Green intelligences

**Melanie Challenger**

Today’s guest is Paco Calvo, a Professor of Philosophy of Science and Principal Investigator of MINTlab (Minimal Intelligence Lab) at the University of Murcia in Spain. He is the author of Planta Sapiens: Unmasking plant intelligence.

**Melanie Challenger**

I think what I want to start with, for listeners who are new to the emerging field of intelligent behaviours, and the intelligence of plant life, would be to start with definitions, because you wrote really good paper that I read a number of months ago, where you're very clear about how you were defining the term and how we therefore start to use that to examine intelligent behaviours in plants. So can we kind of open up with definitions?

**Paco Calvo**

I think this is really a red herring. I mean despite me having made the attempt, or many others of course of trying to crack it down by defining, first of all, what we mean by intelligence, or what we mean by cognition, it's there is a risk involved in you know, in clear cut definitions, which is that it prevents us from exploring elsewhere and trying to play, to toy with different alternative definitions that might work as well. So, you know, I'm kind of resistant to setting in stone the definition. But however, preliminarily, I mean, we can always say, you know, of course, intelligence, whatever it is, it cannot be something that requires, you know, a human-like approach to the world, or the way we see or perceive the world has to do with it, right? It's got to be something broader, something more general, right. And then I would say that we find, you know, intelligence is somewhere out there, whenever we encounter a form of life that is able to behave in a proactive manner that is not behaving reactively, so to speak, and is able to do so in a flexible manner. So you won't find the behaviour that is truly intelligent, and still, you know, it's kind of routed to a routine, like automated responses, like always the same. So it's got to be flexible enough to deal with contingencies, it's got to be able to anticipate future contingencies, right? So it's got to be able to say, hey, something might go wrong, I should mount this response proactively ahead of time to be ready when things might go wrong. So it's got to be anticipatory behaviour. And in a sense, it's got to be goal directed. So that's what I meant, actually in fact, and I put all this pretty much under the same label when I speak of intelligent behaviour as behaviour that is adaptive, but not just adaptive, of course, but it's got to be flexible enough, anticipatory and goal directed. If we have all those things together, then we are talking intelligence.

**Melanie Challenger**

Do you think, though, that the definition hasn't actually changed dramatically since Darwin's day, but perhaps the focus of our research or the way in which we've, you know, what we've built up in science, and also in the application of science socially, so in terms of education, and so forth, approaches to the health of young people or trying to make sense of what kind of intelligence young people have those sorts of ways in which intelligence has sort of drifted across society and gained other kinds of meanings or biases. But if we go back to it, do you think we haven't actually changed our definition that much from the first kind of attempts that Darwin was making?

**Paco Calvo**

Well, actually, I mean, this is kind of again kind of tricky, because, you know, I don't think we can quite remove or do away with the analogies, the metaphors, the gadgets, the toys, the devices that we all have in our different epochs, eras, right? If today we are into this digital world it's very difficult to come up with an approach to intelligence that doesn't resort to, you know, to the computer metaphor.

**Melanie Challenger**

Yes.

**Paco Calvo** We speak freely of AIs. Think of AIs. I mean, can you provide a definition of intelligence like artificial intelligence that doesn't take you back to this metaphor space in which we resort to something which we call the software, and something neuronal that we call the hardware. So in different times, different people have resorted over and over again, to different analogies and different metaphors to try to make sense of what we mean by this. And of course, this takes you back to, you know, to Darwin's times. And way earlier, I mean, it's always been like, like, Okay, what's, what's the best technology, the best gadgets we have at our disposal? And we try to think with them to think with analogies, right? So in a sense, we've been playing in that game, from the very beginning, that's something we cannot fight, we need them, we need metaphors we need this analogical way of thinking.

But with that being said, it's important to emphasise if you go back to the days of Darwin, that we are trying to find a difference or to mark a sharp difference in between truly sophisticated behaviours, but behaviours that just happen to be, you know, smart adaptations, but on a different timescale, right, evolutionarily speaking. But we don't care just about those smart adaptations. I mean, in a sense, that wouldn't be trivial. Of course plants wouldn't be here, if they weren't smart enough in that sense of adaptive behaviour, right? Of course, they wouldn't have passed their genes, if they are here, in a sense, it's because they've been doing something the right way. Right? But it's got to be something that goes beyond the type of genes that we've inherited, and say, oh, courtesy of my genes, the one's I inherited, I am able to do this or to do that. No, no, it's not about that. It's about what else you're able to do that has to do with your disposition to the environment, to the local environment, how the local environment..

**Melanie Challenger**

…a lifetime process, in some ways as opposed to the kind of, you know, inheritance of whatever happened to work for your ancestors, genetically.

