Bringing in the bugs

One of the fundamental qualities of any good organic system is its ability to not only exist within a flourishing natural ecology, but to utilise and enhance this powerhouse of potential stability and health. Commercial greenhouses are often treated differently and for a variety of reasons have very little in the way of a thriving, natural ecosystem. Can we design a better balance for larger scale protected systems and to what purpose?

The first step must be to allow for greater genetic diversity; mono-crops make this difficult, so growing a range of complementary crops is a start. Another step might be to try and understand the local invertebrates and their lives; how do we encourage the beneficial and discourage those that would beat us to dinner? Are we trying to defend our crops from outside invaders or is our internal ecology a continuum of what is happening in the surrounding fields and hedges?

Encouraging a balanced ecology within a productive annual cropping system is rarely characterised by prescriptive strategies, indoors or out. It seems that the best systems have come around through the co-evolution of people and place. As those working the land learn to read the signs and patterns around them, the ecology also settles around established methods, crops and their seasonality. The quick fix solutions, changes in rural traditions and a fickle market have taken their toll on established systems of not only food production but also woodland and other land management practices. In comparison, an appeal for greener greenhouses seems almost petty - why waste such valuable space messing around with wildlife?

The asparagus beetle story

Anyone who has visited Hankham is likely to have heard the asparagus beetle story, how we pulled our fringes and beat our brows upon discovering the dreaded pest and spent two years working out how best to keep them from stripping the crop bare by using pyrethrum at tactical stages. I can't exactly remember when we first noticed a tiny 'fly' with evident interest in asparagus beetle eggs, but in spring 2006 a keen ecologist who was working with us identified the parasitic wasp, *Tetrastichus asparagii*. We stopped spraying and allowed the crop to get to the 'dead Christmas tree plantation' stage four months earlier than is normal. There was a marginal recovery before winter, but fingers were tightly crossed the following spring, when the spears emerged and gave us a reasonable harvest. More interestingly, the following years saw a rapid readjusting of the balance, and the wasps have kept the beetle in check with no further interference ever since. They can both be found with ease, doing their thing, and we lose a few fronds here and there, but the crop is healthy (just don't mention the weeds).

This is all very well for a perennial crop where a permanent presence allows an ecosystem to develop and redress, but asparagus is hardly a typical greenhouse crop. What about annuals such as tomatoes and winter lettuces?

Photos: Peter Dollimore

Flowering coriander next to red russian kale

At this point it is worth mentioning that we do buy in bugs; a program of bio-control from March to October ensures predators and parasites are introduced to specific crops at times of year where we have struggled to retain control in the past. Thanks to this, thrips, red spider mite, aphid and caterpillar problems are usually kept within acceptable levels, but it is obvious that other forces are at work.

Local hero - *Cotesia glomerata*

One particular local standout is the parasitoid wasp *Cotesia glomerata* that lays into the living caterpillar of, in particular, the small white *Pieris brassicae*. This has never been introduced but its activity is well researched and can be easily spotted. Infected butterfly larvae crawl to a high point, sometimes on walls, posts or tunnel plastic, before erupting into a sulphur colour mass of wasp pupae. Those still munching the crop, if squished, can be seen to contain small yellow grubs, which are gradually digesting their internal organs in order of least importance. Thus the final journey is determined by the parasite seemingly driving the host, which has only a barely mobile shell of a body left.

Since identifying this beneficial organism we have cut back our use of *Bacillus thurungiensis* (Bt) both inside and out. We haven't used it, nor protective covers, on outdoor brassicas for four years. Indoors we spray from late October when wasp activity seems to slow down while caterpillars continue to enjoy the soft protected leaves. Use of Bt solves the caterpillar problem but also destroys the developing parasite. Allowing the first generation of parasitised larvae to complete the cycle will ensure plenty of wasps are present.

There have been times when, walking the crop and checking pests, I have failed to find unaffected butterfly larvae. Research has suggested that up to 70% of individuals become hosts, which

is pretty amazing until you note that they do continue to feed, albeit slower, for some time before succumbing to the parasite. The reality in our case seems to be minimal significant crop damage. Perhaps additional ecological interactions are at work, but recognising the role of *Cotesia* leads us to wonder how we can encourage and maintain this useful insect.

I suspect two factors are in our favour:

1. The wasps get an early start by building up their numbers on the caterpillars feeding on spent rocket crops in the glasshouse. This means that by the time outdoor brassicas are getting established in mid-summer, high parasite numbers are already present in the locality.
2. A large amount of suitable nectar sources are maintained by allowing crops such as coriander to flower, and by providing banks of flowering plants inside and out.

