Pearson BTEC Level 3 National in Applied Science

Unit 7: Contemporary Issues in Science

Sample Assessment Materials (SAMs)

For use with Extended Diploma in Applied Science

First teaching from September 2016 Issue 2

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BTEC

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Level 3

Applied Science

Unit 7: Contemporary Issues in Science

Part A

Supervised hours 6

Extended Diploma

Sample assessment material for first teaching September 2016

Instructions

- **Part A** contains material for the completion of the preparatory work for the set task.
- **Part A** is given to learners two weeks before **Part B** is scheduled. Learners are advised to spend no more than 6 hours on **Part A.**
- **Part A** must be given to learners on the specified date so that learners can prepare in the way specified.
- **Part A** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part B** materials must be issued to learners on the date specified by Pearson.

Paper reference

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Instructions to Teachers/Tutors

This paper must be read in conjunction with the unit information in the specification and the BTEC Nationals Information for Conducting External Assessments (ICEA) document. See the Pearson website for details.

This set task has a preparatory period. **Part A** sets out how learners should prepare for the completion of the Part B task under supervised conditions.

Part A is given to learners two weeks before **Part B** is scheduled. Learners are advised to spend no more than 6 hours on **Part A**.

Learners should undertake independent research on the case study given in this **Part A** booklet.

Centres must issue this booklet at the appropriate time and advise learners of the timetabled sessions during which they can prepare. It is expected that scheduled lessons or other timetabled slots will be used of the preparation.

Learners should familiarise themselves with the specific concepts and terminology used in the articles.

Learners may prepare summary notes on the articles. Learners may take up to 4 sides of notes of this type into the supervised assessment (Part B booklet).

These notes should only include information about scientific terminology, quantities and concepts used in the articles and a summary of the scientific issue discussed. This will enable learners to interpret, analyse and evaluate the articles in **Part B**. Other content is not permitted.

Part B must be completed under supervision in a single 2.5 hour session timetabled by Pearson. A supervised rest break is permitted.

The supervised assessment should be completed in the **Part B** Task and Answer booklet.

Teachers/Tutors should note that:

- Learners should not be given any direct guidance or prepared materials
- Learners should not be given any support in writing or editing notes
- All work must be completed independently by the learner.
- Learner notes will be retained securely by the centre after **Part B** and may be requested by Pearson if there is suspected malpractice.

Refer carefully to the instructions in this taskbook and the Information for Conducting External Assessments (ICEA) document to ensure that the preparatory period is conducted correctly and that learners have the opportunity to carry out the required activities independently.

Instructions for Learners

Read the set task information carefully.

This is **Part A** of the set task and gives information you need to use to prepare for **Part B** of the set task.

In **Part B** you will be asked to carry out specific activities using the information in this **Part A** booklet and your preparatory notes.

In your preparation for **Part B** using this **Part A** booklet you may prepare short notes to refer to when completing the set task. Your notes may be up to 4 sides and may be hand written or typed. Your notes should only include information about scientific terminology, quantities and concepts used in the articles and a summary of the scientific issue discussed. This will enable you to interpret, analyse and evaluate the articles in **Part B**. Other content is not permitted.

You will complete **Part B** under supervised conditions.

You must work independently and must not share your work with other learners.

Your teacher may give guidance on when you can complete the preparation.

Your teacher can not give you feedback during the preparation period.

You must not take your preparatory notes out of the classroom at anytime and you must hand it in to your teacher on completion.

Your notes will be made available to you at the beginning of the supervised assessment.

Set Task Brief

You are provided with the following articles:

Article 1: Bees may become addicted to nicotine-like pesticides, study finds

Article 2: Plight of the bumblebee: Pesticides linked to the decline of bee colonies

Article 3: Sick Bees – Part 18F2: Colony Collapse Revisited – Synthetic Pesticides.

You need to become familiar with the articles and gain an understanding of the scientific issue discussed in the articles so that you are able to interpret, analyse and evaluate the articles in preparation for **Part B**.

Your notes should only include information about scientific terminology, quantities and concepts used in the articles and a summary of the scientific issue discussed.

You should spend up to a maximum of 6 hours to complete your preparatory notes. You may take up to 4 sides of A4 notes into the supervised assessment.

Part A Set Task Information

Article 1:

Bees may become addicted to nicotine-like pesticides, study finds

Bees have a preference for sugar solutions laced with the pesticides, scientists say, as a separate landmark field trial shows neonicotinoids harm bee populations.

A foraging red-tailed bumblebee: a study says bees get a 'buzz' from nicotine-like pesticides in much the same way as smokers are stimulated by tobacco. Photograph: Jonathan Carruthers/PA
Karl Mathiesen

Bees may become addicted to nicotine-like pesticides in the same way humans get hooked on cigarettes, according to a new study, which was released as a landmark field trial provided further evidence that such neonicotinoids harm bee populations.

In a study published in the journal Nature, scientists from Newcastle Univeristy showed that bees have a preference for sugar solutions that are laced with the pesticides imidacloprid and thiamethoxam, possibly indicating they can become hooked on the chemicals.

Also published in Nature on Wednesday was a study that has been endorsed as the most conclusive evidence yet that the group of pesticides, neonicotinoids, harm wild bee populations, which include bumblebees and solitary bees.

Scientists from Lund University in Sweden carried out the first successful 'real world' experiment on the effect of neonicotinoids on bees and found that wild bee populations halved around fields treated with them. Bumblebee hives stopped growing and produced less queens where the chemical was present. However the study did not find evidence that more robust honeybees, which are used to pollinate many crops, were affected.

Dr Maj Rundlöf, the lead author of the study, said the impacts on wild bees were "dramatic". "I think it's really important evidence when discussing how neonicotinoids used in real agricultural landscapes influence bees," she said.

Dave Goulson, a bee expert at Sussex University, not involved in the research, hailed the findings as hugely significant.

"At this point in time it is no longer credible to argue that agricultural use of neonicotinoids does not harm wild bees." He said the paper was "a major step forwards in clarifying the neonicotinoid debate… This was the first fully field-realistic, well-replicated trial so far, an impressive piece of work."

Previous field experiments on neonicotinoids have been shown to be inadequate. The current EU moratorium on the use of a group of neonicotinoids on certain crops has been criticised, particularly by the UK government, on the basis that field evidence of neonicotinoids harming bee populations has been difficult to obtain.

Nick von Westenholz, chief executive of the Crop Protection Association that represents neonicotinoid producers Bayer and Syngenta, said: "The latest studies in Nature must be seen in the context of an ongoing campaign to discredit neonicotinoid pesticides, regardless of what the real evidence shows."

He said Rundlöf's results were questionable as the levels of the pesticide found in pollen on the bees was higher than in previous studies, suggesting that Rundlöf had treated the crops herself rather than using industry-standard seeds. Rundlöf said the rapeseed in the study were treated following the manufacturers' recommendations.

"Bayer CropScience is pleased the Swedish study demonstrates yet again there is no effect of neonicotinoids on honeybee colonies in realistic field conditions, consistent with previous published field studies," said a spokesman for the agrochemical giant. But it criticised the methodology of Rundlöf's experiment and said the study offered no proof of increased bee deaths.

Rundlöf said the field trial was not sensitive enough to detect anything less than a 20% drop in colony strength. Honeybee colonies are larger and contain far more worker bees than wild bees, meaning it would take longer for neonicotinoids to impact the hives.

Dr Christopher Connolly, from the Medical Research Institute at Dundee University, said: "Much longer periods would be required to detect deficits in honeybee colonies." He said the evidence of the effect on bumblebees was a "major advance".

In the other study published on Wednesday, a team at Newcastle University in England discovered bees cannot detect the presence of neonicotinoids at low levels. In fact for two varieties of pesticide they tended to prefer toxin-laced sucrose.

Scientists suggested the chemicals, which have a similar molecular structure to nicotine, may be affecting the reward centres in a bee's brain in the same way humans are affected by cigarettes.

Professor Geraldine Wright, who led the study, said that the addictive effect was not something they had tested for and was only a hypothesis.

"Like nicotine they are essentially amplifying the rewarding properties of the sucrose solution that they are located in and the bees think its more rewarding so they go back to that food tube to drink more of it," she said. Previous studies have showed rat' brains responding to neonicotinoid in this way.

Wright said she was confident the evidence that bees cannot taste neonicotinoids would be replicated in the field. This contradicts previous suggestions, again from the UK government among others, that bees can choose to collect pollen from non-treated plants.

Connolly said: "It will be interesting to see if insects become addicted to neonicotinoids over time as humans become addicted to nicotine. Given that the neonicotinoids are commonly found in our farmed environment at these levels, this may have already occurred."

