

The Constitution of Objects by Systems

Aristotle claims that "the question which was raised of old and is raised now and always, and always the subject of doubt, viz. what being *is*, is just the question: what is *substance*." (Aristotle, *Metaphysics*, book Zeta, I 1028b)

I understand Substance (*substantia*) to be that which is in itself and is conceived through itself: I mean that, the conception of which does not depend on the conception of another thing from which it must be formed." (Spinoza, *Ethics*, First Part, Definition III)

Introduction

Aristotle got it wrong, imho. He thinks of substances as self-contained, as having within themselves the wherewithall to be what they are. I will argue that this is incorrect.

The notion of substance that I want to reject is the idea that there are self-sufficient things-in-themselves that are what they are in their own right. An oak tree gets its oakness, and its treeness from within itself, as it were. Nothing more is needed for it to be what it is.

Whether historically Aristotle held this view or not is not my concern at the moment. I'll leave that to people who are better historians than me. My aim is to overthrow this notion whoever held it. I'm going to argue that substances need something else besides themselves to be what they are. What is this extra?

I will start historically with the claim that the extra is subjectivity, using Husserl as the proponent of this view. I will look at Foucault for an alternative to subjectivism. Then I will leave history behind and move to the philosophical position that biological organisms and complex systems offer us alternative answers to the "what more" question.

Part A: History

1 Husserl: Subjectivity

Husserl holds that we should start with what we are given. We are conscious of objects. Let us just describe these objects and this consciousness. We describe them only in so far as they are experienced. We cannot of course step out of consciousness to investigate them as they are in-themselves. We can describe only how things are for us. Husserl maintained that all objects were given to consciousness in so far as they have a sense (*Sinn*), a meaning for consciousness. The project of his phenomenology is to describe these senses as they are given to us. We find that objects come in "regions": there are tables and chairs; numbers and geometric figures; social institutions; emotional states; art objects; organic bodies; objects of physics; and so on. More precisely, as a science, phenomenology describes the "essence" of each given phenomenon, that without which it would be a different kind of object than it is. For example, it is part of the essence of visual objects (such as a desk) that they be given perspectively: that we can only perceive one side of a thing at a

time is part of the essence of any object in the "region" of visual things. If I walked around the other side and found nothing, it would not have been an object, but an illusion. In contrast, numbers, such as 7, are not given one side at a time; the essence that characterizes all objects given in the region we call numbers excludes the possibility of one-sided presentation. There are many regions of being, each having its own regional essence. The project of phenomenology is to discover and describe these essences as given to consciousness.

Since for Husserl all objects are unities of meaning, they must be for-a-subject. The notion of a meaning-in-itself is, he says, a countersense -- nonsense¹. This relationship, however, cannot be passive: what something means for me is the meaning *I* give it. More precisely, he wants to distinguish a subject's active meaning-giving from the more passive experiencing of the object meant. The act of giving meaning he refers to as "constitution"; the use of that meaning in experience is just "empirical." This is a crucial distinction for him.² Establishing the meanings that define the region of visual objects is a quite different activity than perceiving that this lectern is brown. The former is constitution; the latter is just the perception of an empirical fact. Subjectivity then comes in two kinds: In so far as am experiencing the lectern, I am an *empirical* subject. In my functional role of giving meaning to the lectern (and the whole visual region) I am a *constituting* subject. Note that I couldn't even be mistaken and think that the lectern is red except against the horizon of the already constituted region of visual objects.

Another way of putting this is to say that truth is not the primary focus of Husserl. His concern is to account for the status of the objects that truth (or falsity) are about. That is, to account for objectivity. That one region of being is experienced as matter in motion is a constitution issue; whether an asteroid hits the earth or not is an empirical one. The essence of visual objects does not determine whether there is a lectern here now or not. Phenomenology describes the horizon within which lecterns and such are meaningful, that is, experienceable in the first place. Without that, the claim that there is a lectern here would be neither true nor false; it would be meaningless. Prior to the question of truth (Do bees drink nectar? Did gravity cause an asteroid to hit the earth, and so on) is the question of the horizon of these objects, an account of what unifies each entity in the region as a single object, of what kinds of questions are appropriate about it, of how such questions might be answered. This is the issue of constitution: there must be something that truth (or falsity) is about. It is constitution, as meaning-giving, that accounts in the first place for there being objects about which claims could be true or false.

