



# Dialectical Methodology of the Praxis of Biology

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## Abstract

Zwart uses Hegel's dialectical method to develop a dialectical methodology for assessing biology as technoscience during the Anthropocene. In this paper I will evaluate this use of Hegelian dialectics in biology. I will first elaborate the meaning of Hegel's *method* of "Dialectics". This helps me to evaluate Zwart's dialectical scientific *methodology* from the perspective of Hegel's *method* of "Dialectics" and to evaluate Zwart's dialectical scientific *methodology* from the perspective of the praxis of biology. Finally, I will oppose Zwart's claim that the synthetic cell is an appropriate case study to demonstrate the relevance of dialectics for understanding contemporary biological research.

**Keywords** Ddialectical method · Biology · Hegel · Synthetic cell · Technoscience

## 1 Philosophical Starting Point

Science may be studied from several disciplinary backgrounds: history, philosophy, and social science. I totally agree with Zwart that to practice philosophy under current (anthropocenic) conditions, philosophers should know their proper place and position vis-à-vis other research fields. Studying science from a philosophical background is my philosophical starting point and I define it as the critical, systematic reflection on implicit and explicit assumptions about what we do. Like Zwart, I am in favour of an empirical way of doing philosophy in the life sciences. We do philosophy in the life sciences as embedded philosophers, discussing life sciences from within (Gremmen 2007). Starting from case material and concrete actual developments, philosophical concepts are used as flexible tools that can be adapted to specific contexts.

Zwart claims that he develops a dialectical methodology as a philosophical tool for assessing technoscience during the Anthropocene. This is a fairly general claim, but it isn't just a dialectical methodology, it is also a Hegelian one. Zwart uses the synthetic cell as a case study to demonstrate the relevance of dialectics for understanding contemporary

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research. He considers the synthetic cell project as a concrete exemplification of life under anthropogenic conditions. This leads to the following four questions:

1. What do we mean by Hegel's *method* of "Dialectics"?
2. Is dialectical scientific *methodology* adequate from the perspective of Hegel's *method* of "Dialectics"?
3. Is dialectical scientific *methodology* adequate from the perspective of the praxis of biology?
4. Is the synthetic cell an appropriate case study to demonstrate the relevance of dialectics for understanding contemporary biological research?

## 2 Hegel's Dialectical *method*

Zwart uses Hegel's dialectical method to develop a dialectical methodology for assessing technoscience during the Anthropocene. What do we mean by Hegel's *method* of "Dialectics"? Commentators unanimously describe it as a dynamical method that leads to a linear evolution or development from less sophisticated definitions or views to more sophisticated ones later (Maybee 2016). The source of this dynamics is a sort of contradictory process between three sides. These sides are moments of every logical concept. The first moment, understanding, is the moment of fixity, in which concepts or forms have a seemingly stable definition (Maybee 2016). The second moment, the *dialectical moment* or *negatively rational* moment, is the moment of instability. In this moment, a one-sidedness or restrictedness in the concept from the first moment becomes visible, and the concept that was stable in the first moment passes into its opposite (Maybee 2016). Hegel describes this process, from moment A to moment B, as a process of "self-sublation" (translation of *Selbst-aufhebung*). It has a double meaning: it means both to cancel (or negate) and to preserve at the same time. The first moment sublates *itself* because its one-sidedness destabilizes its definition and leads it to pass into its opposite in the second moment. The third moment, the "*speculative*" or "*positively rational*" moment, grasps the unity of the opposition between the definitions in the first- and the second moment. This dialectical process drives to the "Absolute": the final, and completely all-encompassing concept in the relevant subject matter under discussion (Maybee 2016).

Hegel's dialectical *method* is about the dynamics of concepts. The nature of the earlier determinations drives the movement to new determinations *by necessity*, and thus an inward process without the need for some new idea to show up from the outside. From a *methodological* point of view, applying this dialectical *method* to science is to show the dynamics of scientific concepts in three moments. This means that scientists have to:

- a. Describe the seemingly stable definition in the first moment;
- b. Describe the one-sidedness or restrictedness in the second moment;
- c. Grasp the unity of the opposition between the first two moments in the third moment.

In the next paragraph I will use these three steps to evaluate the adequacy of Zwart's dialectical scientific *methodology* from the perspective of Hegel's *method* of "Dialectics".