The pesticide industry said even if there was a preference, there was no effect on the bees' health. "What's important is not whether bees show a slight preference for these crops, but that there is no effect on their health when field-realistic amounts of these pesticides are used," said von Westenholz.

Goulson said that even before the new studies were published on Wednesday, "there was already a large body of evidence which very strongly suggested that exposure of bees to neonicotinoids at field-realistic doses did them substantial harm."

(Source: http://www.theguardian.com/environment/2015/apr/22/bees-may-become-addicted-to-nicotine-like-pesticides-study-finds)

Article 2

Plight of the bumblebee: Pesticides linked to the decline of bee colonies

23:02, 29 March 2012

By Agency staff

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.

Bee side: Tracking device on their backs

Common pesticides could be wiping out bee colonies by causing pollen-gathering insects to lose their way home, research suggests.

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.

One team of British scientists showed that bumblebee colony growth slowed after exposure to one of the chemicals.

Another group of French researchers tracked foraging honeybees and found that another pesticide tripled their chances of dying away from the hive.

The chemical was thought to disrupt the bees' homing systems, causing them to get lost and perish.

Insecticides called neonicotinoids may be partly to blame for Colony Collapse Disorder, the research suggests.

The phenomenon, marked by the abrupt disappearance of honeybee colonies, is a growing problem in northern hemisphere countries. Bumblebees are also at risk.

Professor Dave Goulson, from the University of Stirling in Scotland, who led the British study, said: "Some bumblebee species have declined hugely.

"For example in North America, several bumblebee species, which used to be common, have more or less disappeared from the entire continent. In the UK, three species have gone extinct."

Declining: A bumblebee foraging among flowers

A number of theories have been put forward to explain the declines, including the use of pesticides.

Both research groups focused on neonicotinoids, which were introduced in the early 1990s and are now widely used around the world.

The chemicals are nerve agents that spread to the nectar and pollen of flowering plants.

Doses of the pesticides used on crops are not allowed to be lethal to bees. But the evidence suggests there may be significant indirect effects, such as interfering with an insect's ability to navigate.

The British study exposed developing colonies of bumblebees, Bombus terrestris, to low levels of a neonicotinoid pesticide called imidacloprid.

Colonies were then placed in an enclosed site where the bees could forage naturally for six weeks.

At the start and end of the experiment, researchers weighed the bumblebee nests, including the bees, wax, honey, grubs and pollen.

Exposed colonies were found to gain less weight than untreated colonies, indicating that foraging bees were bringing less food back to the hive.

On average, the treated colonies were 8% to 12% smaller at the end of the study. They also produced 85% fewer queens, the vital founders of future new colonies.

After the winter die-off, the lack of queens could mean 85% fewer nests in the coming year.

"Bumblebees pollinate many of our crops and wild flowers," said Prof Goulson. "The use of neonicotinoid pesticides on flowering crops clearly poses a threat to their health, and urgently needs to be re-evaluated."

Bees are good, bees are good: But three species have gone extinct in the UK

The French team tagged free-ranging honeybees with tiny radio tracking devices glued to their thoraxes.

Some of the bees were then exposed to sub-lethal doses of the pesticide thiamethoxam. They proved to be two to three times more likely to die while away from their nests than untreated bees.

Between 10% and 32% of bees failed to return to their colonies after being released up to a kilometre away and foraging in treated crops.

Bees that were unfamiliar with the foraging site were most likely not to return home. The findings suggested that the pesticide upset their navigation skills.

Data from the tracking experiment was used to predict what might happen to colonies with "lost" worker bees.

The scientists found it was possible for bee populations to decline to a point where they might not recover.

Mickael Henry, from the INRA agricultural research institute in Avignon, said: "Our study raises important issues regarding pesticide authorisation procedures. So far, they mostly require manufacturers to ensure that doses encountered on the field do not kill bees, but they basically ignore the consequences of doses that do not kill them but may cause behavioural difficulties."

Environmental group Friends of the Earth called the findings, published in the journal Science, "very significant".

aul de Zylva, head of the group's Nature and Ecosystems Programme, said: "The bee is a cherished icon of the British countryside and our gardens and is the farmer's friend that helps pollinate our food crops so we cannot afford further decline.

"We now need the Government to look seriously at the emerging evidence from here and other countries and consider whether neonicotinoid pesticides should continue to be used freely in the UK."

(Source: from: http://www.mirror.co.uk/news/uk-news/
pesticides-linked-decline-bee-colonies-776567)

Article 3

Sick Bees – Part 18F2: Colony Collapse Revisited – Synthetic Pesticides

First published in: American Bee Journal May 2013
Randy Oliver
ScientificBeekeeping.com

OK, I hope that since explaining that bees have always had to deal with natural plant toxins, and more recently, with human pollution, that I can finally move on to attempting to answer the original question, "To what extent are manmade pesticides related to colony morbidity, mortality, or sudden collapse?"

Synthetic Pesticides

Not being a toxicologist, I had always assumed that synthetic pesticides were chemically and biologically in a different class than the natural allelochemicals found in nature. How wrong I was!

Synthetic insecticides are essentially nothing more than chemically "tweaked" forms of natural substances, generally modified to make them cheaper, more effective, more or less stable, less toxic to humans, more targeted toward specific pests, and recently, more environmentally friendly. For a good summary of this subject, read John Tierney's "Synthetic v. Natural Pesticides" [1].

Preadaptation

There is nothing new about honey bee exposure to pesticides - bees had by necessity been forced to develop detoxification mechanisms for these classes of chemicals long before humans invented modern pesticides! Prior to that (and still today), bees were exposed to naturally-occurring organochlorides from many natural sources [2], organophosphates produced by cyanobacteria in surface waters [3], carbamates as a natural fermentation byproduct of beebread [4], nicotine (as in neonicotinoids) in a number of plant species [5], pyrethrins (derived from chrysanthemums) [6], insect growth regulators (self-produced hormones), and a host of alkaloids and other toxins in pollen and nectar.

A term used by toxicologists is ***preadaptation***. Honey bees are, by necessity, preadapted to deal with the major classes of synthetic pesticides; the toxicology and metabolism of synthetic insecticides is no different than that for natural toxins (although the synthetics may have a greater degree of toxicity). And despite the widely-cited paucity of detoxification genes in the honey bee genome, Hardstone [7] determined that compared to insects in general, honey bees are not particularly sensitive to insecticides overall, nor even to specific classes of insecticides!

If it hasn't already occurred to you, think on this: there are any number of nectar/honeydew sources that bees concentrate into honey that may be acutely toxic to humans (rhododendron, mountain laurel, tutu, etc.), yet does not appear to affect the bees to any great extent. The toxins of those named plants (grayanotoxin and tutin) are poisonous to insects, yet bees are able to detoxify them better than humans can!

Cresswell [8] notes that some bees may be better preadapted to toxins than others. Remember that I mentioned earlier that tropical nectars tend to contain more alkaloids? Well, honey bees evolved in the tropics, and are apparently well preadapted to metabolize alkaloids, whereas bumblebees evolved in temperate regions in which there were fewer natural alkaloids in the nectars. It's possible that honeybees may be better preadapted to detoxify alkaloids (such as neonicotinoids) than are bumblebees.

Have you noticed yet that this is a complex subject? And that is one reason why I feel that the single-minded focus by some folk on any one particular class of insecticides may be misguided. Lest I sound critical of my fellow environmentalists, I suspect that many remain under the misassumption that *all* pesticides bioaccumulate or biomagnify as do the "Persistent Organic Pollutants" (DDT, chlordane, PCB's, etc) and heavy metals (mercury, lead). Gold [9] explains:

DDT is unusual with respect to bioconcentration, and because of its chlorine substituents it takes longer to degrade in nature than most chemicals; however, these are properties of relatively few synthetic chemicals. In addition, many thousands of chlorinated chemicals are produced in nature… Natural pesticides can also bioconcentrate if they are fat soluble. Potatoes, for example, naturally contain the fat-soluble neurotoxins solanine and chaconine, which can be detected in the bloodstream of all potato eaters.

Oh no—not only do French fries contain toxic acrylamide, but also additional neurotoxins that bioaccumulate in my body fat!

Reality check: our diet, as well as that of the bees, is chock full of natural plant toxins (many of which have been only recently been introduced into the human diet). The bee immune* system does not differentiate between natural toxins, environmental pollutants, or synthetic pesticides. They must all be taken into consideration when we discuss "chemicals" and bees. Rather than focusing on this pesticide or that, what we beekeepers should be assessing is the total toxin load to which colonies in any particular setting are exposed.