**Paco Calvo**

It's definitely whatever is out there right now is shaping up our capacities, our potential. I mean, if there is a tipping point here in this controversial debate of plant intelligence has to do with moving away from the very question of the I mean, you started with a definition of intelligence, right? So defining intelligence, trying to anchor it in biology, in the field of biology, move away from that into trying to anchor it from within the cognitive sciences, psychology, computer science ,neuroscience. And the reason for this is that what we have just done, so moving away from the evolutionary timeline to the local perspective of the interactions, the organism is emerging, then we are into the world of psychological predicates. Now, we are not simply speaking about behaviour that is adaptive or maladaptive. We are talking about organisms that are able to learn, that are able to memorise, that are able to make decisions to make choices. To think ahead of time, anticipatory as we said, so this belongs to the realm of the psychological, and that's the game we are playing to try to project to try to understand how those predicates might apply to non-neural forms of life, which is, after all, why they find so spooky, we find them so weird right? Because plants have no neurons, then we think, well they couldn't possibly learn or memorise. How could they do it if they don't have neural tissue? Well, put it the other way around, we can find out. In fact, we are finding out on a daily basis that precisely because plants are able to do all that, take decisions, solve problems, memorise, learn, etc. Because they are able to do that and they have no neurons, we find that well, neurons weren't needed after all.

**Melanie Challenger**

Okay, so there's a lot there. I think the reason I was saying it hasn't changed that much since Darwin's day is not actually because intelligence has to follow that classic Darwinism that you've just described, in which the psychologies of organisms are not necessarily that relevant are they? In fact they've been underplayed. It's blind sort of random forces and almost accidental behaviours that result in success and the offspring and so forth.

**Paco Calvo**

That we happen to be here something like?

**Melanie Challenger**

Exactly. And it kind of strips the world of its agency, or the organisms of their agency to a certain extent and what you're doing in trying to align, say the kind of well established, firstly, the predominantly well-established focus on human intelligence, and then the kind of increasing in the last few decades, focus on comparative cognition, so across, particularly mammals, but it's predominantly primates, isn't it, really? But we're increasingly looking at corvids, and we're looking at cephalopods and so forth. But now we're looking at plant intelligence and to do that, as you say, it's about focusing on the lifetime of the organism. What adaptive behaviours does the organism show in its lifetime? But in some ways that for me is about what intelligence is doing in the world, rather than the focus on just what is the apparatus of intelligence? So brains, nervous systems and so forth?

**Paco Calvo**

Yeah, it has to do with the meaning making, the way different organisms are able to make meaning to exploit, to struck meaning out of the way they interact with their surroundings.

**Melanie Challenger**

So I think what's going to really fascinate listeners straightaway and what I really struggled with, and it would be great if you could unpick for people, so I think people are very open to this idea that there is something we could call intelligent behaviour. So goal directed, enhancing behaviour on the part of the organism that is aimed at making good choices, especially dynamically in the lifetime of the organism. And then some of that learning, you know, some of that can be learned or remembered or what have you. But when I started really going into the literature, it's a bigger leap, I suppose, because it's requiring a bit more of an insight into what memory looks like in terms of chemistry that is harder for us, even though it's just chemistry still it's biochemistry, again, with, with mammals and so forth, but it feels easier for us to get our heads around it. Because literally, we're thinking about our cognition in the brain. And we it's so well established in our minds just intuitively, even if we don't really understand it. But when we're looking at plant intelligence, we're trying to think about memory, outside of the brain, and we're talking about sort of particular chemistries and behaviours. So can you give us some sort of concrete examples of what for instance learning and memory look like in terms of a plant?

**Paco Calvo**

I know, I'm going to say it again, but I will, this is tricky. Because you see, if you ask five different cognitive scientists what they mean by learning or what they mean by memory storage, they will come up with five different definitions. And I mean, there is a big discussion in the field, within the psychology community as to what is it that we mean when we say that, I mean I'm not talking about plants, even humans or non-human animals, right, so what we mean to say when we see an animal as performing some operation that involves learning or memorising or stuff like that. And then on top of that, I've got to say that the field itself of plant intelligence is actually to me is fascinating, because it's so recent and the last couple of decades, when most of these research models, most of these papers just have come out. And, and it's a literature that is it's actually been in print at the moment or not even in print. So it's we are reading the very latest, as we speak now. Right?

**Melanie Challenger**

Including your forthcoming book, I will say

**Paco Calvo**

Yeah, I mean, I'm putting all this together into this book, ‘Plant Sapiens’ But that's a popular book. But even if you go to the scientific literature, so for example, now we are trying to replicate a well-known experiment by Monica Galiano and colleagues. Back from 2016. And it's I mentioned this in particular because it's an experiment on plant learning, right. Pea plants.

