Towards a philosophical underpinning of the holistic concept of integrity of organisms within organic agriculture

E. Baars[1,*] and T. Baars[2]

[1] Louis Bolk Institute, Hoofdstraat 24, NL-3972 LA Driebergen, The Netherlands
[2] Department of Biodynamic Agriculture, University of Kassel, Witzenhausen, Germany
[*] Corresponding author (e-mail e.baars@louisbolk.nl)

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Abstract

The concept of naturalness can be used to characterize organic agriculture and to distinguish it from conventional agriculture, provided naturalness not only refers to the non-use of synthesized chemicals, but also to the ecological and systemic principles, and to a respect for the integrity of living organisms. Examples of the implicit use of the integrity concept in agriculture will be described to show its practical aspects and implications. The (non-atomistic) holistic concept of integrity of organisms has been the subject of severe scientific criticism – specially from in essence ontological reductionists. In their view, an organism is essentially no more than a complex set of atoms and molecules and its integrity a non-concept. In order to reach scientific acceptance of the integrity concept and to support its use in organic agricultural practice, it needs further underpinning. In this article, based on a critical analysis of (a) ontological and methodological aspects of reductionism, and (b) expert knowledge and the process of pattern recognition and application, the validity of the holistic concept of integrity will be explored.

Additional keywords: holism-reductionism debate, wholeness of organisms

Introduction

During the last decades it has become evident that the concept of naturalness can be used to characterize organic agriculture and to distinguish it from conventional agriculture, provided naturalness refers to (1) abstaining from the use of artificially synthesized chemicals, (2) adopting the ecological principles, and (3) respecting the integrity of living organisms as a holistic concept of thinking (e.g. Lammerts Van Bueren *et al.*, 2003; Verhoog *et al.*, 2003; Lammerts Van Bueren & Struik, 2005).

In this paper we focus on the holistic concept of the integrity of organisms. Starting at the beginning of the 1990s, the concept of integrity received increasing attention in bioethical literature. For example, in the biotechnology discussion the concept of 'genetic integrity' (Vorstenbosch, 1993) was used in connection with the genome of an individual animal. Lammerts Van Bueren *et al.* (2003) distinguished four levels of integrity in relation to plant breeding in organic farming: (1) integrity of life, (2) planttypic integrity, (3) genotypic integrity, and (4) phenotypic integrity. Similar kinds of levels were first developed in relation to the genetic engineering of animals. Expanding on the concept of ecosystem integrity, Thompson (1997) introduced the notion of functional integrity in the discussion on sustainability in livestock farming. We shall argue that, besides this explicit use of the concept of integrity, in agricultural practice there is also an implicit use of this concept.

In spite of this explicit and implicit use of the integrity concept, the concept of integrity has hardly been accepted in agricultural sciences. This is mainly due to the philosophical background of many scientists who are reductionists and therefore consider an organism in essence no more than a complex set of atoms and molecules. In their view, an organism is best studied in an experimental setting where man's purported subjectivity has been completely eliminated and where features of objects and (causal) relationships between the objects can be examined (Looijen, 1998). In this scientific approach there is no room for a holistic concept of integrity, a concept that refers to the existence of a real holistic being. The denial of the latter implies that organisms can be constructed in accordance with human desires and that there is no need for research methodologies at higher levels than the level of pure matter: mainly atoms and molecules.

In order to defend a holistic approach of integrity that not only is acceptable to agricultural practice but also to agricultural sciences, it is necessary to strengthen the philosophical basis of this new concept. This is done in this article by means of:
• a critical analysis of some ontological and methodological aspects of reductionism, and
• a reflection on the methodological role of expert knowledge expressed by practitioners.

The implicit use of the integrity concept in agricultural practice

In agricultural practice and in the way people treat domesticated and wild animals, the concept of integrity has already been used for many years, although often in an implicit rather than an explicit way. For example, animal breeder and geneticist Frederik Bakels integrated knowledge of the domestication process, the habits and living conditions of wild cows into his breeding goals and concepts. His central foci were the cow's needs as a ruminant and its perfect body shape based on wild cows rather than the cow as an efficient producer of proteins and fat (Bakels & Postler, 1986). Bakels' implicit awareness of animal integrity was transformed in his breeding concept based on 'longevity' and 'lifetime production'.

Animal ethologist Temple Grandin developed slaughter houses and improved walking ways for cattle, based on her empathic knowledge of and involvement with animal needs. In relation to her autistic personality, Grandin developed the ability to see the animal-specific fears during their walking into a new and strange environment and she was able to adapt this environment taking into account the animal's needs (Grandin & Johnson, 2005).

