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Goethe's Scientific Method: the road not taken[1]

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Introduction

In many debates on the environmental situation in which we find ourselves there have been attempts to identify the source of the problem in ourselves – our attitudes and approaches to nature –and in the wider related enlightenment project of understanding the world through a broadly dualist and then reductionist scientific approach. Setting ourselves apart from the physical world leads to an alienation of human beings from nature and a resulting attitude where nature is viewed as a commodity (Gómez-Baggethun et al 2011). Thus we can speak of nature as resources, standing reserve, natural capital or ecosystem services and so on (Washington 2020; Deliège and Neuteleers 2015). The task facing us then becomes one of ensuring human survival by enrolling nature into the human constructed, mainly capitalist, structures for our use. This use can include beneficent goals such as equitable distribution or the assurance of nature's continuance (Davidson 2014), but note that this is still in order for it to serve humans.

The intertwining of cultural attitudes of dominance over nature and a mainstream science that prioritised physics as the guiding discipline has led to a perception of the world as inert matter (Merchant 1980; Sheldrake 1990). That approach has led to astounding achievements alongside potential devastation. In fact we would not know the depth of the problems we face without some of those achievements, for example, climate modelling and ecosystem monitoring.

I want to explore a path in the development of the scientific method that was not the one taken. This is the scientific work of the eighteenth century German poet Johann Wolfgang von Goethe. To do this I will first place him in his historical context to see in what ways his thinking was diverging from the way

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science was developing and the trajectory it took. Then I will set out his method of working in such a way that the reader could explore this approach first hand. Whether this path would have not led to the crisis that faces us we cannot know, but engaging with this method does seem to place us in a different relationship to nature: a relationship that is more relational and collaborative than dominating.

Goethe's World

Johann Wolfgang von Goethe's dates are 1749–1832, which placed him chronologically at the watershed between the study of what was then called natural history and the new science of biology. His scientific approach countered both a form of vitalism (that in Goethe's time was characterised by belief that organic entities were infused by a mystical/imperceptible life force or spirit) and mechanistic ways of seeing the world that were coming to dominate the science of his time (Steiner, 1985: 92).

Goethe's scientific work included the areas of geology, meteorology, osteology and botany and the study of colour. Working across a wide range of subjects seems strange to our ever-more specialised contemporary approach to science. Why would someone hop from one realm to another and risk being labelled a dilettante? Even in the late eighteenth century, this would have seemed to be spreading oneself too thinly to make progress in any field of science. To understand this and to make sense of Goethe's scientific writings and discoveries, we have to understand him as embracing a form of holism, of seeing nature as one, and investigating sides of that whole in order to see it in its fullness. Moreover, his individual findings were only part of what he was doing. The core of Goethe's work was to address the nature of science itself. For example, he was also an early exponent of the history of science as a discipline in itself (Fink, 1991: 70). Attending to the cultural milieu from which any scientific work was emerging he believed would direct our attention to why it takes the shape it does and the ways it can be mistaken. Goethe's example of such a problem in science was the tendency to assume that everything is created for a purpose beyond itself, namely for us. He says:

> When a science falters and comes to a standstill despite the best efforts of many researchers, it can often be seen that the fault lies in certain traditional concepts of things, a conventional terminology, which the great majority accepts and follows unconditionally … The progress of natural philosophy has been obstructed for many centuries by the conception that a living being is created for certain external purposes and that its form is so determined by an intentional primal force. This idea still holds us back, although some have voiced vehement opposition to it and drawn attention to the stumbling blocks it creates.

And he proceeds to dig further into the psychological roots of this problem:

> Man [sic] is in the habit of valuing things according to how well they serve his purposes. It lies in the nature of the human condition that man must think himself as the last stage of creation. Why then should he not also believe that he is its ultimate purpose? … Given his need for objects and his use of them, he draws the conclusion that they have been created to serve him. Why should he not resolve the inner contradictions here with a fiction rather than abandon the claims he holds so dear? (Goethe 1995: 53).

To outline how Goethe's approach was different I will focus on three aspects of Goethe's science: the rejection of an over-reliance on theory; the grasping of nature as being in flux; and the role of human faculties in understanding nature. In all of these aspects, he was neither representative of his own time nor foreshadowing the direction that science was to follow. Furthermore, although he did have an early fascination with alchemy, and draws on it in his literary work (Gray, 1952), what he was doing in his scientific work and reflection on science as a discipline was something entirely new.

Rejecting an of Over-Reliance on Theory

At the time that Goethe was writing, mechanistic, reductionist ways of thinking were becoming prevalent in society and science, and these were leading to impressive discoveries and inventions. However, for Goethe, these discoveries were often misunderstandings and science itself was being driven up a blind alley. One aspect of the practice of science on which Goethe wrote extensively was the movement towards an over-reliance on theory. His final extended scientific study, and most controversial work was an exploration of colour. It included an extended and, admittedly, polemical attack on Newton's approach to colour as theory laden and reductionistic (Sepper 1988). Goethe believed that this approach leads us to no longer see the phenomenon we seek to understand; we would see only our own construct. As Goethe argued:

> Someday someone will write a pathology of experimental physics and bring to light all those swindles which subvert our reason, beguile our judgement and, what is worse, stand in the way of any practical progress. The phenomena must be freed once and for all from their grim torture chamber of empiricism, mechanism, and dogmatism; they must be brought before the jury of man's common sense.
>
> Goethe (1995: 309)

Goethe was not saying that theory or hypothesis had no role in scientific investigation; he did, however, want to rein it in and saw it as a tool that needed very careful handling. Goethe rejects both the over-reliance on theory to determine what to look for and the habits of mind that construct phenomena in the way suggested by the preconceived theory. A strong example of this criticism can be seen in the following quotation:

> To rid the human mind of an hypothesis that has unduly restricted it, forcing it to observe erroneously and to combine falsely, to muse instead of seeing, to sophisticate instead of judging, is already to render it an inestimable service. Henceforth it sees the phenomena with greater openness of mind, in other relations and interconnections, orders them after its own manner, and once more gets the chance to err after its own manner, a chance that is invaluable if it soon succeeds in perceiving its error. (Goethe cited in Heinemann, (1934: 68)).

The method by which one is to 'rid the mind' of constricting hypotheses is to approach the phenomenon from all directions. One of these directions will be prior hypotheses, but that is only one direction amongst many diverse approaches. Apart from the importance of a full investigation of the phenomenon as experienced by the scientist, there is also, as the latter part of the quotation reveals, the conscious attention to the action of theory, hypotheses and opinion on perception itself. Thus, the scientist has to investigate their own mind as well as nature to ensure that the necessary openness is maintained and to let the mental faculties be guided by nature.