Husserl is no Kantian, nevertheless his position accords with Kant's on one crucial point: Objects are not in-themselves. For Kant, it is only in so far as they are categorized that objects can be experienced. Only against the background of a constituted region can individual objects be what they are, says Husserl. The "something more" beyond themselves that objects need -- constitution -- is a function of subjectivity.

In his more mature philosophy Husserl, comes to hold that, since scientific objects are for others besides myself, the giving of meaning is a cooperative, communal process, what he calls "Intersubjectivity." In one of his last works, he describes the constitution of the science of geometry -- the regional essence of geometric objects -- as a kind of historical transition from ancient Egyptian engineering to Euclidean concepts and language. That is, regional essences are constituted (given meaning) by means of the communal and linguistic interaction of historical subjects.³ It is this spontaneous, historical creativity that underlies the multiplicity of (regional) realities.

Husserl describes himself as an Idealist -- all reality is for a subject. Yet he insists that his is not a psychological or Berkeleyan idealist⁴; the subject on which objects depend is not an empirical subject, but a constituting subject, ultimately, as we've seen, an historical, communal, intersubjective process. Nevertheless, his answer to our question of what more is needed for there to be objects is something subject-like.

2 Foucault: Socializing constitution

Subjectivity, or at least its exclusive right to constitution, is challenged by many philosophers (Wittgenstein, Brandom, Merleau-Ponty, Derrida and countless others.) Indeed one could argue that Husserl himself, by the end of his career, comes to privilege history and language and that "intersubjectivity" is but a placeholder for these. But I'm going to pick Foucault as representative of the pack.

Foucault rails against phenomenology. He rejects the phenomenological approach on the grounds that it give "absolute priority to the observing subject." "It seems to me that the historical analysis of scientific discourse should, in the last analysis, be subject, not to a theory of the knowing subject, but rather to a theory of discursive practice."⁵

My aim was to analyze this history, in the discontinuity that no teleology would reduce in advance; to map it in a dispersion that no pre-established horizon would embrace; to allow it to be deployed in an anonymity on which no transcendental constitution would impose the form of the subject; to open it up to a temporality that would not promise the return of any dawn. My aim was to cleanse it of all transcendental narcissism; it had to be freed from that circle of the lost origin, and rediscovered where it was imprisoned; it had to be shown that the history of thought could not have this role of revealing the transcendental moment that rational mechanics has not possessed since Kant, mathematical idealities since Husserl, and the meanings of the perceived world since Merleau-Ponty -- despite the efforts that had been made to find it here.⁶

For Foucault, objects do not depend on subjectivity. He turns rather to historical "discursive formations"⁷ (practices or epistemes) as "the conditions necessary for the appearance of an object of discourse."⁸ A discursive practice -- a "science" -- is a system of concepts, methods (strategies), authorities (subjectivities, enunciative modalities) and objects. His detailed historical investigations include the rise of scientific medicine, madness, biology, economics, criminology, etc. In each case, he traces in exquisite detail how the type of reality being investigated -- the object -- is correlated with a set of concepts, methods and "subjectivities." Each discursive practice is an historical contingent development based on relations that "are established between institutions, economic and social processes, behavioural patterns, systems of norms, techniques, types of classification, modes of characterization;"⁹ While subjects are included among the conditions necessary for the objects, they are not sovereign or constitutive subject. Indeed the subjects themselves are but one element within the discursive formation. Just as objects are not in-themselves for Husserl, so for Foucault, subjects lose their foundational, "in-themselves"-like character.