**Melanie Challenger**

And it was controversial wasn't it?

**Paco Calvo**

It was very controversial. But you see because the literature is so recent, some people regard it as anecdotal. The sceptical attitude could to be to say, Hey, I mean, don't we need some independent laboratory to replicate this before we make all this fuss about it? I mean, too many headlines, and very little replication, so to speak, right? So in my lab, we are at the moment trying to replicate it. And as of today, we are I mean, we might be able to report to headquarters in a few months-time. Yeah, I mean, it's actually been for the last, this is an ongoing project for last two years. So it's still work in progress. But just to let you know, I mean, just for the audience to understand how difficult it is. I mean, we've been trying to replicate it for the last two years, and we haven't been able to yet either to report that we couldn't replicate it, or that we could replicate it. So we don't know still, if we have a good example of plant intelligence, in the case of pea plants, associative learning.

For the people, unfamiliar, this is an experiment which Galliano and her team reported that pea plants were able to learn by association. Learning by association is like Pavlov's dog, right? Like, you know, you were pairing like two stimuli, one that would trigger the natural response, like in the dog salivating. If you show food to the dog, the dog would salivate, right? But if you rang a bell, the bell wouldn't trigger the natural response of salivating. But when you were pairing both, that is the bell and the food afterwards, the dog learnt that bell meant food so that soon after the bell rang, the food would be coming right? So that's associative learning that the capacity to couple those two stimuli. Now when this research on this protocol coming from the animal literature was applied to pea plants and in Galliano et Als paper from 2016, they reported that pea plants were able to perform associative learning in pretty much the way we know dogs do or animals do. Now this could be a false positive, this could be a false negative. So it might be true that pea plants are able to do what these researchers reported, it might not be the case. But to me, what's risky is to polarise the debate.

**Paco Calvo**

So to think that we need to stay either a priori on the side of the sceptic, or on the side of the believer that the one who wants to believe come what may in this capacity. So I regard myself as remaining in some neutral stance, I want to find out, right, so we want to find out. Now, you mentioned both the example of learning, but you said something about the chemistry, right? So because of course if there is learning or there is the capacity to store memories,

**Melanie Challenger**

Yes. What does it look like?

**Paco Calvo**

Yeah, well you know, this is important, because after all, if you think of the tree of life itself, so how different species of organisms belonging to different kingdoms were, you know going into different branches, as the Tree of Life kept delivering different adaptations, we find out that after all, that chemistry that was involved in the first place, goes back to the very stamp of the tree of life. So many, many, many of those molecular level, subtract substrate level features are being shared, shared across kingdoms. And just to give you an example, think of melatonin, I mean, that the hormone that we secrete in our pineal gland, right? in fact what do people do when they can't go to bed, they can't fall asleep, they take some melatonin tablet, right? And that puts you to sleep. And what we find out is that pants secrete, they bio synthesise their own melatonin, right? So, we are so blind, we are so unaware. And it's so difficult for us to empathise, to come to terms with the possibility of plant intelligence resorting to the very same chemical or molecular level strategies that it took us decades to actually see, to actually identify melatonin in plants. I mean, this is amazing! mean, observations are so theory laden because we have this preconception that melatonin belongs to us, to animals. We can't quite picture that happening in the green world, in the world of plants. So the molecule was there, you could see melatonin in plans, and it was only 20 something years ago 1995 I seem to recall. We are so stubborn, we are so obsessed with intelligence belonging to us that it took nine more years. the expression phytomelatonin was coined in 2004. So you see less than 20 years ago. And but it's so funny because even once we accept that plants bio-synthesize their own melatonin, and melatonin in plants has to do with a day night pattern, right? So, basically with the circadian clocks, with putting us in rhythm with the planetary cycles. So the very same thing all forms of life do on Earth, right? Even though we understand that melatonin plays a functionally similar role it does in animals, we still stick to the label as if it belonged to us. And then we have to add the prefix ‘phyto’. So we say ‘phyto’ melatonin, instead of melatonin, right?