In considering Goethe within the context of a contemporary search for a holistic science it is interesting to note that Goethe draws on ideas from Francis Bacon: the *bête noire* of nature respecting holistic approaches (Merchant 1980). However, his use of Bacon's 'idols of the mind' was to accept the need for self-criticism and to always return to the phenomenon being studied. And again when he used Bacon's concept of experiment to criticise Newton it was because Newton had unduly narrowed down the phenomenon of colour.

For Bacon an experiment is not to confirm a hypothesis but to rule out some hypotheses. It should place the experimenter at a cross road and the experiment should rule out one or more of the possible hypotheses and perhaps suggest new avenues to follow. Newton's presentation of his prismatic experiment as *experimentum crucis* shifts its meaning and with it the more open context of Baconian induction. As Sepper says:

> ..he [Newton] accomplished a significant transformation of the Baconian method and placed the new concept of the crucial experiment at the centre of natural philosophy, at the centre of science...Newton's Letter, though quasi-Baconian in appearance, proceeds more positively than negatively in that it judges what is wrong from the perspective of what the theory requires; also the phenomena are selected to test the theories, rather than to provide a comprehensive array. (Sepper 1988: 134)

The way in which Newton had distanced the scientist from the phenomena as they arise —in their interacting multiplicity— was the mainstay of Goethe's extended attack on Newtonian optics. To isolate a single complex experiment in order to prove a theory was for Goethe poor science. Although Goethe

was by no means uncritical of Bacon. In Bacon's radical realigning of science with the world as experienced and his assumption that an entirely theory free observation was possible Goethe believed that Bacon had "thrown the baby out with the bath water" (Goethe cited in Nesbit 1972: 30). The idea that an objective view from nowhere is possible denies our inevitable engagement and relationship with the thing studied and the possibility of using that relationship.

Thus, theory had a role to play but to understand Goethe's way of working it is more helpful to think in terms of the principles that open, respectful, diligent observation can find in nature. Or perhaps, in Goethean style, one should say principles that one is led to by nature herself.

Through the many scientific works by Goethe across a range of fields, he found certain principles that are evident in nature and these, for him, helped to explain its endless creativity (Tantillo, 2002). Rather than having strict laws circumscribing what is possible, these four principles are better seen as ways of capturing the way nature does what it does. They are as follows:

Polarity: Goethe's term for the way nature is creative through the juxtaposing of opposites; it remains in flux by breaking apart and rejoining.

Intensification (*Steigerung*): Goethe's term for the way all of nature seems to be striving or overcoming itself through increasing complexity.

Compensation: This recognises that nature creates within limits; forms can develop and change, but they are always sacrificing something to develop something else; for example, adaptability is sacrificed for specialisation.

Generativity: This is the principle Goethe recognised to explain the way an organism's parts can work together or even compete, in some sense, to grow. For example, a plant can produce more of itself vegetatively or sexually and these two impulses are both working generatively and express an inner vitality in the plant. Goethe considers that an abundance of generativity suggests a radical freedom at work, as opposed to a hierarchy where certain parts direct development.

These principles operated for Goethe in the way that a theory or hypothesis operates, although they were, he maintained, found in nature, not created by scientists for their convenience nor to constrain or shape what we are seeing. If we approach nature as a machine, we will find machine-like aspects, not because nature is like a machine but because that is the lens we look through. These principles were for Goethe a means to capture something of nature for the human mind to grasp, but they are, like nature

itself, ever malleable and undergoing change. One way to understand these principles is as guides for reasonable ways of adding the non-physical meaning aspects of a phenomenon, through contemplation of the phenomenon in the light of these principles.

Moving With the Aliveness of Nature: all is flux

An aspect of Goethe's science that seems unusual for the time he was writing was his appreciation of nature as continuously in flux. The project of biology in the eighteenth and early nineteenth centuries was to catalogue and order nature. Nature was understood as created by God, and the human task was to know what was there and to order its objects into static tables. Taxonomy was, in a sense, just the task of putting things in the right boxes. Goethe, as we see from the principles above, is more interested in nature as a whole and how it generates itself.

Indeed, his first published scientific discovery in 1786 of the intermaxillary bone in humans upsets one of the most fundamental divisions: that between humans and other animals. This bone in humans is fused with the maxillary bone, whereas in other animals (even apes) it is freer. Goethe saw this fusing, as opposed to seeing one discrete bone because his scientific question was not, 'which box does it fit into?' but rather, how does dynamic nature shape bones? He was seeing the hard material of bones more fluidly without preconceptions driven by a theory that must separate humans. This fluidity was so new as a concept that Goethe needed to introduce a new term for it, and in 1796, he used the term 'morphology' for the study of the transformation of organisms (Jensen, 2019).

Morphology also suggests the need for a kind of lively apprehending, not only to see the whole form, but to understand it as a whole. The organic, for Goethe, had no fixed form (Goethe, 1995: 64). Thus, the organism seen in everyday consciousness is not the organism as a living thing, to see this we need to bring to it the sense of flux that it is engaging in.

With plants, the picture is even clearer. Unlike his contemporaries, Goethe does not stick to studying plants as dry preserved specimens in herbarium samples. As he discovers, particularly on his extensive and life-transforming trip to Italy (Goethe, 1989), the way a plant grows reflects aspects of its environment such that there can be no stable sample of a plant – its size and development are shaped by where it grows. Alexander von Humboldt dedicated the German edition of his ground-breaking 1807 *Essay on the Geography of Plants* to Goethe (Magee 2007:227). This essay presents an entirely new approach and was the forerunner of biogeography.

In *The Metamorphosis of Plants,* Goethe set out his related insight that the plant develops by transforming its material through time by shaping and reshaping itself. It does not unfold to a strictly determined plan, but it does express a vitality and a drive to develop and reach a point of fruition, when circumstances allow. His cryptic statement 'all is leaf' means that the plant substance, which might now be expressed as leaf, undergoes a transformation (akin to reproduction) to become the other plant parts: sepal, petal, carpal, stamen, etc. Nature's creative process is visible to us once we shift our attention from static form to fluid process. This insight he attributes to encountering the discontinuous metamorphosis in the shape of leaves, which he first noticed with the dwarf palm (*Chamaerops humilis L.*) in the botanical gardens in Padua in 1786 (Arber, 1950: 42). Once observed with that plant he could then see that the way many annuals produce at first simple leaves on petioles then more elaborated leaves then back to simple shapes that hug the central stem as a process of metamorphosis, not of the individual leaves, but of the plant. By engaging his imagination enough to follow that story he then saw that the flower parts are all also a continuation of that same process. The plant's creative process is visible and laid out in front of us if we shift our attention from static form to fluid process.