### 3 Dialectical Scientific Methodology

Zwart describes the concept of life in moment A as something universal, integral and whole. A seemingly stable definition or determination of the concept of life in moment A is absent. He only claims that life in moment A is understood and described in a general way, in universal terms. The content of the concept in moment A is missing. Also he doesn't describe a one-sidedness or restrictedness in the determination from the moment of understanding the concept of universal life. Later in his paper Zwart describes that in moment A natural entities appear "...as they present themselves to us, as natural *phenomena* observed by us, whose integrity is *respected* by us" (This is a *methodological* remark preparing us for what happens in moment B: "... in order to understand something, this entity must be dissected and taken apart. Pushed to its extreme, this means completely destroying it. Analysis (*Zerlegung* in German) is a negative and inherently violent endeavour." This means that also in moment B, where there is a focus on particular processes and components, there is no development of concepts, only the scientific step to analyse (take apart) the natural phenomena observed in moment B. Finally, according to Zwart in moment E the concrete synthetic cell represents the concrete realisation of the inevitable turn towards holism. He interprets this as a scientific step to reconstruct and re-converge. Like in the other two moments, there is no dialectical method of the development of concepts in moment E.

Zwart summarizes his dialectic methodology by the evolution of technoscience in general: "Dialectically speaking, this is how technoscience evolves as a praxis, involving a series of elucidating experiences: from respectful observation via disruptive analysis up to technoscientific individuation" This is a three-step dialectical *methodology* of science and not a dialectic *method* of concept development. However, Zwart equates his dialectical *methodology* in biology with the development of our idea of life: "These three moments (A > B > E) represent the dialectical unfolding, starting from life as something universal, integral and whole (A), via the focus on particular processes and components (B), until individuation is regained on a higher level of comprehension, but now in the form of something very concrete: a metabolic and self-replicating synthetic cell in a test-tube (E)" This means that the three steps of biological technoscience *are* the development from something universal, to processes and components, to something very concrete. Because Zwart doesn't use the dialectical *method* of the development of concepts, he only develops a dialectical scientific *methodology* which is only loosely connected to a dialectic method of conceptual development. In the next paragraph I will evaluate Zwart's dialectical scientific *methodology* from the perspective of the praxis of biology.

### 4 Three Dialectical Methodological Steps in the Praxis of Biology

The first step of Zwart's scientific *methodology* is respectful observation of natural phenomena as they appear to us. To illustrate this he uses the example of technoscience aiming to understand the functioning of a tree. "During the first moment ( $M_1$ ) we discern the tree as it presents itself to us, as a natural phenomenon: a *Gestalt* in a natural *Umwelt*, clad in natural daylight" Although I don't want to deny the possibility of trying to understand the tree as it presents itself to us, I wonder whether this is a *scientific* step. In my view Zwart's description of understanding the tree as it presents itself seems to belong to the field of phenomenology and not to biology. Is there a field in biology which studies life as

something universal? Or may we re-interpret Zwart's) first step as another way to describe the plausible claim that a scientific field often starts with a *theoretical* phase?

The second step is analytic and reductionist. In order to understand the tree, it must be dissected and taken apart. To study it, life first of all has to be negated in a laboratory setting. Zwart concludes that this negativity is an inherent feature of science. However, is scientific analysis always a negative and inherently violent endeavour? I think that the experimental work of Mendel shows that it is possible to focus on biological processes and components without taken the plants apart. From 1856 to 1863 he concentrated on pairs of observable characters, such as color and form of the peas, of *Pisum sativum* (the garden pea) (Hartl and Orel 1992). Mendel studied the statistical laws governing the pattern of their re-appearance in the off-spring. Using special techniques of artificial pollination Mendel found that when two plants were crossed, the ratio of characters in the resulting generations could be expected to have been 1:1. However, he discovered that one character (dominant) appeared three times as frequently as another (recessive) (Hartl and Orel 1992). Although Mendel worked in a garden laboratory, he didn't dissect or violate his plants. He respected his plants and took great care not to damage them. This means that the second step is *experimental* but not necessarily negative.

The third step is about the turn towards holism by taking the scientific step to reconstruct and re-converge. According to Zwart this negates the negativity of technoscience via a concrete countervailing intervention. In my view synthesis, as a holistic methodology, and analysis belong together. It is all a matter of level. For example, on the level of the genome the sequencing data allow biologists to synthesise these data into a map of the genome. To define holism as reconstruction and convergence leads to a bio-engineering approach to biology. In the next paragraph I will evaluate Zwart's claim that the synthetic cell is an appropriate case study to demonstrate the relevance of dialectics for understanding contemporary biological research.