In the 1960s, animal ethologist Jane Goodall was criticized by the main-stream scientific community, because she gave names to the chimpanzees instead of 'objective' numbers. In those days animals were seen as unconscious machines. In her view, however, animals are sentient beings (Goodall & Bekoff, 2002). Her present work on chimpanzee protection and chimpanzee liberation is based on her empathic involvement with the animals in their natural environment. Her scientific methodologies have been adopted by animal ethologists observing other mammals (elephants, wolves, gorillas) (Turner & D'Silva, 2006). For other examples see Verhoog (2007) in this issue.

The concept of integrity is also important for answering ethical questions within organic agriculture, such as whether specific treatments of organisms are 'acceptable'. In (organic) agriculture, the acceptance of the concept of integrity has three major consequences. First, there are consequences for our *basic attitude* towards living organisms. Instead of treating an animal as if it were 'a piece of meat' or 'an efficient milk factory', we encounter a real and true 'being' with a specific nature. This refers to the natural living approach to animal welfare in organic agriculture (Wagenaar & Langhout, 2007). On the basis of the notion of animal sentience, we have to treat the animal in a respectful way (Turner & D'Silva, 2006).

Secondly, we should develop a *personal relationship* with this 'being', like we do in the encounter with fellow human beings, in order to develop an insight into its wholeness. Instead of creating the ultimate professional gap between subject and object in the search for measurable, objective knowledge of the parts and their relationships, we have to 'catch' its identity in the way it expresses itself in the organization of the parts in time (e.g. physiological processes) and place (e.g. morphological processes) (e.g. Schad, 1971; Bortoft, 1996). This is exactly what experienced practitioners implicitly do and what the research topic is in experiential science (Baars & Baars, 2007). Goethean phenomenological science as defined below is an exact and explicit methodology to acquire embedded insight into the observed. The method is currently used in several areas of agriculture, such as landscape development (Pedroli *et al.*, 2007), plant breeding and research into medicinal herbs. A third consequence directs our way of handling organisms to focus on the *creation of preconditions in such a manner that the being is able to express itself in an optimal way*.

An introduction to the holism–reductionism debate

In the foregoing we have explained that the holistic concept of integrity is an important concept in organic agriculture, either explicitly based on ethical reflection, or implicitly by experienced practitioners. But a better philosophical foundation is needed. For this we have to join the holism–reductionism debate. A negative way of defending holism is showing the shortcomings of reductionism. A positive way is to refer to the importance of pattern recognition in science, which is based on a holistic perception.

Definitions and historical development

Definitions

In the philosophy of science, reductionism is usually set against holism or organicism. The statement: '*An organism is essentially nothing but a complex set of atoms and molecules*' lies at the heart of reductionism. At the opposite side of the scale, statements such as '*You cannot just simply reduce an organism to a sack of molecules*' and '*The whole is greater than the sum of its composing parts*' essentially characterize holism (Looijen, 1998). The reductionist model argues that all traits and other characteristics demonstrated by living organisms – their morphology, physiology, behaviour and ecology – can ultimately be fully and exclusively explained in terms of the physical and chemical molecules (DNA, proteins, etc.) of which they are composed. Reductionism assumes that the laws, concepts and theories formulated for a higher level of organization in biology (for example the level of the organism) can be explained by theories developed for a lower level of organization, such as the level of organs, tissue and cells. This means that ultimately all biological concepts, laws and theories can be reduced to the physical and chemical (Looyen, 1998).

Three aspects must be distinguished in the reductionism-versus-holism debate: (1) ontological, (2) epistemological, and (3) methodological aspects (Looyen, 1998). *Ontological* aspects concern the question what entities, things or substances are assumed to make up reality (nature); what characteristics are attributed to these things or entities, and what relationships and functions can be assumed to exist between them. *Epistemological* aspects are about our knowledge of reality; the way in which this knowledge is expressed in theories (amongst other things), and logical connections between theories. In particular, these aspects deal with links between theories developed for different areas of reality or for different levels of organization. *Methodological* aspects concern the way in which knowledge is obtained and the basic principles, laws and strategies used in the process. This is particularly related to the question whether – in order to arrive at 'correct' knowledge or understanding of a certain level of organization (the level of the whole) – we should study the underlying lower levels of organizations (the composing parts and their interactions) or the higher level itself, or perhaps its relationship with still higher levels.