Human Capacities and Their Role in Science

The third aspect of Goethe's approach to science that needs some explication is the role the human being plays in scientific investigation. In the science of his time the aim of distancing the inevitably fallible subjectivity of the human being to leave a, view from nowhere, objectivity was growing (Bortoft 1996). This aim was reconceptualised by Goethe as the need to train human subjectivity through immersion in the phenomenon studied in order for the full capacities of the human being to be available. Here we can see that the prevailing subject/object dualism is radically overturned and science becomes something relational. This is connected to both the preceding points about how we get to retain the baby but not the bath water and about nature in flux.

Goethe said, to understand the whole as a metamorphosing possibility we need to 'remain as quick and flexible as nature and follow the example she gives' (Goethe, 1995: 64). What does he mean by this exactly? The bridge that Goethe used to make the sequential connection from one instance to another, from one leaf to another, from one plant to another, etc., was that of the human imagination. Rather than seeing human faculties such as imagination, or indeed intuition, as impairing scientific objectivity, Goethe saw these human faculties as the means to really understand nature. By allowing nature to work with the human faculties, he thought we would begin to see with the mind's eye and thus make connections and reveal the inner life of nature that was not initially or easily apparent. He was resistant

to the notion of a free-floating idea or concept that was not tied to, or indeed given by, the sense perceptible to the human mind through what seems like a shared contemplation (Stephenson, 1995: 113). The observation and identification of key aspects of nature and an open contemplation of them helps to reveal nature as a whole, and this activity, in Goethe's view, was crucial for the progress of science. His use of the term *Anschauung* captures this well although it is not directly translatable. The English botanist Agnes Arber, commenting on Goethe's work, renders it as 'intuitive knowledge gained directly through contemplation of the visible aspect' (Arber, 1954: 122).

Goethe's lively discussion of philosophical problems with the activity of scientific investigation helps to fill out the picture of how he worked and what he thought was possible. Accounts of Goethe's own perceptual abilities abound (Amrine et al., 1987: 379), and he acknowledges that he was naturally very perceptive, but he also believed in the development of one's faculties. It is clear that he thought the human sensorium was capable of improvement when he discussed the idea of scientific work opening 'new organs of perception'. As he said: 'The human being knows himself only insofar as he knows the world; he perceives the world only in himself, and himself only in the world. Every new object clearly seen, opens up a new organ of perception in us' (Goethe, 1995: 39). The means to improvement was the exercise of looking at, and building a relationship with, nature. He seemed to invoke a cycle of looking at nature, examining oneself, looking at nature again and so on. The procedure then becomes a spiral of enhancing capabilities through experience and closer and closer relationship with the aspect of nature studied. For Goethe, this was the activity of science, he said: 'Insofar as he makes use of his healthy senses, man himself is the most exact scientific instrument possible' (Goethe, 1995: 331). That sense of having to live into, to merge with, the thing studied comes through in his writing.

Thus, we have a scientist very alive to the problem of presuppositions and human tendencies to shape the world to themselves and yet endorsing faculties such as imagination and intuition to arrive at insights about the workings (or rather the being) of nature. To highlight that seeming conundrum, he talked of the kind of approach that was needed as a 'delicate empiricism'. He said, 'There is a delicate empiricism which makes itself utterly identical with the object, thereby becoming true theory. But this enhancement of our mental powers belongs to a highly evolved age' (Goethe, 1995: 307). This delicate empiricism is *Anschauung:* where contemplation leads to intuitive insights by allowing nature to speak because we have placed our faculties at her disposal. Such an enhancement would perhaps allow us to become, for a moment, that which we study, for example, to experience vegetative growth or even

photosynthesis. Moreover, it allows us to bring the wider picture of relationships and forces in nature to bear on our perception.

It is hard to imagine exactly how Western culture, and the way we have treated nature, would be different if the development of science had adopted something of this relational quality. To begin with we would be different people. The shifts in consciousness that Goethe believed were necessary to understand nature would have instilled different abilities and, along with them, different values. What comes across from the bulk of Goethe's scientific work is a heartfelt reverence for nature. Had science taken that direction I suspect that now (to play on John F Kennedy's inaugural address) we would not be asking what nature can do for us but what we can do for nature.

Practicing Goethe's Method

If Goethe's method is an approach to science that was not taken can it found again or reinvigorated? In some ways it was never lost, not just because the written work has always been available but also because there are examples of Western scientists, who do not quite fit the mainstream being inspired by Goethe. For example, the English botanist Agnes Arber whose work on the mutability of plant forms involved the necessity of avoiding hard and fast distinctions. This is an approach in botany now termed 'fuzzy Arberian morphology' (Rutishauser & Isler 2001: 1179) and shows definite aspects of working in a Goethean way. However, the major impetus of keeping alive something of Goethe's method has to be credited to Rudolf Steiner. From his work in editing Goethe's scientific writings for the *Deutsche National-Literatur* Steiner could see that what Goethe was doing was not just outlining certain discoveries, but is also setting out how different states of consciousness are needed to bring out a fully rounded appreciation of any phenomenon. Moreover in Goethe's scientific writing it is clear that these states of consciousness could be schooled and used with the kind of rigour expected in science (Steiner, 1978).

Some historians, such as Karl Fink, see in Steiner's work on Goethe a one-sided or overemphasised view that does not equate with the bulk of Goethe's scientific work (Fink, 1991). Steiner's work certainly developed Goethe's scientific insights, but features such as: a living richness, a clear divergence from the mechanistic/reductionistic orthodoxy, plus a new working method that includes more of the specifically human faculties, were certainly already there to be developed.

Steiner's interpretative work on Goethe's science is a key inspiration for contemporary Goethean scientists, such as Craig Holdrege (2013), Jochen Bockemühl (1985) and Arthur Zajonc (1998). Goethe's

science, in particular his way of approaching phenomena with the human faculties operating in a disciplined 'objective' way – a form of schooled subjectivity – is emphasised repeatedly in the various fields developed out of Steiner's spiritual science, which he called anthroposophy, including Waldorf education, anthroposophical medicine and (relevant to questions of sustainable land use) biodynamic agriculture.