Update 4/27/2013: It's been pointed out to me that I've used the term "immune" too loosely. I should have used the term "detoxification."

Interactions Between Synthetic and Natural Toxins

Bees in agricultural landscapes, as well as in urban and suburban areas, are exposed to a wide variety of manmade toxicants above the background level of natural toxins. Surprisingly, previous exposure to plant allelochemicals may help them to deal with manmade toxicants!

Després [10] found that eating certain natural toxins in a plant may then make an insect more resistant to certain synthetic pesticides. Armyworms fed cowpeas became more tolerant to organophosphates. And those fed xanthotoxin from corn displayed higher tolerance to a pyrethroid insecticide–and appeared to be able to pass that immunity on to their offspring! Don't you just love this stuff!

Biological note: we've barely investigated to what degree the exposure of the previous generation of bees to alleleochemicals or pesticides results in trans-generational epigenetic effects.

On the other hand, Després also found that:

By contrast, exposure to particular plant chemicals can repress the expression of detoxification enzymes involved in insecticide resistance…Finally, it cannot be excluded that an enzyme conferring resistance to a phytotoxin can enhance the toxicity of an insecticide and vice versa. The striking complexity of the repression–induction patterns and substrate specificities of detoxification enzymes has so far represented a major difficulty in the understanding of cross-resistance mechanisms.

"Striking complexity" – well put! Even the type of honey that bees are eating enters into the picture. A study by Mao [11] found that allelochemicals in honey may affect their ability to metabolize pesticides. The researchers also speculate that the practice of wintering bees on sugar syrup may compromise their ability to process environmental toxins!

I hope you are starting to understand why I couldn't just jump into answering the question as to whether pesticides cause CCD! There are a great many contributory variables when we start looking at toxicity, and we just don't yet know that much about a lot of them! But there is one thing that we do know – that there was a major change in honey bee exposure to toxicants starting (in this country) in the 1990's.

Toxicological Eras in Honey Bee Evolution

Let's imagine what honey bee exposure to toxins would look like from an evolutionary perspective (Table 1):

Pre agriculture era	Early egricultural era	Botanical extract era	Synthetic pesticide discovery era	Environmental consciousness era	Early varroa era	The future/ agroecological era
⟵ 8000 B.C. (~50 million yrs)	8000 B.C.–1700 A.D. (~10.000 yrs)	1700–1940 (~200 yrs)	1940–1970 (~30 yrs)	1970–1990 (~20 yrs)	1990–present (~20 yrs)	future ⟶
Honey bees, due to their foraging on a wide range of plant species, were exposed to a broad diversity of natural phytochemicals in nectar, pollen, and propolis. They evolved detoxification mechanisms to deal with them.	Farmers used crude inorganic pesticides such as sulfur, arsenic, fluoride, and copper (which often resulted in the poisoning of the soil, applicators, and consumers). These pesticides were a disaster to bees.	Farmers started to use tobacco extracts in the late 1600's, nicotine sulfate (1910), and then pyrethrum and rotenone (1800's).	The discovery of the insecticidal properties of the organochlorine DDT in 1939 led to its widespread use during WWII to control mosquitoes and lice, and later to agriculture. Organophosphates quickly followed, having their heyday in the 1950's. Pesticide use soared, and every sort of residue made it into bee hives.	Silent Spring was published in 1962 and kick started the environmental movement. The organochlorines fell out of favor, but were replaced by even more bee-toxic organophosphates and carbamates. Finally, things started looking better for bees as EPA started cleaning up our pesticide insult to the environment.	For the first time, beekeepers began to deliberately introduce pesticides into bee hives. The miticides fluvalinate, coumaphos, fenpyroximate, and 2,4-DMPF (from amitraz) soon contaminated beeswax in most apiaries. This was a huge step backward for the poor bees.	Agriculture is moving toward reduced risk pesticides, "biologicals," selective breeding, and integrated pest management. Nature will eventually force us to return to crop rotation. This will be a big win for the bees!

Table 1. Note that honey bees had tens of millions of years to evolve detoxification mechanisms for plant allelochemicals and other natural toxins. They've had only an evolutionary eyeblink of about 70 years of dealing with added synthetic pesticides. But the biggest change has been in the past 20 years, as beekeepers inadvertently contaminated beeswax combs with miticide residues in their attempts to control parasitic mites.

The "Varroa Era"

After 50 million years of evolving effective detoxification mechanisms against natural chemicals, mankind has only recently (on the evolutionary scale) challenged the bee with additional doses of synthetic toxicants. But those exposures were normally inadvertent and only intermittent, allowing the colonies to recover.

The invasion of the parasitic mites ushered in a new era of toxicant exposure [[12]]. Beekeepers were largely unaware that the synthetic miticides that appeared to be their salvation would wind up contaminating their combs with unimaginably persistent residues. I've seen the analyses of many beekeepers' combs. The miticide residues reflect a history of any product that they'd put into their hives in the past decade!

And although there is a great hue and cry about the neonicotinoids of late, Frazier [[13]] (***a must read***) points out:

Indeed, if a relative hazard to honey bees is calculated as the product of mean residue times frequency detected divided by the LD_{50}, the hazard due to pyrethroid residues is three-times greater than that of neonicotinoids detected in pollen samples.

The main pyrethroid in hives worldwide is tau-fluvalinate (Apistan, Mavrik), which accumulates in the combs, along with several other agricultural pyrethroids of additive toxicity. To make matters worse, the other common miticide residue, coumaphos (Checkmite+), then exhibits synergistic toxicity with those pyrethroids [14]. Surprisingly, both of these miticides are still sold in bee supply catalogs!

I've written at length about the synthetic miticides [15]. It's hard to find combs today that aren't contaminated with fluvalinate and coumaphos. Could this be a problem?

There was a significant reduction in adult bee longevity following exposure to 100 ppb of coumaphos in wax during the larval and pupal stages in worker honey bees. A 4-day reduction in summer bee lifespan was observed equaling 16 percent of the total lifespan of summer bees. Reduced adult longevity could impact honey production and or overwintering ability [16].

Their conclusion is an understatement! I've plugged a 10% reduction in worker longevity into my bee population model—the result is striking (Fig. 1)!

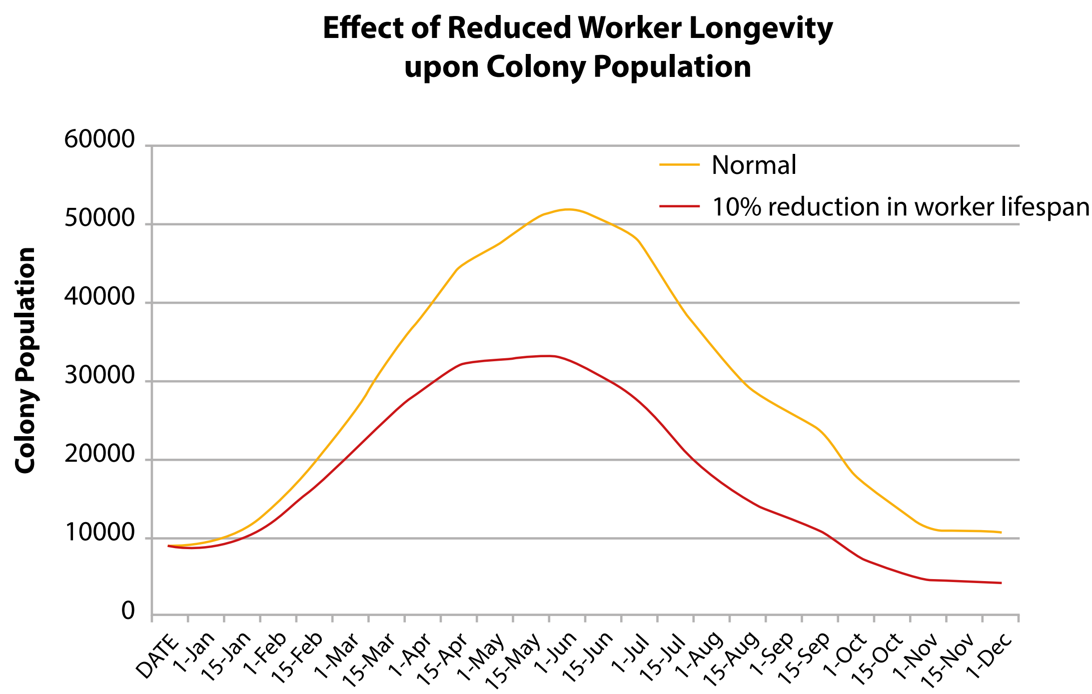

Figure 1. In this crude example, I reduced worker lifespan by 10% on the red plot, assuming a normal mean longevity in Feb-Oct of 35 days; and in Nov-Jan of 60 days. It is easy to see that even a slight reduction in worker longevity dramatically affects colony buildup and wintering ability!