**Paco Calvo**

So we are obsessed with keeping it to ourselves as if it was something special that we only have, animals, I mean. So this is a great story as to how stubborn we are thinking that we are special. And we are not that special. I mean think of this very idea of tuning to planetary cycles to regularities, I mean, it's no surprise that any form of life whatsoever on planet Earth resorts, or relies on information that has to do with the timekeeping of circadian clocks. So circadian clocks in plants and animals alike have to do with that. But simply because the day lasting 24 hours, and things happening within those 24 hours, so peaks and valleys of temperature, relative humidity. That type of information is irrelevant to any form of life whatsoever, but simply because it's a regularity. So it's out there, ticking from the day run the year on a regular basis. Remember we said the plants are able to anticipate? Well you are able to anticipate when would you have the right type of cues, in a world that didn't have any structure whatsoever. In a world where there were not these patterns, this will be regularities, these day/night cycles, you could be way more difficult to anticipate, we are able to anticipate because things happen at certain times more frequently than others. So things happen throughout the clock, right? So the adaptation of timekeeping, of having a circadian clock that allows you to keep time of the day and night that comes handy to any form of life from bacteria to humans. So now when we see that those molecular clocks have to do with the very same type of machinery across the tree of life should be no surprise. But we still find amazing when other forms of life, oh wow they do the same. They need to keep time or they need to go to bed? Well, you know, think of many plants fold their leaves at night, right? That's regulated by melatonin. So it's not such a big deal. It only looks like a big deal when we are obsessed with that we are something special. And we are not so special.

**Melanie Challenger**

I guess that's true. Also, going back to definitions where we're looking for intelligence or what it is in order to try and get any data, what it is that we're actually asking about an organism? And the trouble for us is that our kind of specialisations in our cognition and intelligence are oftentimes, I mean there's, all of that sort of stuff going on. But also, a lot of what we're really focusing on is social relations, because it's a kind of adaptive environment that we have with one another, as well as with the environment. Whereas with plants, I mean, it'd be nice to go into that a little bit. And we can touch on and perhaps some of the controversial ideas about social behaviour among trees. But before that, I think something that would interest listeners would be to look at what it is that the intelligence of plants would have to be doing. So in particular, I'm thinking of things like the tobacco plant, for instance, and the way in which plants have to deal with predators. So obviously plants are eaten a lot, aren't they? So a real focus of their intelligent behaviour must go on surviving the extent to which they're been chewed up and munched on, so can you talk a little bit about some of some of this science that's coming from that area?

**Paco Calvo**

You have many, many, many different examples of plant intelligence that have to do with a vast behavioural repertoire. Now this behavioural repertoire sometimes has to do, of course, with the social life of plants, they are not isolated, they live in communities. And they have to tell kin from non-kin, they need to know if this guy growing next to them is bad news or good news to them. That they can, you know, enter symbiotic relationship, that they can help each other, that there's some foe, there is somebody that is going to compete for resources. Now, all this communication and information gathering on behalf of the individual and the community takes place, both below and above ground. So they need they need to be talking to each other and monitoring, sensing what's happening below ground. At the very same time that they need to be doing pretty much the same thing above ground. And not just that, they need to be integrating all that information coming from below and from above, in order to provide a response that is globally adaptive, because sometimes people say, Hey, we are far too obsessed with what's happening up there, right at the air part of the plant like the shoots. And then we know of course that they communicate through VOCs volatile organic compounds that they emit the signals that are airborne, travelled from one plant, or even from one part of the tree or the branch to the next or from the nearby tree, etc. So we know how volatile are put to the service of allowing plants to alert or to communicate that some danger is coming or whatever, to some other plants nearby in could be belonging to the same species are two different species. Sometimes they make use of this volatile to attract some predator of whoever is damaging them. So you might have this herbivore munching on your leaves and then you emit this call to bring the predator that will eat the herbivore that was damaging you. So the bag of tricks is amazingly sophisticated and vast.

**Paco Calvo**

But one thing that goes beyond that, and that sometimes passes inadvertently, is the fact that plants cannot be responding to one source of stimulation or one type of threat, or whatever, on a one to one basis. So it's not that plants can be responding to this predator and then do something about it as if it was the one and only informational channel that is processing. So plants need to be monitoring everything online continuously in real time. So it's like they can't press pause and say, Okay, I detected this signal, I'm gonna press pause, I'm gonna sit back and relax, and think what am I gonna do about it? No, no, it's got to be on the fly in real time, you cannot stop, right. And at the same time, you need to see what else is happening elsewhere. Right. So something might be happening below ground that is going to affect the way you respond above ground. So it's a global response what we're after and it's a global response or the need to integrate all these informational channels. So that's why it's way more sophisticated than simply responding on a one to one basis to each source of stimulation, see what I mean?