For example, Scientific Medicine as it develops in the 19th century formed a discursive practice in which diseases (the objects) were categorized by concepts such as infection or heredity and in which various clinic and laboratory methods gave us access to such objects. The knowers, the subjects of medical knowledge, were the medical authorities -- the doctors and researchers. They were the ones who, applying medical methods and wielding medical concepts could claim the right, and had the power, to assert truths about the objects, the diseases. But the fact that doctors were the knowers was not due to some status as sovereign, constitutive subjects: their authority, their capacity to know truths, was itself due to the discursive practice that developed during this century. Of course, these subjects of medical knowledge are not conscious of the discursive formations that constitute them (unless they've read Foucault!) Foucault's point is that they are constituted by practices, not by subjective consciousness.¹⁰

Foucault says, "... it seemed to me that, for the moment, the essential task was to free the history of thought from its subjection to transcendence."¹¹ What could he mean by that? Traditionally the process that unifies and categorizes phenomena is not itself in the world as categorized. In Kant, for instance, the categorizing of the objects of physics is not itself a physical process governed by the laws of physics. Categorizing "transcends" the phenomenal world. While Husserl's doctrine of intersubjectivity already suggests that constitution is historical and linguistic, he equivocates by claiming the history he's referring to is a special, constitutive "internal history" (see note #3). Foucault jumps in with both feet and insists that the history that categorizes and that constitutes meanings is real history in space and time, in language and culture. The study of the history of these constitutive practices is what Foucault (borrowing a label from Husserl) calls "Archaeology" (of knowledge). It is empirical, social forces that create meaning, not some airy-fairy constitutive Transcendental Subject that itself stands outside the world. That's what Foucault means by freedom from transcendence.

Let me re-emphasize -- this is important for the rest of my paper -- that Foucault has stripped from consciousness the power to constitute objects. Medical consciousness, I mean the consciousness of individuals in the medical profession, no longer explains the constitution of objects. It is practices that account for both objects and the consciousness of these objects.

Foucault accomplishes four things: He dethrones the subject that had reigned supreme since Descartes; he assigns the constitution of objects, of realities, to a social dynamic; he makes the conditions for the possibility of objects historically contingent rather than eternally necessary; and he embeds objects within a systemic context greater than themselves.

Foucault (and others) has clearly socialized constitution. Some might describe his position as the "naturalizing of constitution", but much depends on what one means by "nature." In the second half of this paper, I want to argue that Foucault didn't go far enough. The next step in this direction is the claim that there is something analogous to social constitution in biological nature. Here too, I want to argue, it is the context of a system that constitutes objects.

Part B: Philosophy

1 Simple adaptation

So let me leave history behind and move on to philosophy and biology. Let me start with a concrete example that has inspired me for many years. The perceptual system of bees has ultra-violet detectors. They use these detectors to track down ultra-violet-coloured flowers for their nectar.¹² Bees pick out ultra-violet-coloured flowers as a class and respond in a similar way to all of them -- by flying to them and sucking their nectar. As [Uexküll](#) and Merleau-Ponty would put it, ultra-violet-coloured flowers are objects in the bee's *Umwelt*, in their "surrounding world." For the bees, these flowers have a standard role in their lives, a common "significance". While bees are not conscious, in their practice they effectively categorize the flowers into one class. This is not of course the same kind of meaning-giving that Husserl discusses; still, the relationship is analogous. Nor is it likely that flowers fall under the regional essence of perspectival objects that Husserl describes in human experience. Nevertheless, the flowers have a kind of practical (*Zuhanden*) unity and form a class with a kind of essence. That is, the species-history of bees has constituted a world for individual bees, a world whose categories allow flowers to be as objects. The closest analogy is to Foucault's discursive social practices (also not conscious), although the bees' practice is not linguistic or discursive, nor is it social in Foucault's sense of human sociality.

The bees, of course, have no transcendence; they are the same kind of reality as their flowers. But that should not prevent us thinking of them as constituters, as giving meaning to their environment. Post-Foucault, the constitution of objects no longer needs consciousness or transcendence.

