it has since become clear that the doses that bees receive from exposure to a treated crop are not enough to kill them swiftly, but impairs their navigation, learning, memory, egg laying and fertility, and their immune systems.

Large-scale field trials have found that this translates into a major impact on the colony health for wild bumblebees and reduced breeding and abundance of solitary bees. Evidence for impacts on honeybee colonies is mixed, and much debated. The agrochemical industry have funded and/or conducted several large field trials on the impacts on honeybee colonies, and found no adverse effects. However, these trials have been widely criticised on numerous grounds including whether it is appropriate for companies that make billions of dollars from the sales of a chemical to be the ones evaluating their safety.

IS THE DAMAGE GREATER THAN FIRST THOUGHT?

Although much of the focus of this debate has been on bees, it has begun to emerge that there are broader problems associated with neonicotinoids. When introduced, they were regarded as providing an excellent targeting tool for crop management and a big improvement on the mass spraying of pesticides from a tractor, but this proved to be incorrect. On average only about 5 per cent of the pesticide is taken up by the crop (much less than can be achieved with a foliar spray). The remainder goes into the soil and consequently soil water, where it can persist for many years, and may accumulate if treated crops are sown every year. Neonicotinoids leach into streams and ponds; water samples collected from locations as diverse as the Netherlands, Canada and California reveal that the majority of waterways in arable areas contain them, often at concentrations exceeding recommended levels and also exceeding levels known to cause mortality in aquatic insects such as mayflies[1]. Neonicotinoids are intended to be taken up by the roots of the target crop, but of course they are just as readily taken up by the field margin and hedgerow plants that have their roots in the same soil. Recent studies have demonstrated that common field margin wildflowers, such as hawthorn, poppy and thistle commonly have neonicotinoids in their leaf tissues and in their pollen and nectar, sometimes at levels exceeding those in the crop[2]. This means that pollinators aren't just threatened by exposure to the crop; they are being exposed all season



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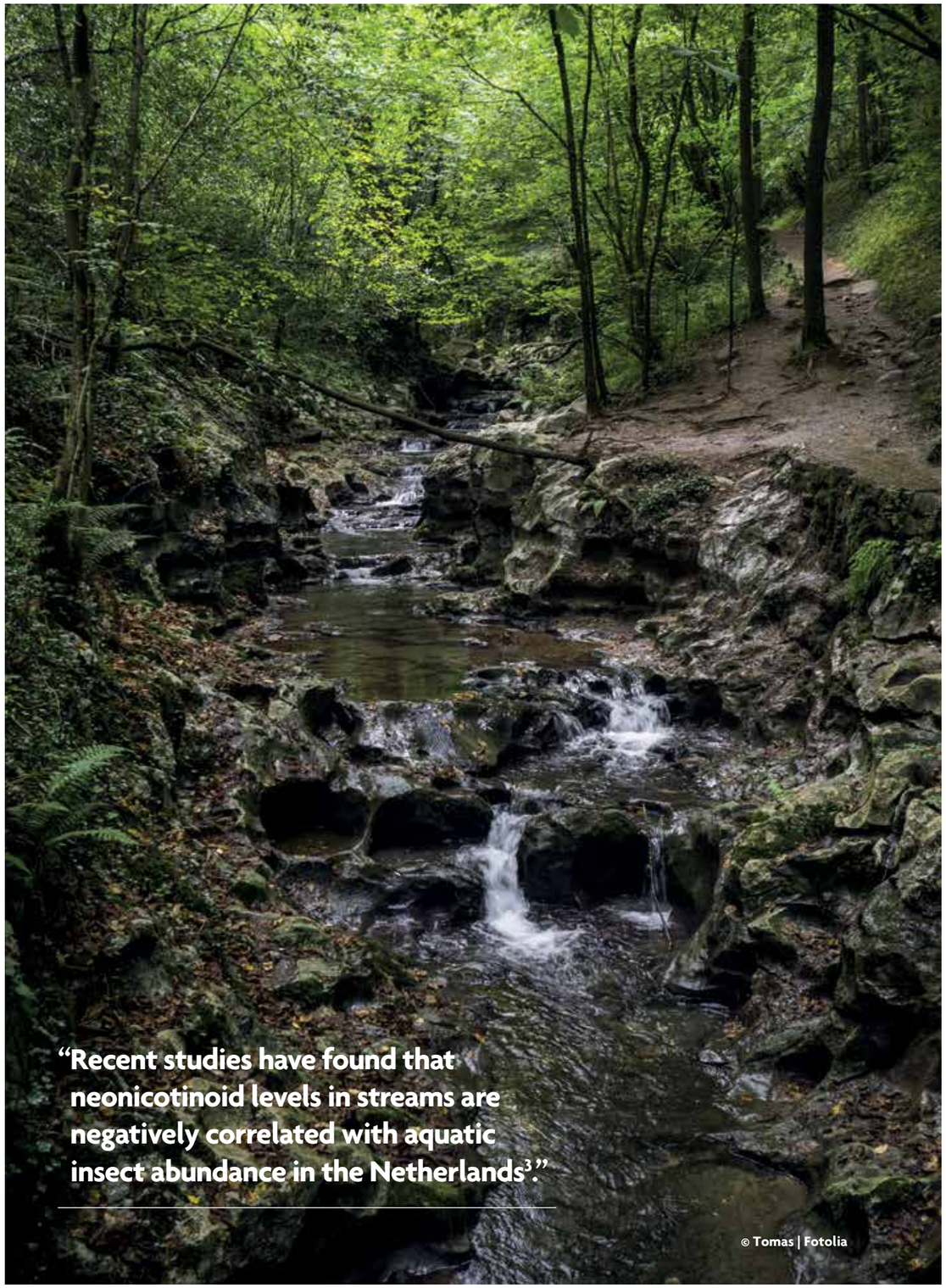