**Paco Calvo**

So how do plants do this? Well, of course, they need some way to orchestrate all this. So that it's not this one to one thing that we were speaking of. So, to do that, we need to put it this way. Remember, we said that we are into how we are approaching plants from psychology and not from biology itself? And this means that if when you go to the physiology, if you think of the vascular system of a plant and think of the of the phloem and the xylem pathways. So these pathways go across the whole plant body to bring the sugars and minerals, water throughout the plant body right from the roots to shoots from the shoots to the roots, all these substances are travelling across. Now, if we just think of the plant in these terms, we are not escaping the physiology trap. So the conceptual trap of thinking that by tracking down the physiological states and thinking in terms of the plant physiology itself, we can understand what the plant is after. No, you cannot understand what it means for a plant, or what is it like to be a plant, or what is meaning-making for the plant? How do they interpret how do they make sense out of their surroundings? To do that, you need to understand the vascular system, these phloem and xylem pathways not simply as the way to translocate these substances. Its not just a matter of using those motorways or those freeways to transport the sugars, the waters or the minerals. We need to understand this vascular system as an information processing system. And that's what we do with animals. If you think of animal cognition or human condition, psychology is about unearthing the information processing system, understanding how the organism processes information for its own sake, right? Now, we need to understand plants in the very same way. So these competencies, whatever the plants are doing both below and above ground, must have to do with approaching their inner doings, in information processing terms, it's about the processing of information and not simply the translocation of substances. That's what we're after.

**Melanie Challenger**

Yeah. So what we are in this tipping point, aren't we, I mean, within sort of environmental philosophy, for instance, there's a focus on this as the vegetal turn. So the animal turn was sort of when we started looking more, well, seeing ourselves as is related and seeing a greater relation between other animals an us and in the vegetal turn as this very new idea that we are now looking at plants in a different way. And with that follows different approaches or different duties or different responses that might be called on by us. But how do you stand with, because this is all proliferating so fast, it's incredible for me to see, you know, going from someone like Anthony Trewavas’ work, for instance, which is only still really very recent, scientifically speaking. But you go from someone like that, who's perhaps not such a well- known but very key figure here in in plant behaviour and intelligence, through to these kinds of massive bestselling books that are talking about the social lives of plants like the fungal networks is kind of like a brain under the under the earth, like neuronal networks and so forth. Do you think that we're rushing too hard into sort of perhaps over-explaining the data and trying to draw too many metaphors between us and them? And not seeing the behaviour and the intelligence absolutely on its own terms? Where do you sort of stand on that?

**Paco Calvo**

Yeah that's a very good question. Actually, it's really difficult to respond because every day, when I go to the lab, I realise I need to remind to myself that you know, you need to train your eye every day. It's not that you're fully trained and wow, now I can appreciate plant behaviour. No, we keep falling back to all these conceptual traps, we keep falling back to these misunderstandings or misperceptions. And this is a world that, it's got to be done and done all over the time, all over again. Because somehow, we have this inertia, we go back to these, you know, metaphors, but metaphors are useful. We need to keep using them. I mean, we couldn't think otherwise. So exploiting metaphors is okay. The problem is when we forget that they are metaphors, we kind of lose track of what's actually at stake. So I think we need to keep training our eye. In a sense his rush you mentioned, I think there is a real threat here. But that's not something that has to do with the research on plant intelligence as such. It's something that goes deeper and has to do with this sense of relief that we have. I mean nowadays with social media and everything, this sense of relief that we have when we simply you know, retweet something or share something with our friends, and then we just feel that we can sit back and relax. Oh, okay. I did my little part. Right. So you know, so this sense of yeah, we are part of the problem, but it's not me really the problem because I'm you know, I am aware of the problem, I do my best. And I think in this rush there is a lot of, well nowadays we speak greenwashing. You know what I mean, right? So put it this way, when we have all these popular books on these non-neural forms of intelligence, my feeling many times, is that we need to be careful, very careful, because one thing that we are still not doing properly is we are not managing not to think of plants still as resources.

**Paco Calvo**

So even though you think, Okay, we have all these problems, you know, climate change, and all these issues that are on the table. And then, we kind of ask, Hey, how should we exploit these resources at our disposal, and then it all appears to boil down to the wise fools, how wise we are in exploiting those resources. Instead of saying, hey, hold on a sec, these are not resources, because to treat them as resources is to treat them as objects. And plants are subjects, are agents. So, they are not objects, they are agents, they are subjects. And if we don't understand that, then, despite all the effort we are making, it's a blind alley. Because we are still discussing in the other conceptual map within the set of discussions that simply have to do with how intelligently we exploit the resources we have at our disposal. Unless we understand that when we speak of these networks below ground with fungi or with plants, of any of these great examples of alternative forms of intelligence. Unless we understand that this as agents, meaning making with consciousness with sentience, unless we understand that, we will still treat them as objects, regardless of how effortly we think we are working towards the solution.