To bring out the sense of working in the way that Goethe was suggesting I want to now lay out his method as a practical approach with suggestions and guidelines to follow. The aim here is to give the steps that can lead to the development of new organs of perception. Why this might be worth trying out is not just to better understand this historical figure but to experience a different way of engaging with the world. As described above this method involves developing and utilising human faculties, such as imagination and intuition, in a disciplined way that allows them to play an insightful role in a holistic understanding of nature and ourselves as part of nature. The four elements of earth, water, air and fire are used here to assist with feeling our way into each of the shifts in consciousness that are involved in the Goethean approach. This journey challenges the reader to step outside their usual preconceptions and, through a type of phenomenology, allows them to experience subjectivity in a new way. The experience sheds light on Goethe's idea of delicate empiricism as an approach to scientific understanding. For addressing the problems we face and engaging with solutions such as living more lightly on the land, and of collaborating with nature's generative powers this method can give a fresh view of what true sustainability could mean.

Some aspects of this method will seem mundane and others strange but it is clear that we cannot approach it with our everyday habitual dualistic thinking in place. To set the scene for a radical change I want to begin with a suitably enigmatic Sufi story.

> Once upon a time, a shopkeeper had an assistant who looked at everything cross-eyed, so he always saw double. One day the shopkeeper asked the assistant to go into the storeroom and fetch a large jar of oil to bring to the front. The assistant returned a moment later and asked, "There are two there. Which one should I bring?" The shopkeeper sighed, since she was used to these questions. So she decided to try a new tack. "Just break one of the jars and bring the other!" So the assistant did it, but when one jar broke so did the other. (Douglas-Klotz 2005: 72)

Goethean Observation as a Careful Process

Goethean observation, as a means to come to know a phenomenon, is widely recognised as having four steps (Bockemühl, 1985, Hoffmann, 2007, Holdrege, 2005, Seamon and Zajonc 1998). My elucidation of it draws from the training given by evolutionary biologist Dr Margaret Colquhoun and others through

the Life Science Trust. Also from my subsequent working with and studying this approach, to inform what is set out here. (The Life Science Trust organised a remarkable series of seminars through residential workshops (some 7 or 9 days and some 3 weeks), each focused on a particular realm of nature, for example, rocks, plants, colour, animals or landscape. They were held over a number of years (from the 1990s to 2000s) at various venues in the UK and, latterly, at The Life Science Centre, Pishwanton in Scotland. Participants generally attended at least four workshops to experience this method with a range of phenomena).

The four steps are usually preceded by a preliminary stage of recognising one's habitual responses. In my own practice, and my own teaching of this process, I place more emphasis on this pre-stage than others do. Perhaps, this is because I am a philosopher by training and thus am aware of the epistemologically controversial nature of claims such as 'being one with the phenomenon studied'. Moreover, this pre-stage is useful for highlighting that Goethean observation requires a challenging switch from our culturally habitual dualistic thinking to a more holistic thinking.

A real strength of the Goethean approach is that it lays out a formal stepped process. Skilled practitioners will move between and meld these steps but, to begin with, it helps to explore and carry them out in a systematic way. This might seem and, at times, feel slow and pedantic, but the point is that we can follow consciously and rigorously what is happening in the world and in ourselves as the practice progresses. Experiencing this process can sometimes be unnerving or strange; for example, we may become aware for the first time of odd physical responses, insights or mystical states. However, engaging in the method produces a careful record and thus a fuller understanding of this shifting relationship between what we usually think of as our external and our internal worlds. Then we can move into and out of these feelings and responses by retracing our own journey.

Choosing a Plant to Study

When learning this approach it is easiest and most instructive to begin with some aspect of the plant realm even if, later on, the intention is to apply the method to an animal or ecosystem or landscape or something from the human realm such as an organisation or community. The plant, as we saw above, was foundational for Goethe's understanding of his method of investigation. In a sense it led him into the necessary shift of consciousness to properly experience the plant as alive. Practice with a plant provides benefits later on with more complex organisms, such as animals, and less responsive entities such as rocks. With a plant it is easy reach an understanding of what these steps feel like and so be more comfortable and assured about where one is in the process.

As with any research question or journey of enquiry, we need to have a focus – what is it that will be studied in this way? For early practice with Goethean study, it is good to work with something that draws the attention in some way; not necessarily something that is well known or that serves a practical purpose – that can come later when one is familiar with the method. Being able to find the thing that it would be fruitful to study is as much about waiting for it to call to or stand out to the observer. This requires patience and a child-like receptivity to hear what it is about the world that one is particularly suited to explore at the time. Being drawn to something could be an attraction or curiosity or it could be a feeling of revulsion or challenge – a troublesome 'weed' plant, for example. As can be seen right at the beginning of this process the mind sets of: 'what can this plant offer me', 'what would be useful', 'can I multi-task this to save time' and so on, have to be set aside.

I will be using italics when giving direct suggestions of ways of working in the preliminary stages and each of the steps and reminders of what needs to have been completed at the end of each step. (Note that taking on this process and working with it is something that requires a personal impulse to work in this way and should not be imposed.)

To begin adopt that child-like receptivity and just wander around and let something strike you and come to (what you might later see as) a mutual decision to enter a relationship. Before reading further, you need to have selected – or perhaps we can say you need to have been selected by – your plant.

Before the Four Steps: clearing the workspace

As human beings our ways of thinking, feeling, moving, responding and simply being in the world are shaped by our physical environment, culture, personal history and a whole web of interactions. In the West many of these are permeated by the dominant tradition of mind-body dualism, scientific reductionism and (perfectly justifiable) practical concerns of survival. It is one thing to acknowledge this but an altogether more difficult matter to escape it. Mind-body dualism, for example, shapes our language so that even to express how something could be different involves using the language that has developed to embody those cultural assumptions. An obvious example is when we talk of 'the environment', the use of 'the' separates us and places us outside of that in which we are actually environed. The process of Goethean observation is a honing of the human being as a scientific instrument. If this is what we are going to be engaged in, understanding the starting point – that is, our normal way of thinking and being – is going to be essential. There is self-reflection involved here and this can bring disquieting insights into oneself. For example, attitudes that we imagined were long outgrown can be unearthed.

What should become apparent is just how much the Goethean method involves self-examination and critical reflection. It is a qualitative approach to the world, but not one that revels in undisciplined subjectivity.