The division of holism and reductionism into these three aspects has important implications for our understanding of the positions of the distinctive scientific approaches. At all three levels either holistic or reductionist choices can be made. At the ontological level one can theoretically distinguish between ontological reductionism (so-called atomism) and ontological holism (so-called vitalism, emergentism and organicism). *Atomism* implies that the entities of the 'lowest' level of organization (atoms, subatomic particles, quantum particles, etc.) are somehow 'fundamental': they are the 'building blocks' of nature. Ontological reductionism states that, for instance in the discussion on genetic engineering, there is nothing but only DNA or that in causal explanations of biological results there is nothing but laws of physics and chemistry. In contrast, *vitalism* claims that animate nature is different from inanimate nature in that there are non-material forces operative in living beings. Another interpretation of holistic ontology is found in *emergentism*. In this holistic view, at each higher level of organization new and irreducible properties appear that are not present at lower levels.

These so-called 'emergent' properties are defined as properties of wholes that are not possessed by their composing parts.

At the epistemological level one can distinguish between *provincialism* – the reductionist view that biology, like chemistry, is a special branch or province of physics – and *autonomism*, which defends biology's autonomy with respect to physics and chemistry.

At the methodological level, the reductionist strategy to obtain knowledge of higher levels of organization is to study lower level entities and interactions between them. The best way to understand phenomena at the level of the whole is to study causal mechanisms at the level of its constituent parts. Holists, on the other hand, claim that in order to obtain knowledge of a certain organization level in biology, one must not study (or at least not only) the lower levels of organization, but (also) the higher level itself as well as its relationships with still higher levels. Because of the emphasis put on the study of wholes at their own level of organization, holism is often associated with a descriptive or phenomenological method (Looijen, 1998).

Historical development

Reductionist and organicist or holistic descriptions and theories have alternated in science since the Middle Ages. Verhoog (1993) summarizes this trend as follows: "In the medieval notion of reading the Book of Nature, nature is seen as an organism, as the body of Mother Earth, a harmonious and self-regulating entity that is treated with respect. In the 16th century this concept of nature was replaced by the concept of 'fallen nature'. Nature is now seen as disorderly and chaotic; the 'blind' forces of nature must be controlled by human reason. So man is no longer seen as an intrinsic element in a nature created by God. The measurable parts of Nature are objectified and materialistically reduced during the mainstream of scientific development of the 16th and 17th centuries. In a nature no longer guided by a divine providence, humans are free to manipulate and use nature as an instrument and for their own purpose. Experimental science provided the means to do this."

In addition to the development of reductionist scientific thinking, Gloy (1996) de-scribes the historical development of *holistic* thought as a development in stages: current ecological thinking was preceded by natural magic in the Renaissance (end 14th – end 16th century), by Leibniz' Monadology, by the natural philosophy of German Idealism and the Romantic Movement, and by vitalistic and holistic concepts at the start of the 20th century. Reductionism often dominates current social and scientific thinking.

A critical analysis of reductionism

There are three central statements related to the theory of reductionism that can be used as objects of criticism:

1. All traits and other characteristics demonstrated by living organisms – their morphology, physiology, behaviour and ecology – can ultimately be fully and exclusively explained in terms of the molecules (DNA, proteins, etc.) of which they are composed. There are no higher levels or non-atomistic organizing principles present (reductionist ontology).

2. The specific concepts, laws and theories used in the sciences of higher levels of organizations of organisms can eventually all be reduced, step by step, to the fundamental theories of physics. There is no need for non-reducible holistic theories about reality (reductionist epistemology).
3. The strategy to obtain knowledge at higher levels of organization is to study lower-level entities and interactions between them. The best way to understand phenomena at the level of the whole is to study causal mechanisms at the level of their constituent parts. There is no need for holistic methodologies that specifically obtain knowledge from the level of the whole (reductionist methodology).

In this article, we shall restrict ourselves mainly to the two central statements: 1 and 3. So the leading research questions for this article are:

- What is the tenablity of reductionist ontology?
- What is the tenability of reductionist methodology?
- What is the philosophical basis for a non-atomistic holistic concept of integrity of organisms?

Although this article discusses thoughts on integrity in agriculture, several topics from other scientific fields will be used in the criticism of the reductionism theory. This is justified, since the reductionism theory is the general basis for reductionist scientists to criticize the holistic concept of integrity of organisms in all scientific fields, including agriculture.