**Melanie Challenger**

It's, it's easy for us to see plants as the environment, almost to see them as the background, they very often are the background in our lives, in fact, many people's interactions with plants these days, are as something they've bought from the supermarket or as something that's in the backdrop to a nice walk that they might go on. So it requires quite a big perceptual shift anyway even though what you're asking, or what you're calling on is for people simply to recognize as you say the agency of organisms. But I think, you know, the trouble is, if you look at comparative cognition with humans and great apes, or humans and other primates more broadly, we've got a lot of data. And that's been the kind that that was the first real area of comparative cognition and the driving force behind that science. Because you know, we forget that many times scientists might be doing something for pure fascination. In reality, scientists are often funded because of how that science or data can be operationalized in the world, because of what it might be doing in the world. And a lot of that research early on was really to do with making sense not of the intelligence of other organisms, but or other primates, but really much more to do with trying to understand why we're so special. And so it started from a bias standpoint, and in the first place, and we can be a little surprised that we're still at the stage where the personhood of a chimpanzee, for instance is still controversial. And it's still not there in law, or of other kind of highly intelligent social animals, like elephants, for instance, let alone how we might, you know, we have really good data on the social behaviour in the intelligence and cognition and sentience of pigs, for instance, but because they are a huge part of people's everyday meals, the reality is, is that it's very difficult for us to consider properly their agency or consider what duties might follow from that were we to properly acknowledge their agency, I think for many people starting to think about Oh, my God, and you know, they're struggling enough to, to kind of push their moral boundaries to farmed animals, when you're starting to get them to think differently and perceive subject-hood in in plants, with that surely a very, very long way off would you say?

**Paco Calvo**

I mean, this is really a thorny issue because I don't think we can look away. I mean, we need to tackle this one because these ethical dilemmas that all these discussions bring about are going to be increasing, as more scientific data and understanding is gathered in the next decades. I mean, we need to face it, we are not alone on planet Earth, and able to do as we wish with the rest of it. We are all fellow neighbours on this planet, which is our home. There are some answers that are maybe uncomfortable, but we are not going to do anything by putting them under the carpet, I mean, we really need to face them. And I don't think this is something that can be learned by reading it on a paper. I think this is something that you only see in the first-person perspective when you are actually interacting, engaging with some other form of life. And it's happened to me in the past, even time lapse in plants. We in our lab use time lapse plans to split them up and study their behaviour. But even when we do so I can actually tell my students to be careful, to every now and then to shut down the camera and do naked eye observations. So with time lapse footage, you can speed plants up. Now, you will need to do it in reverse, we need to slow us down. So we need to sit back to chill out and relax and say, Hey, hold on a sec, I'm gonna appreciate plant life at its own pace. And that means not speeding them up with w technology. But with me sitting back, and trying to observe it to the naked eye in its time frame. And you don't want to know what happens when you do that. I started doing naked eye observations in my attic at home.

**Paco Calvo**

So I have these climbing beans in my attic. And I would sit there on a stool for hours watching it grow, watching it circulate around, so circling around as they are trying to find a pole support. And you know what happens that when I was observing them to the naked eye, for some reason, there was something I was able to see that you couldn't get it in the footage if you time lapse it. So I could time lapse It and absorb it to the naked eye. And it wasn't the same, I could see two different things. And the two different things that you get to see has to do with the type of empathy that develops when you are having a type of relationship with another fellow organism. So when you are actually coupling to it, sitting there, feeling the pass of time yourself, not just recording it and playing the footage, you know, speeding it up. So it's something that is there in the actual time passing taking place, how effortfully they are actually circling, searching for the pole to climb onto.

So that type of experience brought me a sense of understanding that has to do with the first some alert to say, hey, we've got to be way more careful in our experimental designs in the lab. I mean we might be gathering data, and data and data and that might be taking us nowhere, because it's not the type of data that is meaningful, ecologically speaking. So you need to put yourself in the shoes. And this measuring rod we always use, like you mentioned, like when we think of the great apes, primates, etc, mammals. So why are we so fond of mammals? Well, of course, we all share a neocortex, we share the same type of computational machinery in our brains, kind of oh, this comes handy to have all these theoretical layers arranged in the cortex and be able to do to perform all these really abstract competencies thanks to having it. But the risk is that we think by default that they cannot be doing anything smart of or worth pondering over, simply because they don't share that type of computational structure. So when you forget about it, and don't have that prejudice by default and simply sit there, open your eyes and let yourself do away with prejudices and simply watch it and see what's going on. Then you're able to interpret or to find some behavioural repertoire, behavioural patterns that really defy this idea of, if plants are intelligent they somehow must be doing something similar to what I do. Why? Why would it need to be similar to what we do?