Practical application: Miticide residues (or environmental pollutants) in the combs can affect both larval survival and worker longevity. *It doesn't take much of a reduction in either to demonstrably affect colony buildup or winter survival!* And this is before adding any agricultural pesticides!

Some miticide residues don't go away—they leach out of the wax and into the beebread for years! Add their negative impact on brood and adult bee survival to that of other environmental toxins and plant allelechemicals, and today's colonies may already be in toxicological trouble even before they are exposed to any additional pesticides.

Practical application: honey bees have suffered from a "triple whammy" due to the recent invasion of the parasitic mites:

Keep in mind that Apivar is clearly a better way to use amitraz for mite control than homebrews of agricultural formulations, which contain adjuvants that are toxic to bees. I've spoken with Dr. Benoit Siefert of Véto-pharma about the fine points of amitraz and varroa. He explains that the most effective use of amitraz is to partially paralyze the mites, rather than to kill them outright. Such a sublethal effect prevents them from reproducing, which is why the strips must be left in for the full duration (42-56 days). The slow release of the small amount of amitraz keeps residues in the combs and honey to a minimum, and reduces the selective pressure for mites to develop resistance to the active ingredient.

Practical application: Apivar is likely best applied at least two months *before* you put on honey supers, or the same day that you pull them off.

The flip side is that beekeepers NOW HAVE NO EXCUSE for using "off label" synthetic miticides in their hives. There are now (in addition to the unreliably effective Apistan) four other legal treatments for varroa— HopguardÒ, ApivarÒ, thymol (ApiguardÒ, Apilife VARÒ), and formic acid (MAQS). The latter three all are reliably efficacious at reducing mites to safe levels.

Unfortunately, as Johnson [23] points out:

The regulatory system governing the veterinary use of pesticides in bee hives in the USA may be perversely contributing to the problem. … A change in the regulatory system needs to occur to make effective and safe veterinary pesticides available to beekeepers and to spur research into the effects of candidate compounds on honey bee health.

Call to action: there is yet one more safe, natural, and effective miticide that needs to be registered—oxalic acid. I strongly feel that our industry should put pressure on the EPA to follow its registration in Canada.

The availability of a spectrum of legal treatments nowadays means that the only possible rationalization for not using registered miticides is that the illegal treatments are 'cheaper" than the legal treatments. If this is an argument for intentionally breaking the law, it simply doesn't hold water. Not surprisingly, it fails to sway the EPA, which, if it allowed all farmers to use the same argument, might as well throw its hands up in the air (what farmer wouldn't want to make his own rules and save money?)!

OK, it seems as though I have a predilection for saying the unpopular thing in public, but I'm going to stick my foot in it again! ***The commercial beekeeping industry needs to start acting like responsible citizens.*** So long as we keep blatantly using illegal mite treatments, our pleas to regulators to crack down on misuse of agricultural pesticides by farmers are gutted from the get go—if we want to talk the talk, we gotta walk the walk.

Johnson, et al, give us an appropriate scolding:

…beekeepers need to realize that honey bee pests and parasites are community problems, as well as individual problems, and that pesticide labels are crafted to protect the sustainability of pesticides. The use of unregistered products is a serious threat to the beekeeping community and should not occur.

(I am fully aware of the argument that we are not hurting anyone else with what we put into our hives, but that is a deplorably weak excuse when we are producing a food product! Honey's reputation as a pure and natural product stands to be tarnished by careless beekeepers. I'm also aware that farmers have much more latitude in both choices of pest control products and in application methods. But I don't want to focus upon excuses—I want us to move forward. Since the off-label use of amitraz is rapidly leading to the development of resistant mites, now would be a good time to rethink the way we do things!)

Crying "Foul"

Commercial beekeepers reply with the argument that there is a lack of "affordable" registered miticides available to our industry. Somehow, I find that that argument falls flat, since I make my own living running a commercial beekeeping operation using only legal miticides (other that the aforementioned oxalic acid). I must compete for almond pollination and honey prices against those beekeepers who unfairly save money by using illegal treatments. That creates an un-level playing field, giving a competitive advantage to the lawbreakers. This is patently unfair, and I cry "foul"!

Doing the Impossible

I often hear that it would be "impossible" to do without the illegal off-label treatments. The reality is that anything seems "impossible" until you just start doing it! Out of frustration, curiosity, and concern about the detrimental effects of residues, I tried managing my operation without synthetic miticides over a decade ago, and never felt the need to go back (I'd use amitraz in a heartbeat if I ever felt the need, but simply haven't). Since then we've tripled the size of our operation to around a thousand hives, take strong colonies to almonds each year, and have sold hundreds of nucs every spring–so much for "impossible"! I'm not suggesting that others give up on synthetics— amitraz is clearly an effective and safe varroacide—but just start using the new legal strips (or at least make the effort to get your local vet to write you a prescription for the off-label use of another amitraz product—this would at least make you "legal")! Our industry tells the EPA to make farmers do the right thing, even if it costs more, and then pass that cost on to the consumer. Our situation is no different.

CALL FOR ACTION: I call upon the leaders of our industry to set an example and do the right thing…once they do, our industry would no longer have anything to hide, and beekeepers could then start filing the adverse effects reports on pesticides that the EPA is begging for. And if we clean up our own act, we can then demand that farmers do the same!

Acknowledgments

As always, I'm indebted to Peter Borst for his assistance in research. And thanks to Jim and Maryann Frazier, Jerry Bromenshenk, Reed Johnson, Judy Wu, Marion Ellis, Roger Simonds, Diana Cox-Foster, Jennifer Berry, and others whom I'm sure I've neglected to mention, for their generosity in discussing these issues with me.

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(Source: © Randy Oliver – scientificbeekeeping.com)

BTEC

Pearson BTEC Level 3 Nationals

Write your name here

Surname	Forename

Learner Registration Number

Centre Number

Level 3

Applied Science

Unit 7: Contemporary Issues in Science

Part B

Marks

Supervised hours 2.5

Extended Diploma
Sample assessment material for first teaching September 2016

Instructions

- **Part A** will need to have been used in preparation for completion of **Part B**.
- **Part B** must be undertaken in a single sitting of 2 hours and 30 minutes in the assessment session timetabled by Pearson.
- **Part B** materials must be issued to learners for the specified session.
- **Part B** is specific to each series and this material must only be issued to learners who have been entered to undertake the task in the relevant series.
- **Part B** should be kept securely until the start of the 2 hour and 30 minute supervised assessment session.

Paper reference
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PEARSON

Instructions to Teachers/Tutors and/or Invigilators

This paper must be read in conjunction with the unit information in the specification and the BTEC Nationals Information for Conducting External Assessments (ICEA) document. See the Pearson website for details.

Part B set task is undertaken under supervision in a single session of 2.5 hours in the timetabled session. Centres may schedule a supervised rest break during the session.

Part B set task requires learners to apply understanding gained through familiarisation with the articles. Learners should bring in notes as defined in **Part A**.

Learners must complete the set task using this task and answer booklet.

Maintaining Security:

- Only permitted materials for the set task can be brought into the supervised environment
- During any permitted break and at the end of the session materials must be kept securely and no items removed from the supervised environment
- Learner notes related to **Part A** must be checked to ensure length and contents meet limitations.
- Learner notes from **Part A** will be retained securely by the centre after **Part B** and may be requested by Pearson if there is suspected malpractice.

After the session the Teacher/Tutor or Invigilator will confirm that all learner work was completed independently as part of the authentication submitted to Pearson.

Outcomes for Submission

This task and answer booklet should be submitted to Pearson.

Each learner must complete an authentication sheet.

Instructions for Learners

Read the set task information carefully.

Complete all your work in this taskbook in the spaces provided**.**

This session is of 2.5 hours (during the day). Your tutor/invigilator will tell you if there is a supervised break. Plan your time carefully.

You have prepared for the set task given in this **Part B** booklet. Use your notes prepared during **Part A** if relevant. Attempt all of **Part B**.

Your notes must be your own work and will be retained by your centre until results are issued.

You will complete this set task under supervision and your work will be kept securely during any breaks taken.

You must work independently throughout the supervised assessment period and should not share your work with other learners.

Outcomes for Submission

You will need to submit the following documents on completion of the supervised assessment period:

- a completed **Part B** taskbook.

You must complete a declaration that the work you submit is your own.

Set Task

Answer all questions in the spaces provided.