Guidelines for clearing the workspace

To clear the workspace take a preliminary look at what is actually there and how it usually works. Return to your chosen plant in a normal, everyday way and then set down your first impressions in whatever form they may take. These might be: your habitual likes and dislikes, how you might use the plant, feelings of boredom or anger, snippets of information, inspiring ideas or urges to put something right and so on. Instead of acting on these impressions or continuing them with further thoughts or day-dreams, you need to consciously lay them out for inspection and then set them aside. Keep a record of these thoughts and feelings. By naming attitudes and presuppositions that are in the background, you can spot when they might creep into your work in the later steps of the process. That said, a first impression may also be very perceptive and its veracity may re-emerge later on.

Before moving on, make sure you have made some notes about your usual thoughts and feelings about your phenomenon and any prompts to action that might have come up. A small journey into speculation about the origins of those attitudes can be helpful, but avoid holding up the next steps of the process that need to be worked through far more slowly. Your plant is waiting.

Step One: Exact Sense Perception

This first step is characterised by standing away from that very personal first encounter and observing the plant afresh. This is a process of meeting a being and, as 'clearing the workspace' emphasised, this needs to be done on the plant's own terms, that is, without overlaying it with personal preconceptions or normal ways of thinking. Not only personal feelings, but also any known theories about a phenomenon need to be held back in order to let the 'facts' speak for themselves. An example of this very different approach can be seen in Goethe's study of colour as a phenomenon. Rather than draw hasty hypotheses or work from an existing theory, such as Newton's, his painstaking investigations followed every conceivable avenue of experimentation (Sepper, 1988). Thus for Goethe, finding out about the nature of colour involved aspects such as: complimentary colour afterimages, how artists use colour, how dyers use reagents and so on, rather than just the latest idea on colour from physics.

Recording observations can be done in a number of ways such as writing detailed descriptions. However, drawing the phenomenon is one of the best ways to focus attention on the hitherto unnoticed

detail and the relationships between parts. If the aim is to really see a particular tree that happens to be an oak, drawing can be very helpful to prevent the observer slipping into their usual 'seeing oak trees' mode of perception. Artists have the additional problem of having to avoid their personal 'drawing style' influenced mode of perception. The categorised artefact that one's usual mode of perception creates, must be ignored in order to let the observer see the oak tree as if it had never been seen before. A number of drawing exercises are helpfully detailed in Margaret Colquhoun and Axel Ewald's 1996 book *New Eyes for Plants: a Workbook for Observing and Drawing Plants*.

Another tool that is used to help in this first step is to ignore pre-existing knowledge, for example, the names of things. Instead we need to see and describe them outside of learned classifications. This restriction on nomenclature is helpful when sharing observations in a group as the observers have to struggle to find descriptive language that makes sense to others but avoids the readymade and therefore potentially occluding terminology. It is interesting to observe in general how people often want to name, for example, wild flowers and seem disquieted by not knowing the name. For this process it is helpful to recognise that disquiet and then turn it into a more open curiosity.

Jochen Bockemühl's work on phenomenology (1985) uses the four elements (earth, water, air, fire) as a helpful way of characterising each of the steps. This first step has an 'earth' quality: the solid facts are gathered, and the feel of the process here is one careful exactitude. Although fascination with detail is appropriate, one should not get carried away. For some, this step is experienced as being rather tedious, yet for others it is very satisfying, and such differences in themselves show something of our personalities. In the training mentioned earlier, we spent several days on each step with our chosen phenomenon. With the plant it can be hard to stay in this mode, for example, one will be tempted to describe things as 'growing' or 'wilting' and generally anticipating future states or imagining past ones that we can recall; it is quite a discipline to hold those imaginings back and stick with the present. *Make notes about this when it occurs and how it feels to pull back from it.*

Secondary sources can also form part of this first step as a part of the information gathering. It can be helpful to know what other people have discovered. For a plant, this could be some botanical knowledge, or the relevance of the plant in agriculture, herbalism, myth or even the language of flowers in mediaeval paintings. The important point about using secondary sources is to avoid them to begin with (apart from checking in regard to poison) and then have a sceptical eye and always foreground and prioritise the plant itself for verification. With secondary sources one is gathering what other people have said and they could be working from presuppositions and not from the plant itself. However,

secondary sources might suggest new ideas or other forms of access to the phenomenon or questions to pose for further investigation. On the other hand, it also gives more material that has to be set aside in order to really see the plant.

Guidelines for carrying out step one

Try to experience your chosen plant as if you had never seen it before. From that perception, begin to record all that you can about it. Recording as you go is important: have a note book and drawing materials to hand. It is important to remember that you have multiple senses, so don't just concentrate on sight. With plants, smell and texture are obviously important as is, for example, response to the wind. Taste can also be explored – with caution (do check that your plant is not known to be poisonous before tasting it).

When writing descriptions try, as explained above, finding a word that expresses what you are seeing rather than taking the ready-made ones such as stalk, leaf, flower etc. This will prompt more looking and thus more potential to see fresh relationships. Also you could try for a moment to ignore assumptions about where your plant begins and ends – can a caterpillar on the leaf be described as part of the plant and soil around the roots be described as part of the plant? Ensure you know the details such as: the number of flower parts, how the leaves are arranged around the stem, is the stem ridged or round and is it the same colour all the way along, and so on.

Try drawing exercises as: drawing the outline of a plant without looking at the paper, using shading for depth with no regard for actual shades or shadows, or creating the form by shading the outside area of the paper as if chipping the form from a block. You could also use watercolour paint, pencils or pastels to mix the exact colour of different parts. One of the most useful drawing exercises, and this one should never be left out or cut short, is to draw from memory. You may think that you know everything about the appearance of a plant, only to have that assumed knowledge disappear the moment the plant is hidden from view. Drawing from memory by first closing your eyes and building the plant in your imagination as you have come to understand it, is extremely helpful in trying to build the bridge – so crucial to Goethean science – between the phenomenon and the human being as a scientific instrument. It is important to set aside any personal concerns about your ability to draw; the point is not to produce a beautiful picture, but to train your perceptions.

Do not move on until you have a collection of drawings and descriptions and a solid feeling of getting to know the 'what is' of your plant. This will provide your anchor for the work ahead.

It is impossible to continue in exact sense perception indefinitely. To register all the great amount of variety and detail would be, as Goethe said, 'like trying to drink the sea dry'. (1995: 24). Simply amassing facts about the phenomenon as a static object at the moment at which it is observed will not allow us to really see what the thing is nor come to any firm idea of it. Exact sense perception is only the foundation on which the following steps rest and to which they return, when necessary, to compare conclusions reached by other means.