**Melanie Challenger**

Well, you know, that's one of the main reasons that I'm actually slightly wary of some of the metaphors because we've been really bad through history at valuing difference across the biotic community. The easy route into any value that we place on our discoveries of other organisms and their capacities or behaviours or interests even, have always come through what it is that we value in ourselves. And actually, it's the otherness of plants and the very different pathways that they've gone down that I find so fascinating. But what would this look like though, Paco, in terms of an ethical landscape? So where might we be heading as we learn more about plant intelligences?

**Paco Calvo**

Yeah, well, again, let's see what we can say, because I don't think there is a silver bullet here. I mean, the one and only risk is that we polarise the debate unnecessarily, in between, you know, the good and the bad, guys. And I don't think it's about that. And I think that is something we are all missing in this debate, both sides foes and sympathisers alike. Because you don't need to believe in plant intelligence in an unscientific manner. So I just mentioned the case of pea plant learning, I am still trying to find out whether they are able to learn, I don't know if they are able to learn this. So the question is not that we should respond to the sceptic with another a priori move, like anti-sceptic, by default. We don't need to sign any blank cheque. And this has ethical implications because if you still don't know, if you keep an open mind, and think that well, we'll find out about plant intelligence in the future, the more we research, the more we will find out there are good signs, the good indications that something is going on there. The literature is there, I mean, we can browse it and make up our own minds. But regardless of whether that takes us to more or less conclusive interpretations of plant behaviour, we can still say, hey, insofar as we still don't know, as the jury is still is out, insofar as that is the case. By default, let's not produce stress unless it’s strictly necessary. So the type of stress that we are, you know, inflicting plants with or animals within farms, we need to think how it can be lowered in such a way that it can still deliver the goods that we need. So it's not a debate, for example, many people think, you know, many times when I give talks on plant intelligence, some people say, Hey, I was a vegan, or I was a vegetarian or a vegan. Now what?

**Melanie Challenger**

We're going to have to eat air!

**Paco Calvo**

Yeah, I mean, I always get this question. And I don't get it. Why there should be a problem? Because the problem, you see this is a clear example of polarisation of the debate. So the problem shouldn't be whether, if animals are intelligent, I don't eat meat. Now, if plants are intelligent, so what the hell do I eat? The problem is that regardless and respecting everyone's dietary choices, if we respect each other's choices, whichever those choices are, we all have choices to make within our own boundaries. So put it this way, imagine you are omnivorous, you eat anything whatsoever and you still have the same dilemma. So imagine we are growing greens in a very stressful way. So we are stressing them up with artificial lighting with bad photoperiods putting them to sleep, when it's not the time of the day. So we keep plants on jetlag so to speak. So we can induce many forms of stress too in agriculture as we surely do. And then you might have some chicken in a farm that is being taken care of ecologically. And then when the time comes, it gets to the supermarket. But it might have had a good life, so to speak in the meantime. Now in that case, I might wonder what's better? To eat the greens that have been stressed since germination? Or the chicken that had a good life? So it's not meat or greens? It’s whichever food you eat, did it go through some stress that were really unnecessary prior to getting to becoming the food we buy in the supermarket?

**Melanie Challenger**

Yeah, I think we could be here for many more hours if we're going down the ethics path, because it is it is very complicated. And I do think, for me, it's about a relationship. Your lovely thought-provoking anecdote which has actually lots of different nuances and sort of resonances within it in terms of just sitting and observing an organism on its own time frame. Because on its own terms, I think that a lot of what we're learning about enables us to have a richer and a more honest relationship with another organism. And from that just automatically, if you properly engage with it here may be changes that have to do with actually looking at the interests and agency of another organism and responding to what it is that that that organism actually requires. And that is going to be very, very different. And it doesn't collapse animals let alone plants, because you get very, very different kinds of duties that might follow from very, very different needs and interests that organisms have. I think animals, the fact that they do have certain kinds of cognitive behaviours or capacities sentiency and nervous systems, and that plants don't have something that's directly analogous to that does matter. It doesn't mean that plants are of less value, it just means that their interests will be different, and their needs for flourishing will be different. And like you say, I think we have a tendency to polarise this or to radically simplify it. And actually, it requires a stopping pausing paying attention to the incredible diversity of different sorts of needs that other animals have. And other species, fungi, whatever they happen to be.

**Paco Calvo**

I like to say different problems, different solutions.

**Melanie Challenger**

Exactly. A quicker and neater way of saying it.

**Paco Calvo**

What is true, we are obsessed with our lifestyle, because we need to fetch or buy whatever, get our food? Well, you know they sit there, they do photosynthesis, they don't need to go to Tesco or the supermarket. That's our problem, not theirs.