Looking at the research on this wasp, one particular name pops up again and again. Felix L Wäckers has written and co-written many papers investigating how nectar provision can attract and support pest parasites and his work is well worth checking out if you have more than a passing interest in this subject.

Predators for aphids

Aphids *Aphis gossypii* and *Myzus persicae* are our most consistently frustrating glasshouse pests; their ability to populate in favourable conditions is unparalleled, and the way they can render a perfectly nice looking spring lettuce unmarketable has been a recurring theme for me over the last twenty years. That said, I have also seen them literally vanish from a crop overnight. I am still largely mystified by this phenomenon, though the lifecycle of certain predators possibly combining with a surge in plant resistance may offer an explanation.

One such predator is another native bug, the hoverfly *Syrphidae* spp. It is a joy to watch the adults zipping around, feeding on coriander and *Limnanthus* flowers and even more so in the knowledge that they will be laying eggs among lettuce, chard, beans and spring greens. The larvae will feed on the aphid, hoovering them up like a street cleaner, before forming into a shiny, drop-shaped pupae. Customers would be forgiven for thinking they had a few bonus maggots in their greens, which may not be a vast improvement on the greenfly, but for those of us direct selling this is a great opportunity to both educate and enthuse our customers about the amazing ecology which co-exists with their food production!

Spring greens with poached egg plant

One particular tactic we deploy is to sow a few poached egg plants (*Limnanthus douglasii*) at the same time as our spring greens. This is around early October for planting late November. They are planted around and within the cabbage beds which are prone to cabbage aphid in May and help attract hoverflies into the crop in spring as they flower.

Although difficult to quantify the degree to which such tactics assist, anecdotal evidence and observation should be helpful in directing the efforts of further research. In light of the fact that we run a commercially successful enterprise it can be seen that these methods are used without detriment to the viability of the business. This is important to consider when deciding how to encourage the right type of biodiversity as we are conserving it within a cropping system which needs to remain productive and manageable.

Predator and nectar strips

The creation of specific predator and nectar strips within the greenhouse will use valuable space, but it seems a lot can be done with a small area. With careful selection of host plants it may not only benefit the growing system but can positively add to the ambiance of the place, improving the mood and motivation of those working there. The idea is to provide refuge and food for beneficial species, predators, parasites and pollinators, encouraging them to build up numbers and perhaps maintain a population when the crops alone are not able to do so. After research and lots of trial and error the following species are regularly planted within the glasshouse for their flowers or hosting role. Some also provide a harvest though might not be grown if it wasn't for the the added benefit. Some readily self-seed and can be selected for when weeding.

Solidago (golden rod)

Achillia millefolium and *Ptarmica* (yarrow and sneezewort)

Cosmos bipinnatus

Anethum graviolens (dill)

Borago officinalis (borage/star flower)

Calendula officinalis (pot marigold)

Limnanthes douglasii (poached egg plant)

Origanum vulgare (oregano)

Origanum majorana (marjoram)

Thymus vulgaris (thyme)

Predator/nectar strip at Hankham

For practical purposes they can be combined in a bed with the order of the list being tallest to shortest, so middle of bed to outside edge. Borage and *Calendula* can provide edible flowers for salad bags, the culinary herbs can be grown as such but large quantities are difficult to market so a few used to extra effect makes a lot of sense.

Golden rod provides an excellent source of nectar to beneficial insects. *Achillia* also can, although there is some evidence it can repel some too. What we really love about it is that a type of aphid, the Yarrow aphid, feeds only on *Achillia* and the clumps of foliage provide a good overwinter environment for ladybirds. We have found them emerging from hibernation to begin feeding and breeding on the aphid, building up their numbers then moving out into the crops. Again this is not a carefully measured process but has been observed most years to some degree.

Harvesting ladybirds

While on the subject of ladybirds, it always seemed a shame, when clearing the bolting overwintered leaf beat erbette in April, that we were composting loads of ladybird larvae. These were just hatching out, representing the first generation of the year ready to start gobbling the black bean aphid as they moved onto the sappy flowering shoots. Looking into the cost of purchasing these fabulous predators it soon became obvious that collecting them up was a worthwhile exercise. They are relocated to the spring lettuce and propagating peppers to continue their meal and hopefully go on to produce the next generation.

Collecting ladybird larvae from leaf beet in late April

Photos: Peter Dollimore

Bumblebees love borage and cosmos and live happily within the glasshouse helping to pollinate beans and tomatoes. Dill flowers are popular with hoverfly and parasitoid wasps and dill also flowers more rapidly then most of the umbellifer family that, like coriander, are all useful but can take a while to go from harvestable crop to nectar provider.

