Interview with Dr. Claire Kremen by Eiman Elnoshokaty & Derek Oxley, UBC

CK: Dr. Claire Kremen

CK: 00:00 – My name is Claire Kremen, and I am a professor and president's excellence chair in a number of departments including Zoology, the Institute for Resources, Environment and Sustainability, and I am also a member of the Biodiversity Research Center. And I work on pollinators, which in the work that I do is mostly wild bee species.

CK: 00:20 – So, let me talk about the solitary bee and what the solitary bee is doing. So, a typical solitary bee would emerge in the spring, and I am thinking of a female solitary bee. She might already be mated possibly from the prior seasons. Let's say she has already mated, she is ready to lay eggs, so what she's going do is she is going to find a nest site. Many solitary bees are digging their nests in the ground, so let's take one of those typical ones. She digs a nest in the ground, it's a long tunnel and off that tunnel there is a different little alleys, blind alleys that she digs, and digs a sort of cavity to put a pollen ball inside and then lay an egg on top. So, when she got this tunnel with the blind alleys off of it and the little nest sites, she's going to go out and collect pollen. And so, she'll do that until she's got enough pollen which she stores in, usually in special structures on her hind leg. She brings that pollen back to the nest and just goes out repeatedly foraging until she creates a pollen ball. Then on top of that pollen ball which she moistens with nectar to keep it in a kind of nice lump, she'll lay an egg, and then she'll seal off the entrance to that little blind alley. And she'll then, continue doing that until she's created pollen balls and laid eggs in all of the blind alleys of the nest, and then she'll seal up the whole nest and she'll leave.

CK: 01:53 – And that's it! She doesn't take care of the babies at all. She has already given them everything they need. Then, so down in one of these blind alley tunnels, the babies will ultimately hatch, and they will start chewing on the pollen ball, and they will go through the successive molts, which means that they shed their hard outer skin and get bigger, and then they
eat some more, shed their hard outer skin and get bigger, until eventually they get big enough

and then they're going to turn into a pupa when they undergo metamorphosis, so they change from sort of a grub-like or caterpillar-like form to what you think of as a six-legged, four-winged insect with big compound eyes. And once the pupa has undergone this quiescent phase and metamorphosis again into the adult bee, and that bee will crawl up to the tunnel and digs its way out of these pullout entrances. And it will come out at the right time of year to repeat the cycle. So it will then, you know, come out, get mated, and continue with its life.

CK: 03:04 – They're a fascinating set of organisms that vary hugely in many aspects of their biology from how they nest - we talked about the nesting in the ground - but some of them, some species nest in holes in dead wood, or they'll bore into wood or bore tiny cavities into soft pithy, the soft pith of twigs and reeds and things. Some even nest in structures like snail shells and you know it's just fascinating how they radiated into all these different niches. And then they also differ greatly in how specialized they are on different kinds of pollens, so some of them will only use one type of pollen for their nests in order to feed their larvae, whereas others, will use many, many different types of pollen. And they vary a lot in how they collect that pollen and how they carry it. I mentioned they usually carry in on their back leg, but there's a whole family of bees that carry it on specialized hairs on their abdomen and so, there's lots of fascinating things about these tiny creatures. They vary hugely in their colors, they can be bright green, iridescent blue, brown and yellow, they can be furry or they can be not furry, anyways, they're just a fascinating set of species.

CK: 04:35 – I think a lot of the historic relationships do revolve around the relationships with social bees, like the honeybee. I am not a deep student of this, but I think that back in, in the pyramids, for example, of Egypt, they find hieroglyphics that show people tending honeybees and they also have pottery urns filled with honey that were left for the embalmed people in the pyramids. So, it definitely goes back at least that far, if not further, that relationship of tending bees. And there have been different kind of structures that people have used to tend bees. The very simplest would have been just simply taking a cavity in the wood, where maybe a beehive

already was, and bringing it/placing it somewhere to be able to tend the bees in that way. There are other kinds of honeybees, different species in Asia, and for many, many thousands of years Indigenous people have come up with very inventive ways of collecting the honey. Quite dangerous because these bees make these huge open combs way up on cliffs, and so people had to learn how to scale those cliffs and calm the bees long enough to get these huge, huge combs down. But they're just an enormous amount of honey. And there are some wonderful films that document this that still goes on till today.

CK: 06:06 – A healthy pollination process means having sufficient pollinators around, and it turns out that there is a variety of circumstances in which we know that having different species around actually improves pollination. I can give you a couple of examples. So, it can be the number of individual pollinators but also the types of pollinators. So, strawberries are actually a great example. Strawberry, when you think about a strawberry, you know it's got all these little dimples in it – it's actually a multi-seeded fruit, meaning that there's lots of ovules that need to get pollinated to produce a nice fruit. So, if you have only honeybees for example pollinating strawberries, some studies have shown that the honeybee will come and land on, sort of, on the top part of the flower. And, so, it will pollinate the – if you look at a strawberry flower, they've got these white petals and it's got the sort of yellow cone-like thing in the middle, which is where all of the ovules are. The honeybee will land on the top, the cone-like thing is going to develop into a strawberry, think of the strawberry tip and the strawberry base. So, the honeybee will be landing on where the tip is, but if only the honeybee comes, then all the ovules around the lower part of the flower might never ever get visited and might not ever actually develop the fruiting parts of the strawberry. So, the strawberry will end up being kind of deformed looking - only part of it actually got pollinated.