**Melanie Challenger**

And I guess where it could really hopefully matter from my perspective would be, not that any discussion of biodiversity is uncomplicated, either. We live in an incredibly dynamic planet. It's not just a straightforward, stable planet, everything is very complex. That said, I think very few people really are as engaged with what's happening to plant diversity and the massive drops in abundance and diversity across plants. They're much more focused still on animals, we definitely are very animal centric, I would say. And so if this sort of science can push back against that a bit, I think that would that's a really a really positive outcome.

**Paco Calvo**

Yeah, definitely. So you know, what's my latest obsession? So I, as I was finishing writing the book, I couldn't help but bringing a final chapter on education. By education, I mean, from day one. I don't mean university education or higher-level education. I mean from the very beginning, I mean, unless we get started from scratch, and from the earliest ages. Because you know there is something that has to do with attitude. And what's relevant in the anecdote of the attic and me watching the climbing beans grow is not what I was able to find. There is something which is even more important, which is the actual wanting to spend the time, the three, four hours sitting on a stool, regardless of what the outcome was going to be. So the time we spend, you know, that's the attitude, that's what we need to do for younger generations, that's something that can only happen if we start with different education from primary school, from kindergarten. Especially nowadays with all this rush and just you know, people all day with their fingers scrolling down on their screens. So not only literally I mean, really, we have a huge problem, and it can only be tackled if we get started, we try to do something about it from the very beginning. And that takes us all the way down to education with a big capital E. I mean, to me, there is no other way out.

**Melanie Challenger**

I think that, you know, oftentimes there can be a fear of biology, and particularly comparative biology, because we think that somehow, if we ally ourselves, and obviously when I'm using a we here, I'm very much talking particularly about Western modes of thought. But there has been a tendency within our sort of classic education systems, that somehow this sort of comparative biology or engaged biology of this kind, might be threatening to this sort of meaning making of the human experience. But actually, what a lot of this does is call on different ways of seeing, and those ways of seeing are meaning making of their own, you know, and I think I think that that they are opportunities to see the world afresh.

**Paco Calvo**

Well, you know, this is funny, because there is one thing we don't quite get. I mean, if you see the history of scientific progress, it's been history of one defeat after another. We were not the centre of the universe. Then came Darwin, we are just one more species. We've been losing all these battles one after the other. But, there is something that we still don't quite understand. And it's that we are missing a great chance to truly understand ourselves. Because if we stop seeing this as competency, like acknowledging other forms of intelligence, acknowledging it as what is natural. Of course, intelligence is all over the tree of life. If we didn't see it as competency to our privileged status. If we were able to do that little step, then we would win a lot, because we will win not just understanding of plant intelligence, but the actual revisioning to understand our own intelligence under a different light. So not just Hi, yeah, let's welcome plants to the cognitive club. Now, that's not just about allowing them in together with animals, it’s to truly rethink what we mean by human intelligence. We wouldn't be able to drill in, Hey, oh, I am intelligent, not because of where I felt I was, it's not that I was able to do this or that. No, what is it that makes me human, truly intelligent? So I think we will win a lot. If we put it in those terms. Not just like, Oh, we lost one more battle. No, no, we're winning the war. If we use it conceptually speaking, if you understand the metaphor. By putting it in those terms, no, no, it's not that Oh, bad news. Another kingdom in the tree of life that is full of intelligence. So what am I am I just nothing else? Nothing else? No, no. rethink what you mean by human intelligence? Once you've acknowledged that it's thriving all over the place. I think that's what we really need to understand.

**Melanie Challenger**We’re living through the so-called vegetal turn these days. Through the pioneering work of individuals like Anthony Trewavas and Paco Calvo, and others, we’ve begun to rethink plants and their capabilities. In fact Darwin was deeply curious about the behaviour of plants, and recognized the actions of carnivorous plants like sundews. But since then we’ve tended to see plants as food or as a pretty backdrop. That these are also living beings, yes, without the nervous systems and brains of animals, but still with extraordinary abilities to respond to environmental change and all the various challenges that the many thousands and thousands of plant species must face in the different places that they find themselves. I love the idea that Paco had to learn to do his science differently too, to match more sensitively to the nature of his study species. If anyone, like me, loves Tolkien’s Lord of the Rings books, the Ents, those walking, talking trees of the forests of Middle Earth, speak in a language that requires a perceptual shift. Entish takes time, just as some trees, the oaks and yews and bristlecone pines of our world, pass their lives of hundreds, even thousands of years, as whole human eras, even societies come and go. For Paco, to study his plants requires him to work on plant-time rather than human-time. It seems to me that is a patience worth cultivating.