1 Discuss the implications of the scientific issue identified in the articles.

12 marks

Total for Question 1 = 12 marks

2 Identify the different organisations/individuals mentioned in the articles and suggest how they may have an influence on the scientific issue.

6 marks

Total for Question 2 = 6 marks

3 Discuss whether article 3 has made valid judgements.

In your answer you should consider:

- how the article has interpreted and analysed the scientific information to support the conclusions/judgments being made
- the validity and reliability of data
- references to other sources of information.

12 marks

Total for Question 3 = 12 marks

4 Suggest potential areas for further development and/or research of the scientific issue from the three articles.

5 marks

Total for Question 4 = 5 marks

5 You are a chairperson for the local beekeeping association.

You have been asked to raise awareness of the declining bee population in your local community.

Your task is to write an article for your local community on this issue.

Use information from the three articles provided for this task.

When writing your article you should consider:

- who is likely to read the article
- what you would like the reader to learn from the article.

15 marks

Total for Question 5 = 15 marks

END OF TASK **TOTAL FOR TASK = 50 MARKS**

Article 1:

Bees may become addicted to nicotine-like pesticides, study finds

Bees have a preference for sugar solutions laced with the pesticides, scientists say, as a separate landmark field trial shows neonicotinoids harm bee populations.

A foraging red-tailed bumblebee: a study says bees get a 'buzz' from nicotine-like pesticides in much the same way as smokers are stimulated by tobacco. (Source: Photograph: Jonathan Carruthers/PA Karl Mathiesen)

Bees may become addicted to nicotine-like pesticides in the same way humans get hooked on cigarettes, according to a new study, which was released as a landmark field trial provided further evidence that such neonicotinoids harm bee populations.

In a study published in the journal Nature, scientists from Newcastle Univeristy showed that bees have a preference for sugar solutions that are laced with the pesticides imidacloprid and thiamethoxam, possibly indicating they can become hooked on the chemicals.

Also published in Nature on Wednesday was a study that has been endorsed as the most conclusive evidence yet that the group of pesticides, neonicotinoids, harm wild bee populations, which include bumblebees and solitary bees.

Scientists from Lund University in Sweden carried out the first successful 'real world' experiment on the effect of neonicotinoids on bees and found that wild bee populations halved around fields treated with them. Bumblebee hives stopped growing and produced less queens where the chemical was present. However the study did not find evidence that more robust honeybees, which are used to pollinate many crops, were affected.

Dr Maj Rundlöf, the lead author of the study, said the impacts on wild bees were "dramatic". "I think it's really important evidence when discussing how neonicotinoids used in real agricultural landscapes influence bees," she said.

Dave Goulson, a bee expert at Sussex University, not involved in the research, hailed the findings as hugely significant.

"At this point in time it is no longer credible to argue that agricultural use of neonicotinoids does not harm wild bees." He said the paper was "a major step forwards in clarifying the neonicotinoid debate … This was the first fully field-realistic, well-replicated trial so far, an impressive piece of work."

Previous field experiments on neonicotinoids have been shown to be inadequate. The current EU moratorium on the use of a group of neonicotinoids on certain crops has been criticised, particularly by the UK government, on the basis that field evidence of neonicotinoids harming bee populations has been difficult to obtain.

Nick von Westenholz, chief executive of the Crop Protection Association that represents neonicotinoid producers Bayer and Syngenta, said: "The latest studies in Nature must be seen in the context of an ongoing campaign to discredit neonicotinoid pesticides, regardless of what the real evidence shows."

He said Rundlöf's results were questionable as the levels of the pesticide found in pollen on the bees was higher than in previous studies, suggesting that Rundlöf had treated the crops herself rather than using industry-standard seeds. Rundlöf said the rapeseed in the study were treated following the manufacturers' recommendations.

"Bayer CropScience is pleased the Swedish study demonstrates yet again there is no effect of neonicotinoids on honeybee colonies in realistic field conditions, consistent with previous published field studies," said a spokesman for the agrochemical giant. But it criticised the methodology of Rundlöf's experiment and said the study offered no proof of increased bee deaths.

Rundlöf said the field trial was not sensitive enough to detect anything less than a 20% drop in colony strength. Honeybee colonies are larger and contain far more worker bees than wild bees, meaning it would take longer for neonicotinoids to impact the hives.

Dr Christopher Connolly, from the Medical Research Institute at Dundee University, said: "Much longer periods would be required to detect deficits in honeybee colonies." He said the evidence of the effect on bumblebees was a "major advance".

In the other study published on Wednesday, a team at Newcastle University in England discovered bees cannot detect the presence of neonicotinoids at low levels. In fact for two varieties of pesticide they tended to prefer toxin-laced sucrose.

Scientists suggested the chemicals, which have a similar molecular structure to nicotine, may be affecting the reward centres in a bee's brain in the same way humans are affected by cigarettes.

Professor Geraldine Wright, who led the study, said that the addictive effect was not something they had tested for and was only a hypothesis.

"Like nicotine they are essentially amplifying the rewarding properties of the sucrose solution that they are located in and the bees think its more rewarding so they go back to that food tube to drink more of it," she said. Previous studies have showed rat' brains responding to neonicotinoid in this way.

Wright said she was confident the evidence that bees cannot taste neonicotinoids would be replicated in the field. This contradicts previous suggestions, again from the UK government among others, that bees can choose to collect pollen from non-treated plants.

Connolly said: "It will be interesting to see if insects become addicted to neonicotinoids over time as humans become addicted to nicotine. Given that the neonicotinoids are commonly found in our farmed environment at these levels, this may have already occurred."

The pesticide industry said even if there was a preference, there was no effect on the bees' health. "What's important is not whether bees show a slight preference for these crops, but that there is no effect on their health when field-realistic amounts of these pesticides are used," said von Westenholz.

Goulson said that even before the new studies were published on Wednesday, "there was already a large body of evidence which very strongly suggested that exposure of bees to neonicotinoids at field-realistic doses did them substantial harm."

(Source: http://www.theguardian.com/environment/2015/apr/22/bees-may-become-addicted-to-nicotine-like-pesticides-study-finds)

Article 2

Plight of the bumblebee: Pesticides linked to the decline of bee colonies

23:02, 29 March 2012

By Agency staff

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.

Bee side: Tracking device on their backs

Common pesticides could be wiping out bee colonies by causing pollen-gathering insects to lose their way home, research suggests.

Two studies provide some of the strongest evidence yet that pesticides sprayed on farmers' fields threaten bumblebees and honeybees.

One team of British scientists showed that bumblebee colony growth slowed after exposure to one of the chemicals.

Another group of French researchers tracked foraging honeybees and found that another pesticide tripled their chances of dying away from the hive.

The chemical was thought to disrupt the bees' homing systems, causing them to get lost and perish.

Insecticides called neonicotinoids may be partly to blame for Colony Collapse Disorder, the research suggests.

The phenomenon, marked by the abrupt disappearance of honeybee colonies, is a growing problem in northern hemisphere countries. Bumblebees are also at risk.

Professor Dave Goulson, from the University of Stirling in Scotland, who led the British study, said: "Some bumblebee species have declined hugely.

"For example in North America, several bumblebee species, which used to be common, have more or less disappeared from the entire continent. In the UK, three species have gone extinct."

Declining: A bumblebee foraging among flowers

A number of theories have been put forward to explain the declines, including the use of pesticides.

Both research groups focused on neonicotinoids, which were introduced in the early 1990s and are now widely used around the world.

The chemicals are nerve agents that spread to the nectar and pollen of flowering plants.

Doses of the pesticides used on crops are not allowed to be lethal to bees. But the evidence suggests there may be significant indirect effects, such as interfering with an insect's ability to navigate.

The British study exposed developing colonies of bumblebees, Bombus terrestris, to low levels of a neonicotinoid pesticide called imidacloprid.

Colonies were then placed in an enclosed site where the bees could forage naturally for six weeks.

At the start and end of the experiment, researchers weighed the bumblebee nests, including the bees, wax, honey, grubs and pollen.

Exposed colonies were found to gain less weight than untreated colonies, indicating that foraging bees were bringing less food back to the hive.

On average, the treated colonies were 8% to 12% smaller at the end of the study. They also produced 85% fewer queens, the vital founders of future new colonies.

After the winter die-off, the lack of queens could mean 85% fewer nests in the coming year.

"Bumblebees pollinate many of our crops and wild flowers," said Prof Goulson. "The use of neonicotinoid pesticides on flowering crops clearly poses a threat to their health, and urgently needs to be re-evaluated."

Bees are good, bees are good: But three species have gone extinct in the UK

The French team tagged free-ranging honeybees with tiny radio tracking devices glued to their thoraxes.