Calendula, aside from its wonderful flowers, will host the introduced bug *Macrolophus caliginosus* throughout the year. After initially introducing it for whitefly and spider-mite control we realised it was happily overwintering within the greenhouse and recently discovered that *Calendula*, along with a run of mild winters, was largely responsible for this with dozens present per m^2 patch.

Oregano, marjoram and thyme all provide excellent flowers for nectar feeders. Thyme is popular with mason bees who can be easily encouraged to stay by providing bundles of old bamboo canes cut into sections and stacked in an open sided box off the ground somewhere within the nectar strip. Oregano was identified in one of F. Wäckers' papers as the optimal parasitoid food source out of eleven plants studied for attractiveness and nectar availability to three different wasp species.

BioGreenhouse strategies

Interestingly, recent developments in policy at European level have taken a similar path with the promotion of functional diversity and banker plants. The BioGreenhouse project identifies five strategies that are desirable in improving the ecological sustainability of our commercial greenhouses:

- functional diversity of natural enemies,
- food sprays (harvested pollen is sprayed into the crop to feed predators when pest numbers drop),
- banker plants,
- habitat and climate management, and
- induced plant resistance (worth looking up if you haven't heard of it!).

Bugs off the shelf

As I mentioned earlier, we buy in bugs as well as trying to encourage the locals in. The five points above are generally aimed at the management of introduced agents such as using *Calendula* as a *Macrolophus* host. Commercial glasshouses may use containers of prepared grass to breed parasitic wasps such as *Aphidius colemani*. They parasitize the grain aphid (specific to monocotyledon plants), retaining a population for aphid control within the dicotyledonous crop and reducing the need to keep buying them in.

With a wide range of crops a similar effect can be achieved, as old crops are cleared the aphid are removed from the glasshouse while the more mobile parasitoids fly off to find a new spot. Last year (Spring 2015) we had some serious blackfly problems; a pretty good run over previous years had perhaps bred complacency.

By the time we realised how bad it had got we were into damage limitation. Most of the cucumbers were lost but the courgettes pulled through and it was mostly the work of *Aphidius colemani* that saved them along with soapy water just to keep the growing tip and developing fruit clean. The underside of the leaves were covered with the tiny bronze mummified aphid, and as we had decided to clean up the recovering crop a bit we removed the oldest leaves and took this bank of wasps out to the field, placing them around the broad beans. Blackfly were just starting to spread out here, too, but the situation turned around pretty quick following this activity which felt almost like a traditional ritual that great granddad might have done, back in the day.

Maintaining *A. colemani* populations has been a mix of buying them in to get an early start and target particular crops, then allowing winter and successive spring coriander crops to flower, removing one lot once the next has a good show on. These are possibly the best flowers for beneficial nectar feeders and they attract bees, hoverfly, parasitic wasps and a whole heap of bugs I just haven't had the time to start identifying properly.

Outdoors too

While interior strategies are important, especially for large protected areas, managing the outdoor hedges and fields properly has to be critical, too, especially in an open border state. A nice mixed native hedge flowering through the season will be far better than a row of spider mite infested conifers. Most mixed organic holdings will have a lovely range of species buzzing around but specialised greenhouse nurseries may not have considered managing the surrounding habitats to encourage the native potential.

My favourite scheme of late has been to mix a pack of cornfield annuals into the grass/clover ley we sow outside in early September. This results in the otherwise fairly dull green patch being transformed into a splatter of pink, blue, red, yellow and white flowers before the clover really gets going. To prolong the effect we mow strips through it rather than cut the whole lot in one go. Four or five staged cuts and the whole lot has had a trim by August without the sudden shock. We are lucky enough to be in an area full of vibrant natural habitats, and our efforts hopefully add something to this as well as contribute to the general health of the growing system.

It's both fascinating and heartwarming to stand in the glasshouse on a warm evening and not only hear but feel the hypnotic hum as insects work the flowers and go about their various businesses. Sometimes you hurry, on a mission, past a patch of flowering rocket and think "hmm…not much going on there". But stop and watch, just for one minute, and gradually you'll notice it, the constant activity of tiny beasts, invisible to the brain full of half done jobs and rearranged plans. They've got their own missions and you're the invisible one.

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This article was originally a presentation given at the 2016 ORC Organic Producers' Conference in Bristol. Visit http://tinyurl.com/ORC16-Dollimore for accompanying slide show.