Step Two: Exact Sensorial Imagination

The previous step, was an attempt to capture what the phenomenon is presenting right there in the present. The activities involved being exact about what is seen, heard, felt or smelled etc. but the entity studied cannot really be captured in a frozen present. It exists as a process, and so to get to what it really is, one has to live into that process so that we can begin to accompany it in its being. We do this by using the human faculty of imagination. But not imagination as we often think of it in the human realm as distanced from reality. Imaginative activity in Goethe's sense is called by him 'exact sensorial imagination' (Bockemühl, 1985) and it builds on the rigour of the previous step, but now it is set in motion. The aim of this activity is to perceive the phenomenon as a dynamic entity. Just as the previous step required a certain policing of one's usual ways of thinking, our imaginations also need some schooling to allow us to stick with the phenomenon, not as we have come to know it as an entity frozen in time, but as a being in process. It is the plant realm that gives us a clear picture of the need for a shift in our thinking if we are to understand a plant as a plant and not just as a marker in our system of classification or an entity to be utilised. This is where we can first detect that the quasi empiricism, which in the first step seemed exacting and pedantic, is now on a path to what Goethe termed a delicate empiricism. Delicate because it does not impose a theory, and neither does it deny the human faculties their role in coming to know the world. Rather, the faculties have to treat the world with delicacy in order to find it, rather than just find humanness reflected in it.

There is something dreamlike about this step. However, because it follows laying aside our theories, our presuppositions and undergoing a rigorous working in exact sense perception, our dreams are 'in the style of' the phenomenon and not drawn from our own personal fancies or presuppositions. These experiences need to remain dreamlike, because any fixing of them will put us back into the first step.

One of the easiest ways into this type of imagination, and seeing how it could lead to understanding something about a phenomenon, is through Goethe's work on the metamorphosis of plants. It is here that we can see his use of exact sensorial imagination as a shift in consciousness that now connects with

the phenomenon in a new, but nevertheless still rigorous, way. As we saw above, in the section on flux, discontinuous metamorphosis in a sequence of leaves gave Goethe the invitation to enter the process of the plant. Many plants produce a sequence of different leaves, often beginning with a simple shape, becoming more differentiated and then contracting to a more pointed form and eventually there is a transition to the flower parts (Holdridge 2013:76).

Jochen Bockemühl, whose work makes extensive use of leaf sequences, explains the process and shows just how different this kind of watery perception is from the earthy style exact sense perception of step one.

> With the mode of observation corresponding to the watery element, it becomes possible to go beyond the single elements of form and reach a realm not directly accessible to sense perception; here the sequence of forms appears as formative movement, and the formative forces can be experienced. If something is observed as an object, it is always seen from the outside, it is seen separately and seemingly from all sides at once. There, one's own standpoint is unimportant. The object exists without me. If, however, one begins to become aware of the formative forces in the way described, one's own inner activity (intentionality) and one's own position within the whole becomes significant. Bockemühl (1985: 21)

With any living entity, it is easy to move into this second step because the phenomenon seems to require it. We cannot capture the livingness of a plant if we stick with exact sense perception. Our thinking in that mode is too static to live into the phenomenon and experience it as changing and growing. Something of the phenomenon has to live in us if we are to make a connection between, for example, the sapling and the tree. Our thinking has to be mobilised to grasp the becoming of nature and the way nature is constantly creating. Although we know, in ordinary consciousness, that plants grow and change, here we experience it afresh and understand as if from the inside.

It is imagination that makes this mobilisation of our thinking possible. In this mode of perception, we are living in the phenomenon as a process. We are imaginatively engaged in those same processes. We need to enter this not by bringing in human meanings but by living in the phenomenon as the being it is. Although we cannot leave our humanity out of the picture, as this is the source of our imaginative ability, in this and the steps that follow we are placing our faculties *in the service of the phenomenon*. Exact sensorial imagination leads us to a holistic apprehending where we understand, for example, the plant as a metamorphosing possibility, connected to its place and to the plant realm.

Guidelines for carrying out exact sensorial imagination

Working with a plant will draw you into this mode (observing growing, wilting, etc.), so you may have already ventured there and had to hold back. How does it feel to now open that possibility?

An easy experience of moving a plant imaginatively is through observing your plant at different stages of growth by finding others of the same type. For example, you could be studying a particular wild carrot (Daucus corota) but around it are others at earlier and later stages of growth or flowering or fading. See if you can imaginatively take <u>your</u> wild carrot backwards or forward in time using these others as indications of your plant's process. You could also enter into the plant as a process the same way as Goethe through its discontinuous metamorphosis. Try to move through the sequence of leaves on one stem as if you are inside the plant to exercise and school your imagination. In your sketch pad try to imaginatively produce leaf forms that could appear in between those that are evident in your plant. This helps you to experience the plant as a dynamic process of metamorphosis as opposed to recording only its visual form. (If your chosen plant does not show any obvious aspect of this discontinuous leaf metamorphosis, you could practice with one that does, such as mustard, buttercup or groundsel, to get a feel for these changes before returning to your plant.)

Other exact sensorial imagination exercises to help here include imaginatively growing your plant through a whole life cycle or imaginatively taking your plant through the seasons. The richer the pictures you can build, for example, the changing light, the changing insect visitors and so on, the more you will be sensing into the plant. Growing the plant in your imagination before sleep can be very helpful for continuing your study the following day. This activity seems to connect you with the dreamlike realm that is needed here and it facilitates the later steps.

You could also try, with care, 'imagining it otherwise' (Brook, 1998: 55). This is where you purposely misuse your imaginative faculty to impose something on the plant, for example, imagining an ash tree (Fraxinus excelsior) is evergreen. The purpose here is to feel for a response. By now, you will be in a relationship with your plant and will feel (perhaps viscerally or emotionally) the wrongness of your imaginative fancy. Such a response kick helps to get you listening in to what is really there and tuning into where insightful responses might come from in your own body.

Ensure you have felt the shift in consciousness into this dreamy, watery style of thinking and feeling before moving on. You should have things such as a leaf sequence with some imaginatively realised intermediate stages that do not actually exist but could have. You should also have drawings entirely from imagination of your plant in past and future stages in your sketch book and notes about feelings and responses. You should now be able to move freely into and out of the plant and carry something of its being in your consciousness.

Step Three: Seeing-in–Beholding

This third step goes beyond the fluid mode where the phenomenon could be built up imaginatively through its changing forms. However, that fluid mode is still somewhat attenuated. It provides the training of the imagination but what is now necessary is to tune in to the phenomenon as it is, as a living whole, rather than as parts brought together imaginatively. The element here is air. This takes the human being even further back from our ordinary way of engaging with the world. Here what is needed is to quiet the imaginative activity in order to make space for the phenomenon to present itself.