Some of the bees were then exposed to sub-lethal doses of the pesticide thiamethoxam. They proved to be two to three times more likely to die while away from their nests than untreated bees.

Between 10% and 32% of bees failed to return to their colonies after being released up to a kilometre away and foraging in treated crops.

Bees that were unfamiliar with the foraging site were most likely not to return home. The findings suggested that the pesticide upset their navigation skills.

Data from the tracking experiment was used to predict what might happen to colonies with "lost" worker bees.

The scientists found it was possible for bee populations to decline to a point where they might not recover.

Mickael Henry, from the INRA agricultural research institute in Avignon, said: "Our study raises important issues regarding pesticide authorisation procedures. So far, they mostly require manufacturers to ensure that doses encountered on the field do not kill bees, but they basically ignore the consequences of doses that do not kill them but may cause behavioural difficulties."

Environmental group Friends of the Earth called the findings, published in the journal Science, “very significant”.

aul de Zylva, head of the group’s Nature and Ecosystems Programme, said: “The bee is a cherished icon of the British countryside and our gardens and is the farmer’s friend that helps pollinate our food crops so we cannot afford further decline.

“We now need the Government to look seriously at the emerging evidence from here and other countries and consider whether neonicotinoid pesticides should continue to be used freely in the UK.”

(Source: from: http://www.mirror.co.uk/news/uk-news/pesticides-linked-decline-bee-colonies-776567)

Article 3

Sick Bees – Part 18F2: Colony Collapse Revisited – Synthetic Pesticides

First published in: American Bee Journal May 2013

Randy Oliver

ScientificBeekeeping.com

OK, I hope that since explaining that bees have always had to deal with natural plant toxins, and more recently, with human pollution, that I can finally move on to attempting to answer the original question, "To what extent are manmade pesticides related to colony morbidity, mortality, or sudden collapse?"

Synthetic Pesticides

Not being a toxicologist, I had always assumed that synthetic pesticides were chemically and biologically in a different class than the natural allelochemicals found in nature. How wrong I was!

Synthetic insecticides are essentially nothing more than chemically "tweaked" forms of natural substances, generally modified to make them cheaper, more effective, more or less stable, less toxic to humans, more targeted toward specific pests, and recently, more environmentally friendly. For a good summary of this subject, read John Tierney's "Synthetic v. Natural Pesticides" [1].

Preadaptation

There is nothing new about honey bee exposure to pesticides - bees had by necessity been forced to develop detoxification mechanisms for these classes of chemicals long before humans invented modern pesticides! Prior to that (and still today), bees were exposed to naturally-occurring organochlorides from many natural sources [2], organophosphates produced by cyanobacteria in surface waters [3], carbamates as a natural fermentation byproduct of beebread [4], nicotine (as in neonicotinoids) in a number of plant species [5], pyrethrins (derived from chrysanthemums) [6], insect growth regulators (self-produced hormones), and a host of alkaloids and other toxins in pollen and nectar.

A term used by toxicologists is ***preadaptation***. Honey bees are, by necessity, preadapted to deal with the major classes of synthetic pesticides; the toxicology and metabolism of synthetic insecticides is no different than that for natural toxins (although the synthetics may have a greater degree of toxicity). And despite the widely-cited paucity of detoxification genes in the honey bee genome, Hardstone [7] determined that compared to insects in general, honey bees are not particularly sensitive to insecticides overall, nor even to specific classes of insecticides!

If it hasn't already occurred to you, think on this: there are any number of nectar/honeydew sources that bees concentrate into honey that may be acutely toxic to humans (rhododendron, mountain laurel, tutu, etc.), yet does not appear to affect the bees to any great extent. The toxins of those named plants (grayanotoxin and tutin) are poisonous to insects, yet bees are able to detoxify them better than humans can!

Cresswell [8] notes that some bees may be better preadapted to toxins than others. Remember that I mentioned earlier that tropical nectars tend to contain more alkaloids? Well, honey bees evolved in the tropics, and are apparently well preadapted to metabolize alkaloids, whereas bumblebees evolved in temperate regions in which there were fewer natural alkaloids in the nectars. It's possible that honeybees may be better preadapted to detoxify alkaloids (such as neonicotinoids) than are bumblebees.

Have you noticed yet that this is a complex subject? And that is one reason why I feel that the single-minded focus by some folk on any one particular class of insecticides may be misguided. Lest I sound critical of my fellow environmentalists, I suspect that many remain under the misassumption that *all* pesticides bioaccumulate or biomagnify as do the "Persistent Organic Pollutants" (DDT, chlordane, PCB's, etc) and heavy metals (mercury, lead). Gold [9] explains:

DDT is unusual with respect to bioconcentration, and because of its chlorine substituents it takes longer to degrade in nature than most chemicals; however, these are properties of relatively few synthetic chemicals. In addition, many thousands of chlorinated chemicals are produced in nature… Natural pesticides can also bioconcentrate if they are fat soluble. Potatoes, for example, naturally contain the fat-soluble neurotoxins solanine and chaconine, which can be detected in the bloodstream of all potato eaters.

Oh no—not only do French fries contain toxic acrylamide, but also additional neurotoxins that bioaccumulate in my body fat!

Reality check: our diet, as well as that of the bees, is chock full of natural plant toxins (many of which have been only recently been introduced into the human diet). The bee immune* system does not differentiate between natural toxins, environmental pollutants, or synthetic pesticides. They must all be taken into consideration when we discuss "chemicals" and bees. Rather than focusing on this pesticide or that, what we beekeepers should be assessing is the total toxin load to which colonies in any particular setting are exposed.

Update 4/27/2013: It's been pointed out to me that I've used the term "immune" too loosely. I should have used the term "detoxification."

Interactions Between Synthetic and Natural Toxins

Bees in agricultural landscapes, as well as in urban and suburban areas, are exposed to a wide variety of manmade toxicants above the background level of natural toxins. Surprisingly, previous exposure to plant allelochemicals may help them to deal with manmade toxicants!

Després [10] found that eating certain natural toxins in a plant may then make an insect more resistant to certain synthetic pesticides. Armyworms fed cowpeas became more tolerant to organophosphates. And those fed xanthotoxin from corn displayed higher tolerance to a pyrethroid insecticide–and appeared to be able to pass that immunity on to their offspring! Don't you just love this stuff!

Biological note: we've barely investigated to what degree the exposure of the previous generation of bees to alleleochemicals or pesticides results in trans-generational epigenetic effects.

On the other hand, Després also found that:

By contrast, exposure to particular plant chemicals can repress the expression of detoxification enzymes involved in insecticide resistance…Finally, it cannot be excluded that an enzyme conferring resistance to a phytotoxin can enhance the toxicity of an insecticide and vice versa. The striking complexity of the repression–induction patterns and substrate specificities of detoxification enzymes has so far represented a major difficulty in the understanding of cross-resistance mechanisms.

"Striking complexity" – well put! Even the type of honey that bees are eating enters into the picture. A study by Mao [11] found that allelochemicals in honey may affect their ability to metabolize pesticides. The researchers also speculate that the practice of wintering bees on sugar syrup may compromise their ability to process environmental toxins!

I hope you are starting to understand why I couldn't just jump into answering the question as to whether pesticides cause CCD! There are a great many contributory variables when we start looking at toxicity, and we just don't yet know that much about a lot of them! But there is one thing that we do know – that there was a major change in honey bee exposure to toxicants starting (in this country) in the 1990's.

Toxicological Eras in Honey Bee Evolution

Let's imagine what honey bee exposure to toxins would look like from an evolutionary perspective (Table 1):

Pre agriculture era	Early egricultural era	Botanical extract era	Synthetic pesticide discovery era	Environmental consciousness era	Early varroa era	The future/ agroecological era
⟵ 8000 B.C. (~50 million yrs)	8000 B.C.–1700 A.D. (~10.000 yrs)	1700–1940 (~200 yrs)	1940–1970 (~30 yrs)	1970–1990 (~20 yrs)	1990–present (~20 yrs)	future ⟶
Honey bees, due to their foraging on a wide range of plant species, were exposed to a broad diversity of natural phytochemicals in nectar, pollen, and propolis. They evolved detoxification mechanisms to deal with them.	Farmers used crude inorganic pesticides such as sulfur, arsenic, fluoride, and copper (which often resulted in the poisoning of the soil, applicators, and consumers). These pesticides were a disaster to bees.	Farmers started to use tobacco extracts in the late 1600's, nicotine sulfate (1910), and then pyrethrum and rotenone (1800's).	The discovery of the insecticidal properties of the organochlorine DDT in 1939 led to its widespread use during WWII to control mosquitoes and lice, and later to agriculture. Organophosphates quickly followed, having their heyday in the 1950's. Pesticide use soared, and every sort of residue made it into bee hives.	Silent Spring was published in 1962 and kick started the environmental movement. The organochlorines fell out of favor, but were replaced by even more bee-toxic organophosphates and carbamates. Finally, things started looking better for bees as EPA started cleaning up our pesticide insult to the environment.	For the first time, beekeepers began to deliberately introduce pesticides into bee hives. The miticides fluvalinate, coumaphos, fenpyroximate, and 2,4-DMPF (from amitraz) soon contaminated beeswax in most apiaries. This was a huge step backward for the poor bees.	Agriculture is moving toward reduced risk pesticides, "biologicals," selective breeding, and integrated pest management. Nature will eventually force us to return to crop rotation. This will be a big win for the bees!