Criticism of reductionist ontology in molecular biology

As stated above, ontological reductionism or atomism implies that the entities of the 'lowest' level of *organization* (atoms, sub-atomic particles, quantum particles, etc.) are somehow 'fundamental'. They are the indivisible 'building blocks' of nature, the 'cement of the universe'. However, Gloy (1995) states that since the atomism theory was introduced three fundamental problems with this theory have not been solved (sufficiently). First of all, in no version of the atomism theory, the fundamental opposition has been solved between the postulate of smallest indivisible parts and simultaneously the postulate of their spatial extension. Secondly, although necessary content-wise, within the atomism theory mechanistic and teleological thought remain unconnected. Thirdly, it still remains to be seen whether or not the elements of a mechanistic world view will ever be able to construct living nature. So far, this view does not seem to be able to do this. All 'new organisms produced by men' (e.g. cloned animals) have originated from already living organisms, and they have not been built from the fundamental 'building blocks of nature'.

The limitations of reductionist thinking are also demonstrated in genetic research. Original reductionist paradigms are (1) DNA – and in some viruses RNA – forms the genetic material, (2) the genetic stream of information goes from DNA to RNA to protein, and (3) the basic DNA sequence transforms, via the RNA, exactly into the amino acid sequence of the polypeptides. Furthermore, the assumption that a single gene encodes for a single protein is currently refuted in various manners. All options are possible: (1) a gene encodes for a protein, (2) a gene encodes for several proteins, (3) many genes encode for the same protein, and (4) many genes encode for many proteins (Ho, 1999). In the inheritance of genetic information between generations, there is more than only the inheritance of the DNA; frequently, so-called 'epigenetic inheritance' occurs (Russo *et al.*, 1996; Jablonka & Lamb, 2005). In several studies the determining importance of context in gene expression has been described (e.g. Gurdon, 1999; Ho, 1999). For example, the transplantation of DNA nucleids of highly specialized cells into other surroundings shows that both the function and the devel-opmental stage are adopted (Kienle & Kiene, 2003). Molecular biologists argue, however, that in many cases, reductionist thinking itself was able to explain and to incorporate all new data, by extending its theoretical fundament accordingly. In addition, they state that current and future unexplained phenomena would eventually be explained by experimentally tested reductionistic hypotheses.

Furthermore, genetically equal cells differentiate systematically into distinguishable cell types and distinguishable protein compositions and therefore distinguishable gene expressions. This leads to the question how the different genes are switched on and off when the genetic 'equipment', the 'genetic programme' is the same everywhere. This is the so-called logical dilemma of developmental biology (Hamburgh, 1971). The cause must therefore be sought outside of the DNA: 'epigenetically'. In people and animals extra cellular forms and patterns such as arms and legs occur in equal cell types (bone, skin cells, etc.); the extra cellular form, the spatial partitioning of the equal cells, is therefore independent of gene expression (Müller & Hassel, 2002).

Comparative evidence indicates substantial incongruities between genetic and morphological evolution, and demonstrates that the same genotypes do not necessarily correspond with identical phenotypes (Lowe & Wray, 1997). On the one hand, genetic and developmental pathways can change over evolutionary time even when morphology remains constant (Felix *et al.*, 2000); on the other, similar gene expression patterns can be associated with different morphologies (Muller & Newman, 2003). Nijhout (1990) concludes that genes do not cause or control morphogenesis; they enable it to take place.

Summarizing we can conclude that ontogenesis and morphogenesis of organisms show that – in addition to DNA – other sources of information, organization and other heredity flows must be present (Kienle & Kiene, 2003; Jablonka & Lamb, 2005).

Criticism concerning an ontological reductionist approach of the organization of organisms

Ontological reductionism also states that there are no higher-level, non-atomistic organizing principles. However, research on topics linked by one common underlying theme, the organization of the elements of organisms in time and place (e.g. self-regulation, immunology, chronobiology, morphology, complexity), questions the tenability of the reductionist view. For example, Müller & Hassel (2003) describe with regard to the research on (the origin and the diversification of) organismal form that the nature of the determinants and rules for the organization of design elements constitutes one of the major unsolved problems in the scientific account of organismal form. The Neo-Darwinian paradigm that still represents the central explanatory framework of evolution can account for the phenomena it concentrates on, namely variation of traits in populations. However, it leaves aside a number of other aspects of evolution, such as the roles of developmental plasticity and epigenesis or of non-standard mechanisms such as assimilation. Most importantly, according to the authors, it completely avoids the origin of phenotypic traits and of organismal form.