This needs to be like air, not flowing through the forms like water, but making them visible. Using elemental language to describe these steps does not mean that we are looking for particular characteristics in a phenomenon. We are not looking for airy aspects of the phenomenon; instead what is required is a shift into an airiness in one's consciousness. Bockemühl describes the way the observer must be:

> It is characteristic of air to expand in all directions, offering its own being and activity in order that the being and activity of another can appear. Insofar as we move inwardly in accordance with this image of air, we reach the cognitional attitude corresponding to the air element. An inner readiness is thus created for that which manifests in the world to reveal itself in us, as an image which discloses a being. (Bockemühl 1985: 26)

It is the human faculty of inspiration that now offers itself to the phenomenon. Through stillness, the phenomenon can present its real self, and this is often felt as a particular gesture, a gesture that somehow speaks or presents that phenomenon. The insights that arrive in this third step can seem strange to any normal ways of thinking. It can be exciting or emotionally moving, and because what arrives seems foreign to oneself, it enhances the sense that it is given. It should feel like something received rather than made. These received indications can be captured and explored in some form of artistic representation where gesture and meaning are brought out and the inner mood is expressed.

Guidelines for carrying out seeing-in-beholding

Try to adopt a state similar to some meditative practices where your habitual self is quieted and you just are the contemplation of your plant. For this inspirational step don't be concerned about expressing what is given in emotional language, this is just how it often comes. Emotional language might seem paradoxical as this step is far from normal, self-absorbed emotional subjectivity. Working artistically with colour can help to deepen the indications that arrive. For example, aim for the mood colour of the plant, which might be very different from its physical colour. What should be expressed is the gesture of the phenomenon, something that points to its essential nature. Again, do not worry about any lack of

familiarity with, for example, writing poetically or painting, it is the process of attempting that is important.

Make sure you have captured any insights into the gesture of your phenomenon. This can be hard to record in language or image, but try to get something down. The process of writing, painting, moving or singing etc. is not just the representation of the insight, the activity itself helps you to live into the insight and to feel it more deeply. In your sketch book you should have attempts at capturing the atmosphere/mood and gesture of the plant. You might just have a list of words, try for a freely rendered haiku from those words as a way of really honing down and capturing the gesture of the plant.

Step one gave us the solid facts that anchored our imagination to the phenomenon and allowed us, in step two, to enter into the livingness of the phenomenon, which in turn gave us enough familiarity with it to see through to and express its inner/fundamental gesture. This gesture of the whole can push us into the fourth step of being-one-with the object (Goethe, 1995: 75).

Step Four: Being One with the Object

The first three steps of the Goethean method involve different activities and ways of thinking, and these could be characterised as first using *perception* to see the form; second, using *imagination* to perceive its mutability and, third, inviting *inspiration* to reveal the gesture. The fourth step uses *intuition* to both combine and go beyond the previous steps. Here we experience the 'what it is' of the phenomenon in its full power and potentiality. It is here that the phenomenon can be understood, and it presents itself to the human being as an idea or even a theory. Thus, in the Goethean process, we do not start with theory and overwrite the phenomenon with our own thinking, instead we place our human thinking and theorising capacities at the service of the phenomenon.

In terms of the elements, the shift in consciousness we now need is to fire. This fourth step is also the most physically abstract, having the least connection to the outer appearance of the phenomenon. However, that abstraction from the specific allows the perception of what is essential to the inner nature of the thing. Bockemühl calls this an experience of the 'being's beingness'. He expresses the fire step thus:

> We are here at the limit of what can be called a mode of observation. The warmth enters us – our inner activity itself becomes an organ. We do not experience the outer expression of a being, we become aware of its inner impulse. At these moments of inner identity, all outer manifestations disappear. They are 'burned up'. (Bockemühl 1985: 30)

Fire or warmth is also suggestive of another feature of this step: the connection to the inner impulse of the thing comes about through our own inner impulse to act. At this point, we are prompted to action, not only in the sense of wanting to express something of the being, as in the third step, but to *do something about it*. We feel 'fired up'. Because of the journey that precedes it, this is not a subjective expression of one's own personal will. The intention is to combine the being of the phenomenon with the human ability to both think and to act in the world.

In teaching this method with groups, particularly with regard to landscape, it is interesting to note the difference between a first impression impulse to do something – make a change, clear an area, develop a path – and an impulse that arrives out of combining one's thinking with the phenomenon. Clearing the workspace and the four steps are intended to bring us to a point of understanding and collaboration with the phenomenon. Now we are in a position to move forward, to act collaboratively out of that relationship.

Guidelines for carrying out being-one-with the object

How you work to bring about this is step harder to explain, in my experience it just arrives suddenly when working in step three. It is as if from the acquiescent air process, where our usual thinking is held back, concept or idea or determination suddenly arrives, but with a strange clarity, a kind of shininess, that is unlike one's normal thought processes or perceptions. As a process I suggest continuing with the activities of the third step but with even less self-intention. Free yourself from having to express the gesture and just wait for an intuitive impulse – a thought and its attendant action. This will most likely come when you give up. It feels even more distanced from your normal self and something of a shock – an intuition can feel like a thought or concept without the thinking of it. Write it down as best you can and just live with it soulfully before trying to analyse what it means.

Summary of the method

The steps with their indicative elements and human faculties emphasised can be summarised in Table (?) for ease of reference.

Table 20.1 The Four Steps of the Goethean Approach and Related Human Faculties and Elements

Steps	Human Faculty	Elemental Feel

1	Exact sense perception	Perception	Earth – solidity
2	Exact sensorial imagination	Imagination	Water – flowing
3	Seeing in beholding	Inspiration	Air – surrounding but ephemeral
4	Being one with the object	Intuition	Fire – fast, concentrated

Once you are familiar with the shifts in consciousness of these four steps by experiencing them through a journey or two with something from the plant realm, it is possible to branch out to other realms and take a phenomenon such as a rock, or an animal. This approach is particularly helpful when considering actions involving whole landscapes, for example, in agroecology, conservation, restoration or rewilding. Within a Goethean process, if you want to make changes to landscapes, social spaces, or green spaces etc. inspired by insights from the fourth step, you need to move forward into a new set of phases that mirror the previous steps (3, 2 and 1). This is about testing out and double-checking a planned action before landing it (earthing it) in the world. A useful discussion of these mirrored steps with practical examples can be seen in Christopher Day's 2003 book *Consensus Design: Socially Inclusive Process*.