From one perspective (that of the bees!), we can offer a simple, indeed simplistic, adaptationist explanation: given the presence of ultra-violet-coloured flowers in their environment, bees with better ultra-violet-detectors have a selective advantage. They can gather more nectar and so reproduce better than other bees. Over a period of generations most surviving bees will be the ones with better ultra-violet detectors. Since it is bees equipped with these detectors that categorize the flowers, we have a naturalistic evolutionary account of this constitution. This gives us a kind of object-formation based on biological evolution and takes us beyond Foucault social, human-centred constitution.¹³

2 Co-evolution

But there is another perspective on the situation: the flowers'. To reproduce, flowers need insects to pollinate them and, in an environment with ultra-violet-perceiving bees, those flowers that have the best ultra-violet pigments have a selection advantage. Over time, more of the surviving flowers will have ultra-violet pigments. From this perspective, the flower is playing the role of constituter and categorizing the bee as an object in its environment.

Both of these alternative perspectives are based on a simplistic interpretation of evolution. A more sophisticated account -- "co-evolution" -- proposes that what evolves is not the bees or the flowers, but the interdependent system of their interaction. Ulanowicz labels the process "autocatalytic mutualism."¹⁴ This is perhaps the most appropriate term. Since the flowers also co-evolve with organisms in the soil that deliver nutrients to their roots and which in turn feed off decaying flowers in the soil, and since the bees have their own co-evolvers, what we have is a mutual relationship in which each component receives positive feedback from many other components.¹⁵ The simplistic explanation based on a dichotomy of adapting organism and its passive environment, of categorizer and categorized, is superseded by a wider interaction of equal components. It is not so much that organisms (or species) evolve: it is primarily the whole ecosystem that evolves and only secondarily the individual species.¹⁶

This analysis borrows a central concept from Foucault's approach: practice. It is the ensemble of practices within the system that makes the objects -- the ultra-violet flowers and the ultra-violet detecting bees -- what they are. While it is true that bees have perceptual organs, it is not their perceptions that account for the whatness of the flowers; it is the interactions of the system as a whole. This is not idealism: even if one were to attribute consciousness to the bees -- which I do not -- or think of them as subjects, they would still be no more the constituters of objects than the conscious, subjective doctors are in Foucault's account of medical practice. There is no transcendence here, as Foucault might put it; there is no reliance on consciousness or subjectivity to account for the origin of object unity. But nor is there any recourse to language or to (human) society: constitution has been naturalized in the biological sense of "nature."

According to this analysis, it remains the case that objects are not substances in Aristotle's sense of being self-subsistent. Flowers and bees depend for what they are on the wider system of which they are parts. Only within such a system are there "bees" or "ultra-violet-coloured flowers." They are constituted realities, not things-in-themselves. It is not that flowers are "for-bees" nor that bees are "for-flowers," rather both are "for-the-system." The system is the source of their unity, of their being, and of their being-such. The system as a whole is the condition for the possibility of bees and of flowers.

Note that this kind of naturalization is non-reductionistic. The components of the system interact not because of their mechanistic properties, but because of their role in the system. Different flowers use different pigments for their ultra-violet colour, that is, pigments governed by different chemical and physical laws. But this is irrelevant for understanding which objects the system constitutes. Similarly, which physical processes are involved in the bees' capacity to detect ultra-violet light makes no difference to our account. The organic system has a formative role in which the parts interdefine each other with a certain independence from the physical laws that may subvene.

Interestingly, Kant partly anticipated this point centuries ago:

An organized being is, therefore, not a mere machine. For a machine has solely *motive* power, whereas an organized being possesses inherent *formative* power, and such, moreover, as it can impart to material devoid of it -- material which it organizes. This, therefore, is a self-propagating formative power, which cannot be explained by the capacity of movement alone, that is to say, by mechanism.¹⁷

It is no doubt the case that in an animal body, for example, many parts might be explained as accretions on simple mechanical laws (as skin, bone, hair). Yet the cause that accumulates the appropriate material, modifies and fashions it, and deposits it in its proper place, must always be judged teleologically. Hence, everything in the body must be regarded as organized, and everything, also, in a certain relation to the thing is itself in turn an organ.¹⁸