CK: 07:47 – There's these other bees called sweat bees, that are very small and they tend to like to go into a strawberry flower and kinda literally crawl around the base of that yellow cone-like piece that I mentioned to you, and they pollinate that part. So, there's this complementarity based on body size, between the honeybees and the other bees, and with all of them you get a

more complete pollination and you get a nice plump of strawberry. The thing is that 75% of our crops do improve production based on the visits of animal pollinators, and what that means: if we go back to our strawberry for example, strawberries can, there are some varieties that can self-pollinate, so they can produce a crop maybe without any visits at all. But there's many varieties that are going to have improved production with cross pollination. There are a few crops like, let's see, squashes for example, melons, that never self-pollinate, they are absolutely dependent on animal pollinators.

CK: 08:58 – The problem with monoculture farming for bees is that - well there are two main problems. The first one is that monoculture farming tends to really alter the habitat and resources that bees need. So, most bee species need a progression of floral resources, that is flowers that are blooming throughout their own adult lifecycle, the time in which they are out collecting resources. So, when you have a monoculture, if it's a crop that is pollinator attractive like sunflower, for example, then there's lots of those resources available but they're only available through a very short time window. Usually in any given location those resources might only be available for a couple of weeks, and after that the crop is harvested or stops blooming and those resources aren't available.

CK: 09:56 – Now in a monoculture farm it's one crop so there's just a lot of uniformity in the timing of when that's blooming. And often they use herbicides to get rid of competing plants, so there aren't flowering weeds nearby either that can provide resources at different times when the crop is blooming. So, the first problem is the loss of floral resources. The second way that monoculture affects bees negatively is that it can also get rid of any nesting resources, and by nesting resources I mean ground that is not disturbed frequently and that can be used by the ground nesting bees, or sources of woody material that the bees can nest in if they are above ground nesters that can use cavities - pre-existing cavities of wood, or they create their own cavities. So, the nesting resources are often also eradicated during monoculture farming.

CK: 10:58 – Then the third problem is the heavy use of pesticides. The neonicotinoids are

important to mention among all of the pesticides for a couple of reasons. First of all, they are extremely widespread - they've pretty much taken over the pesticide market, I am not sure exactly what the percentage is but it's something like around the order of 70% of pesticides in use around the world are neonicotinoids. And why is this? Well, when they were first developed they were thought to be safer than other pesticides, and it partly due to their mode of action: they were thought to target insects more than other creatures – to have actually quite low effects on vertebrates for example. That has since come into question. And they were also thought to provide protection to the plant across its lifecycle, the reason being that they are what's called systemic pesticides. They're water soluble and they're taken up by the plant, and then they go through the entire plant and are expressed throughout it. That means that, for example, if they are delivered as a seed coating, that it means that the seed is protected and so is the seedling through its complete development.

CK: 12:19 – And that was seen as a big advantage. And it is potentially an advantage in terms of crop protection, but it can also be a means of more widely distributing this pesticide to non-target organisms, as well as to non-target environments. As I mentioned it is water soluble that means it goes everywhere, and these neonicotinoids have been found pretty much everywhere that people have looked for them in the soil and the water. So, it is concerning in that way. For pollinators it is particularly bad because if this is a plant that when it flowers is attractive to pollinators, it means that they will be delivered – neonicotinoids - to the pollen and the nectar, and that's where the concern has come, specifically around honeybees but also around our native pollinators because they are getting exposed to nicotinoids when they collect pollen and nectar from these plants.

CK: 13:16 – Well, the best thing that you can do, I would say they're two things: in your backyard in your garden, make sure that you have a variety of different flowers available for bees, and there are some great places to get resources on that. One that is fantastic for North America is the Xerces society, they have resources from many different regions of North

America on what to plant. But it can be a combination of your typical ornamental plants but also - I favor, planting native plants, but you don't have to. The most important thing is to have a mixture of things that bloom at different times, and that bees like. The second really important thing is not use pesticides in your own backyard. It's really possible to plant a vegetable garden without using pesticides. Or if you do have to use them, you can use in a very, very restricted way, and try not to - try to find out if nursery plants that you purchased are, if they are using the neonicotinoids, on those plants or not. Because sometimes while you might not be using pesticides the plant that you purchased may have been grown using neonicotinoids, and those neonicotinoids could even still be present in the plant. So, those would be my recommendations. I think we really can promote pollinators in our backyards, and it's fun too because you can start taking a look at what you have out there, and see how that changes as you put in additional plant species, and have more flowers available to them.