Table 1. Note that honey bees had tens of millions of years to evolve detoxification mechanisms for plant allelochemicals and other natural toxins. They've had only an evolutionary eyeblink of about 70 years of dealing with added synthetic pesticides. But the biggest change has been in the past 20 years, as beekeepers inadvertently contaminated beeswax combs with miticide residues in their attempts to control parasitic mites.

The "Varroa Era"

After 50 million years of evolving effective detoxification mechanisms against natural chemicals, mankind has only recently (on the evolutionary scale) challenged the bee with additional doses of synthetic toxicants. But those exposures were normally inadvertent and only intermittent, allowing the colonies to recover.

The invasion of the parasitic mites ushered in a new era of toxicant exposure [[12]]. Beekeepers were largely unaware that the synthetic miticides that appeared to be their salvation would wind up contaminating their combs with unimaginably persistent residues. I've seen the analyses of many beekeepers' combs. The miticide residues reflect a history of any product that they'd put into their hives in the past decade!

And although there is a great hue and cry about the neonicotinoids of late, Frazier [[13]] (***a must read***) points out:

Indeed, if a relative hazard to honey bees is calculated as the product of mean residue times frequency detected divided by the LD_{50}, the hazard due to pyrethroid residues is three-times greater than that of neonicotinoids detected in pollen samples.

The main pyrethroid in hives worldwide is tau-fluvalinate (Apistan, Mavrik), which accumulates in the combs, along with several other agricultural pyrethroids of additive toxicity. To make matters worse, the other common miticide residue, coumaphos (Checkmite+), then exhibits synergistic toxicity with those pyrethroids [14]. Surprisingly, both of these miticides are still sold in bee supply catalogs!

I've written at length about the synthetic miticides [15]. It's hard to find combs today that aren't contaminated with fluvalinate and coumaphos. Could this be a problem?

There was a significant reduction in adult bee longevity following exposure to 100 ppb of coumaphos in wax during the larval and pupal stages in worker honey bees. A 4-day reduction in summer bee lifespan was observed equaling 16 percent of the total lifespan of summer bees. Reduced adult longevity could impact honey production and or overwintering ability [16].

Their conclusion is an understatement! I've plugged a 10% reduction in worker longevity into my bee population model—the result is striking (Fig. 1)!

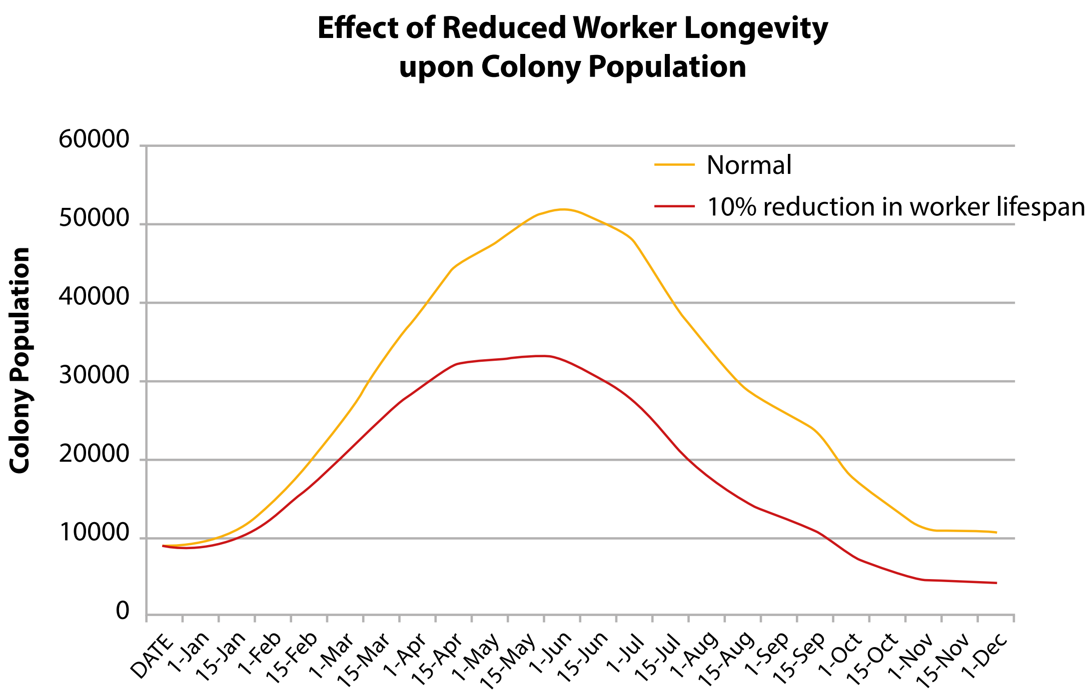

Figure 1. In this crude example, I reduced worker lifespan by 10% on the red plot, assuming a normal mean longevity in Feb-Oct of 35 days; and in Nov-Jan of 60 days. It is easy to see that even a slight reduction in worker longevity dramatically affects colony buildup and wintering ability!

Practical application: Miticide residues (or environmental pollutants) in the combs can affect both larval survival and worker longevity. *It doesn't take much of a reduction in either to demonstrably affect colony buildup or winter survival!* And this is before adding any agricultural pesticides!

Some miticide residues don't go away—they leach out of the wax and into the beebread for years! Add their negative impact on brood and adult bee survival to that of other environmental toxins and plant allelechemicals, and today's colonies may already be in toxicological trouble even before they are exposed to any additional pesticides.

Practical application: honey bees have suffered from a "triple whammy" due to the recent invasion of the parasitic mites:

Keep in mind that Apivar is clearly a better way to use amitraz for mite control than homebrews of agricultural formulations, which contain adjuvants that are toxic to bees. I've spoken with Dr. Benoit Siefert of Véto-pharma about the fine points of amitraz and varroa. He explains that the most effective use of amitraz is to partially paralyze the mites, rather than to kill them outright. Such a sublethal effect prevents them from reproducing, which is why the strips must be left in for the full duration (42-56 days). The slow release of the small amount of amitraz keeps residues in the combs and honey to a minimum, and reduces the selective pressure for mites to develop resistance to the active ingredient.

Practical application: Apivar is likely best applied at least two months before you put on honey supers, or the same day that you pull them off.

The flip side is that beekeepers NOW HAVE NO EXCUSE for using "off label" synthetic miticides in their hives. There are now (in addition to the unreliably effective Apistan) four other <u>legal</u> treatments for varroa— HopguardÒ, ApivarÒ, thymol (ApiguardÒ, Apilife VARÒ), and formic acid (MAQS). The latter three all are reliably efficacious at reducing mites to safe levels.

Unfortunately, as Johnson [23] points out:

The regulatory system governing the veterinary use of pesticides in bee hives in the USA may be perversely contributing to the problem. … A change in the regulatory system needs to occur to make effective and safe veterinary pesticides available to beekeepers and to spur research into the effects of candidate compounds on honey bee health.

Call to action: there is yet one more safe, natural, and effective miticide that needs to be registered—oxalic acid. I strongly feel that our industry should put pressure on the EPA to follow its registration in Canada.

The availability of a spectrum of legal treatments nowadays means that the only possible rationalization for not using registered miticides is that the illegal treatments are 'cheaper" than the legal treatments. If this is an argument for intentionally breaking the law, it simply doesn't hold water. Not surprisingly, it fails to sway the EPA, which, if it allowed all farmers to use the same argument, might as well throw its hands up in the air (what farmer wouldn't want to make his own rules and save money?)!

OK, it seems as though I have a predilection for saying the unpopular thing in public, but I'm going to stick my foot in it again! ***The commercial beekeeping industry needs to start acting like responsible citizens.*** So long as we keep blatantly using illegal mite treatments, our pleas to regulators to crack down on misuse of agricultural pesticides by farmers are gutted from the get go—if we want to talk the talk, we gotta walk the walk.