3 Complex systems

But I want to go further. The biological, autocatalytic system is just one kind of "Complex System." Contemporary Complex Systems Analysis studies many different kinds of systems that involve self-organizing, emergent patterns. Even when they are non-biological, they have, in Kant's terms, "a self-propagating formative power." Can my naturalizing of the constitution of objects be taken one step further?¹⁹

First I need to explain what a complex system is. Complexity is not the same as being complicated. "Complexity" is a technical term, a term of art. "A complex system is a system composed of interconnected parts that as a whole exhibit one

or more properties (behavior among the possible properties) not obvious from the properties of the individual parts."²⁰ To qualify for complexity analysis, a phenomenon must form a whole that goes beyond its component parts and generates emergent entities with properties that are difficult or impossible to explain by investigating the behaviour of the parts. Often the component processes themselves can only be understood by reference to the emergent structure.

Some examples may help to make the notion clear.

- [Sand dunes](#) etc.
 - In each of these cases there is a clear pattern but it is difficult or impossible to predict it on the basis of the components.
- [Fractals](#)
- [Swarming](#)
 - Swarm intelligence is the collective behaviour of decentralized, self-organized systems, natural or artificial. ... Swarm intelligence systems are typically made up of a population of simple agents or boids interacting locally with one another and with their environment. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the emergence of intelligent global behaviour, unknown to the individual agents. ([Wikipedia Swarm Intelligence](#))
 - Note that similar patterns are generated whether we are dealing with birds, fish, insects or artificial computer "agents" -- boids
 - [Bats swarming](#):
 - computer elements swarming ([YouTube](#))
 - Fish shoaling
- Bénard cells
 - If we put a pot of water on the stove and heat it, molecules at the bottom of the pot carry energy to the surface then, to make room for others, they must return to the bottom. I would have expected the molecules to move in a more or less random, unpredictable fashion. Surprisingly, they self-organize into well-patterned up-down columns. Trillions of molecules spontaneously agree to cooperate in an efficient structure for transferring the energy.
 - [Bénard cells](#) (Wikipedia)
- Hurricane
 - [Tropical Cyclone](#) (wikipedia)
 - Hurricanes are formed by the interaction of many variables: geography, winds, humidity, air temperature gradients, ocean currents and surface temperatures, the rotation of the earth. These are not independent variables. The temperature gradient depends on the winds which depend on the temperatures; the humidity depends on the winds which depend on the temperature which depends on the winds. The hurricane as an enduring entity is sustained by its component processes which themselves are generated by the hurricane. (Kant's circular causality.)

Complex systems have an internal dynamism to them, an ability to sustain themselves and act as patterned wholes. Many of the complex systems referred to in the literature are biological one. I have deliberately chosen some non-biological ones to explore the possibility that even in physical systems we could assimilate their relationship to their parts to the constitutive structures we've seen in organisms and in Foucault's discursive formations. Many seem to think that organisms themselves are special, but highly developed, complex systems. If so, then organisms are not analogous to complex systems; they are just one kind of complex systems.²¹

Complex systems are, more or less by definition, wholes that cannot be adequately understood by reference to their parts. Rather, the parts are what they are because of the system. Winds, temperatures, and humidity gradients can be explained only by reference to the hurricane itself. What exactly is this relationship? Some call it "downward causation:" It is the hurricane as a whole that by downward causation causes the parts, for instance, the winds. I think this is an unhappy way to put it. The ultra-violet pigment in a particular flower might be said to cause this bee to approach it, but it is stretching the concept of cause beyond reason to say that the bee-flower system causes the flower to have ultra-violet pigment -- or causes anything, for that matter. The cause of this flower having the pigment is its genetic structure which itself is caused by its ancestors and the contingent events that happened in their evolutionary history. The role of the system is to structure such chains of causes. (One could think of this as an Aristotelian Formal cause rather than an Efficient cause.) A system is not itself the kind of entity that could act causally on its component objects.