## 5 From the Synthetic Cell to Systems Biology

Zwart uses the synthetic cell as a case study to demonstrate the relevance of dialectics for understanding contemporary research. He claims that after the past twelve decades of dissolving living cells into their basic molecular and informational components, now it is time for a holistic turn, putting all these components together again. According to Zwart the synthetic cell project represents the inevitable transition, already envisioned by Hegel, from chemistry (unsustainable processes) to biology (self-sustainable processes). In his view this summarises all partial scientific experiences since the onset of contemporary life sciences research around the year 1900. In my view this is not an adequate historical picture of biology. I will illustrate this by the field of origin-of-life research.

Darwin already suggested that life arose from a 'warm little pond'. This begged the question of where the building blocks for life would have come from (Hyman and Brangwynne 2012). In 1924 Oparin argued that conditions on early Earth nurtured the synthesis of amino acids and their assembly into protocells. Oparin's book *The Origin of Life* (1938) describes the Earth's early atmosphere as a strongly reducing environment, rich in methane, water and ammonia. He posited that, with time and a supply of energy such as lightning or geothermal activity, these simple components would form the complex building blocks of life. Oparin's work made it possible to study the abiotic synthesis of organic biomolecules under prebiotic conditions. In 1952 Miller and Harold Urey tested Oparin's hypothesis

by sending a continuous electric current through a glass vial containing water, hydrogen, methane and ammonia (Hyman and Brangwynne 2012). A substantial amount of the carbon had been converted into complex macromolecules, including many amino acids. This 'Miller–Urey' experiment not only confirmed the significance of Oparin's ideas, but transformed origins-of-life research from a largely *theoretical* to an *experimental* science and an explosion of data and ideas has blossomed in the decades that have followed (Hyman and Brangwynne 2012). The origin-of-life case also illustrates that scientists started this holistic field a long time before research on the synthetic cell. Also systems biology started much earlier as a *theoretical* field.

## 6 Conclusion

Around the turn of the 21th century, systems biology emerged. To facilitate many experimental biologists in this field, Yuri Lazebnik (2002) published a thought-provoking article about the importance of approaching complex biological circuits with an engineering perspective opposed to classical biological reductionism. He illustrated this by comparing the attempts of a biologist to repair a broken Russian transistor radio with the work of a trained electro-technical engineer. His suggestion was to develop a simple, quantitative language that experimental scientists could use to introduce themselves to formal descriptions of biological processes. Although such a language is still lacking, the switch from reductionist biology to bio-engineering seems to resonate positively with the ideas of Zwart

However, a closer look at the Lazebniks (2002) paper shows another picture. From his mentor he learned how his own field of apoptosis (a form of programmed cell death, or "cellular suicide") developed in four stages. At the first stage, a small number of scientists would somewhat leisurely discuss a problem that would appear esoteric to others. At this stage the understanding of the problem increases slowly, and scientists are generally nice to each other. Then, the second stage "...starts with an unexpected observation that makes many scientists realize that the previously mysterious process can be dissected with available tools. At once, the field is converted into a Klondike gold rush with all the characteristic dynamics, mentality, and morals. ... The resulting rapid expansion of the field increases the understanding of the biological process accordingly and results in a [third] phase of crystal clear models that often explain everything" (Lazebnik 2002: 179). This leads to the fourth stage at which models that seemed so complete, fall apart, and is characterized by a sense of frustration at the complexity of the process. The intensity of research remains unabated for a while, resulting in thousands of publications, many of which are contradictory or largely descriptive. "This [fourth] stage can be summarized by the paradox that the more facts we learn the less we understand the process we study" (Lazebnik 2002: 179).

In Zwart's paper I recognize more or less the first three stages in the development of a biological research field: a first *theoretical* stage, a second *experimental* stage and a third holistic stage. Instead of using the complex philosophy of Hegel to develop a scientific methodology, I propose to focus on the practice of science (Gremmen 2002). This offers the opportunity to address scientific concepts and compartment in specific sites and circumstances without attempting to address science as a vacuous generality relying on a "truly scientific" methodology (Galison 2008).

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