Johnson, et al, give us an appropriate scolding:

…beekeepers need to realize that honey bee pests and parasites are community problems, as well as individual problems, and that pesticide labels are crafted to protect the sustainability of pesticides. The use of unregistered products is a serious threat to the beekeeping community and should not occur.

(I am fully aware of the argument that we are not hurting anyone else with what we put into our hives, but that is a deplorably weak excuse when we are producing a food product! Honey's reputation as a pure and natural product stands to be tarnished by careless beekeepers. I'm also aware that farmers have much more latitude in both choices of pest control products and in application methods. But I don't want to focus upon excuses—I want us to move forward. Since the off-label use of amitraz is rapidly leading to the development of resistant mites, now would be a good time to rethink the way we do things!)

Crying "Foul"

Commercial beekeepers reply with the argument that there is a lack of "affordable" registered miticides available to our industry. Somehow, I find that that argument falls flat, since I make my own living running a commercial beekeeping operation using only legal miticides (other that the aforementioned oxalic acid). I must compete for almond pollination and honey prices against those beekeepers who unfairly save money by using illegal treatments. That creates an un-level playing field, giving a competitive advantage to the lawbreakers. This is patently unfair, and I cry "foul"!

Doing the Impossible

I often hear that it would be "impossible" to do without the illegal off-label treatments. The reality is that anything seems "impossible" until you just start doing it! Out of frustration, curiosity, and concern about the detrimental effects of residues, I tried managing my operation without synthetic miticides over a decade ago, and never felt the need to go back (I'd use amitraz in a heartbeat if I ever felt the need, but simply haven't). Since then we've tripled the size of our operation to around a thousand hives, take strong colonies to almonds each year, and have sold hundreds of nucs every spring–so much for "impossible"! I'm not suggesting that others give up on synthetics— amitraz is clearly an effective and safe varroacide—but just start using the new legal strips (or at least make the effort to get your local vet to write you a prescription for the off-label use of another amitraz product—this would at least make you "legal")! Our industry tells the EPA to make farmers do the right thing, even if it costs more, and then pass that cost on to the consumer. Our situation is no different.

CALL FOR ACTION: I call upon the leaders of our industry to set an example and do the right thing…once they do, our industry would no longer have anything to hide, and beekeepers could then start filing the adverse effects reports on pesticides that the EPA is begging for. And if we clean up our own act, we can then demand that farmers do the same!

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Unit 7: Contemporary Issues in Science - Sample marking grid

General Marking Guidance

- All learners must receive the same treatment. Examiners must mark the first learner in exactly the same way as they mark the last.
- Marking grids should be applied positively. Learners must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the marking grid not according to their perception of where the grade boundaries may lie.
- All marks on the marking grid should be used appropriately.
- All the marks on the marking grid are designed to be awarded. Examiners should always award full marks if deserved. Examiners should also be prepared to award zero marks if the learner’s response is not rewardable according to the marking grid.
- Where judgment is required, a marking grid will provide the principles by which marks will be awarded.
- When examiners are in doubt regarding the application of the marking grid to a learner’s response, a senior examiner should be consulted.

Specific Marking guidance

The marking grids have been designed to assess learner work holistically.

Rows within the grids identify the assessment focus/outcome being targeted. When using a marking grid, the ‘best fit’ approach should be used.

- Examiners should first make a holistic judgement on which band most closely matches the learner response and place it within that band. Learners will be placed in the band that best describes their answer.
- The mark awarded within the band will be decided based on the quality of the answer in response to the assessment focus/outcome and will be modified according to how securely all bullet points are displayed at that band.
- Marks will be awarded towards the top or bottom of that band depending on how they have evidenced each of the descriptor bullet points.

Question 1: Discuss the implications of the scientific issue identified in the articles (12 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Understanding the impact in terms of ethical/ social/ economical/ environmental	**0**	**1-3**	**4-6**	**7-9**	**10-12**
	Level of response not worthy of credit	• Demonstrates limited knowledge and understanding of the scientific issues with generalised comments made. • No or limited attempt to draw links to ethical/social/ economic/ environmental implications. • The discussion will be unstructured and limited to basic points made.	• Demonstrates adequate knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. • Attempts to draw links to ethical/social/ economic/ environmental implications. • The discussion shows some structure and coherence.	• Demonstrates good knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. • Draws some links to and between ethical/social/ economic/ environmental implications. • The discussion shows a structure which is mostly clear, coherent and logical.	• Demonstrates comprehensive knowledge and understanding of the scientific issues by identifying and selecting relevant implications from all three articles. • Draws a wide range of links to and between ethical/social/ economic/ environmental implications • The discussion shows a well-developed structure which is clear, coherent and logical.

Question 2: Identify the different organisations/individuals mentioned in the articles and suggest how they may have an influence on the scientific issue (6 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3
Understanding the influence of different organisations / individuals	**0**	**1-2**	**3-4**	**5-6**
	Level of response not worthy of credit	• Demonstrates adequate knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying different types of organisations/individuals. • A basic explanation of how the organisation/individual may have an influence is given but with general statements made and limited linkages to the articles.	• Demonstrates good knowledge and understanding of how key organisations/individuals can influence the scientific issue by identifying different types of organisations/individuals (including any references/ acknowledgments in footnotes) from all three articles. • An explanation of how these organisations/individuals may influence the issue is given which is occasionally supported through linkage and application to the articles.	• Demonstrates comprehensive knowledge and understanding of how key organisations/ individuals can influence the scientific issue by identifying and selecting different types of organisations/individuals (including any references/ acknowledgments in footnotes) from all three articles. • An explanation of how these organisations/individuals may influence the issue is given which is supported throughout with linkage and application to the articles.

Question 3: Discuss whether article 3 has made valid judgements. (12 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Interpretation, analysis and evaluation of scientific information	**0**	**1-3**	**4-6**	**7-9**	**10-12**
	Level of response not worthy of credit	• Vague statements about the validity of article 3 are made with limited attempt to consider: - how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made - the validity and reliability of data - references to other sources of information. • The discussion will be unstructured and limited to basic points made.	• The validity of article 3 is discussed which is partially supported by a consideration of: - how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made - the validity and reliability of data - references to other sources of information. • The discussion shows some structure and coherence.	• The validity of article 3 is discussed which is mostly supported by a consideration of: - how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made - the validity and reliability of data - references to other sources of information. • The discussion shows a structure which is mostly clear, coherent and logical.	• The validity of article 3 is discussed and is consistently supported throughout the consideration of: - how the article has interpreted and analysed the scientific information to support the conclusions/ judgments being made - the validity and reliability of data - references to other sources of information. • The discussion shows a well-developed structure which is clear, coherent and logical.

Question 4: Suggest any potential areas for further development and / or research of the scientific issue from the three articles (5 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3
Interprets, analyses and evaluates articles to identify potential areas for further development and/or research	**0**	**1**	**2-3**	**4-5**
	Level of response not worthy of credit	• Areas for further development and/or research of the scientific issue are identified but these are usually vague descriptions with limited analysis/evaluation of the articles to support the statements being made.	• A description for further areas of development and/or research of the scientific issue is given. • Provides occasional evidence from the analysis/evaluation of the articles and attempts to synthesise and integrate relevant knowledge.	• A description for further areas of development and/or research of the scientific issue is given. • Consistently provides evidence from the analysis/evaluation of the articles and demonstrates throughout the skills of synthesising and integrating relevant knowledge.

Question 5: You are a chair person for the local bee keeping association. You have been asked to raise awareness of the declining bee population in your local community. Your task is to write an article for your local community on this issue. (15 marks)

Assessment focus	Band 0	Band 1	Band 2	Band 3	Band 4
Synthesises content ideas and demonstrates an understanding of scientific reporting and its relationship with reporting medium and target audience	**0**	**1-4**	**5-8**	**9-12**	**13-15**
	Level of response not worthy of credit	• Identifies some of the main points and evidence from the three articles with limited attempt to summarise these. • Shows little awareness of audience or purpose. • The article will be unstructured and limited to basic points made.	• Summarises the main points and evidence including any supporting and conflicting statements from the three articles. • Shows an awareness of audience and purpose. • The article shows some structure and coherence.	• Summarises and attempts to synthesise the main points and evidence including any supporting and conflicting statements from the three articles. • Selects material to suit audience and purpose, with appropriate use of tone, style and scientific terminology. • The article shows a structure which is mostly clear, coherent and logical.	• Summarises and synthesises the main points and evidence including any supporting and conflicting statements consistently from the three articles. • Consistently selects and organises material for particular effect, with effective use of tone, style and scientific terminology. • The article shows a well-developed structure which is clear, coherent and logical.

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