Conclusion

In this chapter we have seen that Goethe was creating a different approach to science. One where we can approach nature with an objective subjectivity that also becomes a kind of practical reverence. Historically speaking, this is important as it avoided the errors of two conflicting approaches that were informing the science of his time: vitalism and the mechanistic approach. For Goethe, vitalism gave away the self-generative power of organisms and of nature herself to a vague mystical idea of some free-floating force; it was thus a kind of obfuscating mystery mongering. Whereas, for him the mechanistic approach ignored the complexity of the intertwined relationships in nature and denied the generative power of organisms in their full majesty. Science, as it developed from the eighteenth and into the nineteenth centuries, rejected vitalism and fully embraced mechanism. This ignored the possibility that other options were available.

To address the problems we face in the twenty-first century, we need a way of working with nature, one that does not destroy it or replace it with some limited imaginings. Goethe's approach provides a means to begin the process of undoing our habitual dualistic patterns of thought. It nourishes new

organs of perception that are receptive to, and respectful of, nature so that we might begin to glimpse what nature really is, what place we have within it and how we may collaborate or co-evolve with it. For example, imagine how such an approach might impact on preservation, conservation, agroecology or teaching the ecology related disciplines?

As the presentation of the steps and whole process of the Goethean method above has shown, the roles of imagination, inspiration and intuition involve both a personal engagement and a transformation of our thinking and our being. This heartfelt engagement means that in our humanity we cannot conceptualize nature as simply a resource for ourselves but nor can we absent ourselves from nature, as if we are only a problem. Through this method we can become alive to the way nature herself seems to be teaching the means to and inviting collaboration.

References

Amrine, Frederick, Zucker, Francis, and Wheeler, Harvey. Eds. 1987. *Goethe and the Sciences: a reappraisal*. Dordrecht: D. Reidel Publishing Co.

Arber, Agnes. 1950. *The Natural History of Plant Form.* Cambridge: Cambridge University Press.

Arber, Agnes. 1954. *The Eye and the Mind*. Cambridge: Cambridge University Press.

Bockemühl, Jochen. 1985. 'Elements and Ethers: modes of observing the world' in *Towards a Phenomenology of the Etheric World.* Ed Jochen Bockemühl, 1-67. New York: Anthroposophic Press Inc.

Brook, Isis. 1998. 'Goethean Science as a Way to Read Landscape'. *Landscape Research* 23:1, 51-69.

Colquhoun, Margaret and Ewald, Axel. 1996. *New Eyes for Plants.* Edinburgh: Hawthorn Press.

Davidson, Marc. 2014. 'Rights to Ecosystem Services'. *Environmental Values* 23(4) 465-483.

Day, Christopher. 2003. *Consensus Design: socially inclusive process*. Oxford: Architectural Press.

Deliège, Glen and Neuteleers, Stun. 2015. Should Biodiversity be Useful? Scope and Limits of Ecosystem Services as an Argument for Biodiversity Conservation. *Environmental Values* 24 (2) 165-182.

Douglas-Klotz, Neil. 2005. *The Sufi Book of Life.* London: Penguin Compass.

Fink, Karl. 1991. *Goethe's History of Science.* Cambridge: Cambridge University Press.

Goethe, Johann Wolfgang von cited in Heinemann, F. 1934. 'Goethe's Phenomenological Method'. *Philosophy,* 9(33): 67-81.

Goethe, Johann Wolfgang von. 1989. *Goethe: Italian Journey.* Eds T. Saine, and J. Sammons. Trans. R. Heitner, New York: Suhrkamp Publishers.

Goethe, Johann Wolfgang von. 1995. *Goethe: Scientific studies* Ed. and Trans. D. Miller. New York: Suhrkamp Publishers.

Gómez-Baggethun, Erik and Ruiz-Pérez. 2011. Economic Valuation and the Commodification of Ecosystem Services. *Progress in Physical Geography* 35(5) 613-628.

Gray, Ronald. 1952 *Goethe the Alchemist: A study of alchemical symbolism in Goethe's literary and scientific works.* Cambridge: Cambridge University Press.

Hoffmann, Nigel. 2007. *Goethe's Science of Living Form.* New York: Adonis Press.

Holdrege, Craig. 2005. Doing Goethean Science. *Janus Head* 8:1

Holdrege, Craig. 2013. *Thinking Like a Plant: a living science for life.* Great Barrington, MA: Lindisfarne Books.

Jensen, A. 2019. Johann Wolfgang von Goethe. *Internet Encyclopaedia of Philosophy* https://www.iep.utm.edu/goethe/#H4 accessed September 5th 2022.

Magee, Judith 2007. 'Alexander von Humboldt: a vision of the unity of nature' in R. Huxley Ed. *The Great Naturalists.* 224-232. London: Thames and Hudson.

Merchant, Carolyn. 1980. *The Death of Nature: women, ecology and the scientific revolution.* New York: Harper and Row.

Nisbet, H.B. 1972. *Goethe and the Scientific Tradition.* London: Institute of Germanic Studies.

Rutishauser, Rolf and Isler, Brigitte. 2001. 'Developmental genetics and morphological evolution of flowering plants especially bladderworts (*Utricularia)*: fuzzy Arberian morphology complements classical morphology'. *Annals of Botany* 88: 1173-1202.

Seamon, David and Zajonc, Arthur. 1998. *Goethe's Way of Science: a phenomenology of nature.* New York: SUNY Press.

Sepper, Dennis. 1988. *Goethe Contra Newton.* Cambridge: Cambridge University Press.

Sheldrake, Rupert. 1990. *The Rebirth of Nature.* London: Century.

Steiner, Rudolf. 1978. *A Theory of Knowledge: Implicit in Goethe's world conception.* Trans. O. Wannamaker. New York: The Anthroposophic Press.

Steiner, Rudolf. 1985. *Goethe's World View.* Trans. W. Linderman. New York: Mercury Press.

Stephenson, R.H. 1995. *Goethe's Conception of Knowledge and Science.* Edinburgh: Edinburgh University Press.

Tantillo, Astrida. 2002. *The Will to Create: Goethe's philosophy of nature.* Pittsburgh: University of Pittsburgh Press.

Washington, Haydn. 2020. Ecosystem Services -A Key Step Forward or Anthropocentrism's 'Trojan Horse' in Conservation? 73-88. In H. Kopina and H. Washington Eds *Conservation: integrating social and ecological justice.* Cham: Springer.