The relationship of a system to the objects within it is better conceptualized as constitution. To enter into a causal relationship, an object must already be the kind of object it is. This is the job of the system: to unify ultra-violet flowers under the one concept so that each can be a cause. The system constitutes the objects, embeds them in a network of causal relationships and so authorizes causal explanations between the constituted objects. Systems are constitutive; causes are empirical.

The discovery of self-organizing complex systems suggests that to be ordered, the world does not need to rely on subjects, constitutive or empirical, nor on discursive practices, not even on biological adaptive practices. Complex systems emerge and generate within them the unities we call objects.

Conclusion

Challenging Aristotle's claim that substances are self-sufficient, I have examined their insufficiency. What more is needed for there to be substances? My trajectory starts with the Idealist claim that the "what more" is subjectivity. Already we step back from this position when we distinguish, with Husserl, a special kind of constituting subject that is not simply "empirical." The move to Intersubjectivity takes us one step further towards desubjectivizing the process of constitution. With Foucault, we drop the monopoly that subjectivity held in constitution, but continue to understand the formation of objects as embedded in human, social practice. This is one step in naturalizing constitution. The next is to step back not just from subjects, but from human-centredness and realize that something like practice can constitute objects even in the sphere of biology. The categorizing of the world was already occurring without us. Finally, I have speculated about the possibility that the constitution of objects occurs even in physical systems. Of course, if by "physics" one means 17th century causal mechanism this can't work. But the development first of evolutionary theory and then of the concept of complex systems frees us from the ideology of reductive mechanism and opens the possibility that even non-biological systems can constitute objects.

Objects are not self-subsisting substances that exist in-themselves; they can be what they are only within systems. Substance is not the primary sense of being: system is.

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Endnotes

- 1 “To take them [realities of every kind and level] as existing in the absolute sense is consequently a countersense. ... *all real unities are 'unities of sense.'* Unities of sense presuppose ... a *sense-bestowing* consciousness. ... An absolute reality is just as valid as a round square.” (Husserl, Edmund, *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy, First Book*, The Hague: Martinus Nijhoff, 1982. 128-129.)
- 2 The greatest problems of all are the functional problems, or those of the “constitution of consciousness-objectivities.” These problems concern the way in which noeses, e.g., with respect to Nature, by animating stuff and combining it into manifold-unitary continua and syntheses bring about consciousness of something such that the Objective unity of the objectivity allows of being harmoniously “made known,” “legitimated” and “rationally” determined.
... Consciousness is precisely consciousness “of” something; it is of its essence to bear in itself “sense,” so to speak, the quintessence of “soul,” “spirit,” “reason.”
... It is therefore a matter of inquiring, in the most comprehensive universality, into how Objective unities of any region and category are “constituted in the manner peculiar to consciousness.” It is a question of systematically showing how, by its essence, all the concatenations of actual and possible consciousness – precisely as eidetic possibilities – are predelineated...
(Husserl, Edmund, *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy, First Book*, The Hague: Martinus Nijhoff, 1982. 207-209.)
- 3 Husserl, however, hedges his bets on the kind of history involved. He writes of an “internal history” and “the universal historical a priori.” It is more like what Aquilar calls a ‘philosophical’ history than a narrative of empirical facts. See Husserl, Edmund, *The Crisis of European Sciences and Transcendental Phenomenology*, Evanston: Northwestern University Press 1970. 378.
- 4 “If anyone reading our statements objects that they mean changing all the world into a subjective illusion and committing oneself to a ‘Berkeleyan idealism,’ we can only answer that he has not seized upon the sense of those statements.” (Husserl, Edmund, *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy, First Book*, The Hague: Martinus Nijhoff, 1982. 129.)
- 5 Michel Foucault, *The Order of Things: An archaeology of the human sciences*, London: Tavistock, 1970. xiv
- 6 Michel Foucault, *The Archaeology of Knowledge*, London: Harper Colophon, 1976. 203 paper (223-224 digital).
- 7 Michel Foucault, *The Archaeology of Knowledge*, London: Harper Colophon, 1976. 38
- 8 1. The conditions necessary for the appearance of an object of discourse, the historical conditions required if one is to ‘say anything’ about it, and if several people are to say different things about it, the conditions necessary if it is to exist in relation to other objects, if it is to establish with them relations of resemblance, proximity, distance, difference, transformation — as we can see, these conditions are many and imposing. Which means that one cannot speak of anything at any time; it is not easy to say something new; it is not enough for us to open our eyes, to pay attention, or to be aware, for new objects suddenly to light up and emerge out of the ground. But this difficulty is not only a negative one; it must not be attached to some obstacle whose power appears to be, exclusively, to blind, to hinder, to prevent discovery, to conceal the purity of the evidence or the dumb obstinacy of the things themselves; the object does not await in limbo the order that will free it and enable it to become embodied in a visible and prolix objectivity; it does not pre-exist itself, held back by some obstacle at the first edges of light. It exists under the positive conditions of a complex group of relations.
2. These relations are established between institutions, economic and social processes, behavioural patterns, systems of norms, techniques, types of classification, modes of characterization; ... (Michel Foucault, *The Archaeology of Knowledge*, London: Harper Colophon, 1976. 44-45)
- 9 Michel Foucault, *The Archaeology of Knowledge*, London: Harper Colophon, 1976. 45
- 10 Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception*, London: Tavistock. 1973. passim.
- 11 Michel Foucault, *The Archaeology of Knowledge*, London: Harper Colophon, 1976. 203