long if they visit almost any flowers in conventional arable farmland. Of course this also means that other insects that live in our hedgerows: grasshoppers, frog hoppers, the caterpillars of butterflies and moths and so on, are all exposed since their food sources are contaminated with these potent neurotoxins.

Recent studies have found that neonicotinoid levels in streams are negatively correlated with aquatic insect abundance in the Netherlands[3], honeybee colony deaths and rates of local extinction of wild bees correlate with neonicotinoid use in the UK[4,5], rates of decline of insect-eating birds are highest in areas of the Netherlands that have higher levels of neonicotinoid pollution[6] and UK farmland butterfly declines are neatly predicted by annual rates of application of neonicotinoids[7]. These are all sophisticated analyses that attempt to take into account other factors that might affect insect and bird populations, such as changing weather and land use. Yet all are dismissed by the pro-pesticide lobby as mere correlations. Through repetition they have created a myth that correlations are not a valid tool of statistical inference. Of course correlation is not proof of causation, but when one repeatedly finds a strong correlation between insect declines and insecticide use, it seems reasonable to infer that causation is the most likely explanation.

DO NEONICOTINOIDS HAVE A FUTURE?

The pro-pesticide lobby states that highly potent and persistent neurotoxic pesticides effectively control and target farm pest insects while having no effect on non-target bees, butterflies or other insects living on those farms. In previous decades they made the same claims for previously used pesticides, such as the organochlorides (e.g. DDT) and organophosphates, which are now largely banned.

Interestingly, politicians in different countries have drawn markedly different conclusions as to where the balance of evidence lies. The European Food Standards Agency (EFSA) published reports in 2013 reviewing the evidence to date which concluded that the three most commonly used neonicotinoids pose “an unacceptable risk to bees”. As a result, the European Parliament proposed a moratorium on their use on flowering crops, which was passed and came into effect in December 2013. This continues to the present, and is currently being reviewed. Since 2013 the evidence that neonicotinoids harm the environment has become much stronger, as highlighted in a recent review by the European Academy of Sciences in 2015[8].

It seems reasonable to conclude that the moratorium will remain or be extended in the EU, and both France and Germany are unilaterally moving towards total bans on neonicotinoids. However, the UK government (and a small number of other countries) opposed the moratorium in 2013, and has not since indicated that it has changed its mind.

Outside of Europe, no national government has taken steps to limit or ban neonicotinoid use in response to the growing evidence of environmental harm (though Ontario is legislating to greatly decrease use). The UK’s National Farmers Union and the agrochemical industry continue to lobby for the moratorium to be rescinded, and with Brexit the UK government will be free to do so. At a time when Britain’s farmland wildlife continues to decline, with farmland bird populations down 54 per cent since 1970 and farmland butterflies down 40 per cent since 1990, this might well be the final nail in the coffin for many UK species.

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