Endnotes

- 12 Bee's-eye view: Wikipedia UV photo of flower with nectar.
http://en.wikipedia.org/wiki/File:Mimulus_nectar_guide_UV_VIS.jpg
- 13 Flowering plants first appear about 130 million years ago. Some explanation like this is the most likely, although the co-evolution of flower perfume and insect scent-detectors is also a likely factor. (Note that for humans, the category ultra-violet-coloured flowers makes no perceptual sense, since we have no ultra-violet detectors.)
- 14 Robert E. Ulanowicz, *A Third Window: Natural Life beyond Newton and Darwin*. Templeton Foundation Press, 2009. 76
- 15 Other useful illustrations of co-evolution are birds and pine cones (<http://evolution.berkeley.edu/evosite/evo101/IIIF1Casestudyofcoevo.shtml>), *Utricularia* and zooplankton (Ulanowicz 66), and malaria parasites and the immune system.
- 16 "Our study is consistent with the emerging theory that insect sensory biases have played a major role in driving reproductive adaptations in flowering plants," said Ramirez. "It highlights the ecological and evolutionary inter-dependence of flowering plants and their specialized pollinators, suggesting that new threats to insect pollinators may have profound effects on the ecosystems they inhabit." (<http://newscenter.berkeley.edu/2011/09/22/bees-outpace-orchids-in-evolution/>)
- 17 Immanuel Kant, *Critique of Judgement*, Oxford: Oxford University Press, 2007. 202 (5:374 para. 65) Available: <http://lib.myilibrary.com/ge2a-proxy.mun.ca/Open.aspx?id=114689>
- 18 Immanuel Kant, *Critique of Judgement*, Oxford: Oxford University Press, 2007. 205 (5:377 para. 66) Available: <http://lib.myilibrary.com/ge2a-proxy.mun.ca/Open.aspx?id=114689>
- 19 Ulanowicz writes of three "windows" onto nature: Newton's deterministic causal mechanism; Darwin's processes of adaptation; and autocatalytic complex systems. (Robert E. Ulanowicz, *A Third Window: Natural Life beyond Newton and Darwin*. Templeton Foundation Press, 2009. 39)
- 20 http://en.wikipedia.org/wiki/Complex_system (Accessed 2013-03-18)
- 21 Complex systems are not rare exceptions in a regular, Newtonian world. It is more likely that most events in nature are embedded in complex systems. Newtonian mechanics can explain only abstract events that are artificially restricted to cases of non-interacting variables, or laboratory experiments designed to prevent the interaction of variables. Think of frictionless planes, or Newton's First Law which postulates what would happen if there were a body with no forces acting on it.