As to the organization of matter several authors conclude: “It is clear that what the parts (molecules and ions) are doing and the patterns they form are what they are *because* of their incorporation into the system-as-a-whole. In fact, these are patterns within the system in question.” (Peacocke, 2003). “The parts would not be behaving as observed if they were not parts of that particular system (the ‘whole’). The state of a system-as-a-whole is affecting (i.e., acting like a cause on) what the parts, the constituents, actually do. Many other examples of this kind could be taken from the literature on, for example, self-organizing and dissipative systems.” (Peacocke, 2003); “The properties or the behaviour of the parts can be explained only in terms of their function in the whole: they contribute to the adequate functioning, the survival and reproduction of the whole. According to organicists (holists), such *functional explanations* are indispensable in biology. And because they do not occur in physics and chemistry, they form an important argument in favour of biology’s autonomy with respect to these other sciences” (Looijen, 1998). On the basis of research in complexity of organisms, Service (1999) concludes that when we get to a certain network complexity, we completely fail to understand how it works.

Criticism concerning an ontological reductionist approach of the psycho-social aspects of man

In a strictly reductionist approach, the various aspects of the psycho-social aspects of man can ultimately be explained by reductionist physico-chemical theories. This so-called issue of physicalism is central to the philosophy of mind and a currently extensively debated topic. In a review Stoljar (2001) states that there are three main arguments against physicalism: (1) the notion of qualia or felt qualities of experience, (2) the problem of intentionality of mental states, and (3) methodological issues. According to many authors (e.g. Chalmers, 1997) the qualia or experience problem is *the* unsolved mystery and *the* argument against physicalism in the philosophy of mind. Being able to discuss this topic only briefly, we shall focus on this main argument: “The notion of qualia raises puzzles of its own, puzzles having to do with its connection to other notions such as consciousness, introspection, epistemic access, acquaintance, the first-person perspective and so on.” When we think and perceive, there is a whir of information processing, but there is also a subjective aspect. “Why is it that when our cognitive systems engage in visual and auditory information processing, we have visual or auditory experiences: the quality of deep blue, the sensation of middle C? How can we explain why there is something it is like to entertain a mental image, or to experience an emotion?” (Chalmers, 2004, p. 619). “But, for example, would purely objective research into colour vision ever have discovered that certain colour combinations are very pleasant, or that some colours appear warm, others cold, or that some people hear coloured sounds?” (Gordon 2004, p. 227). “It is widely agreed that experience arises from a physical basis, but there is no good explanation of why and how it so arises. Why should physical processing give rise to a rich inner life at all? It seems objectively unreasonable that it should, and yet it does” (Chalmers, 2004, p. 619).

Although the physicalism debate has not reached its finale, for the time being we can conclude that there are strong arguments against a strictly reductionist approach towards the various psycho-social aspects of man.

Criticism on reductionist methodology

The golden standard of methodology in reductionist science is the experiment. The experiment is a phase in the so-called empirical cycle in which a hypothesis is tested. The entire empirical cycle includes the phases of: (1) observation, (2) induction, (3) deduction, (4) testing (of the hypothesis by means of the experiment), and (5) evaluation (whether the tested hypothesis based on the experimental results can be rejected or not).

Several authors have criticized (aspects of) the phases of the empirical cycle (e.g. Hume, 1896; Chalmers, 1999; Gloy, 2003; Gordon, 2004) as well as the experiment specifically in its role as the golden standard (e.g. McComas, 1996; Chalmers, 1999; Kiene, 2001). In this article we focus on the problem that the empirical cycle does not fully cover the reality of the scientific process. This is especially true for the *generation of new hypotheses*. Neither induction nor deduction is able to produce new hypotheses (Broeders, 2003). Therefore, already Peirce (1878) introduced the term of abduction, next to induction and deduction. Abduction is to look for a pattern in a phenomenon, and suggests a hypothesis.

More generally, the studies of for example the great discoveries in science (e.g. Van Der Bie, 2003), creative thinking (e.g. Robertson, 2001), and intuition (e.g. Davis-Floyd & Sven Arvidson, 1997) show that there is always a creative moment in 'producing new insight'. Even the toughest empirical scientist who tries to follow the empirical cycle rigorously must depend on intuitive moments that bring new insight, even if – as an empirical scientist – he is striving towards excluding metaphysical elements. Davidson (2003) describes on the basis of his review that so far no satisfactory explanation has been found for the phenomenon of new insights as 'the sudden realizations of a solution'. In the context of his study on the great discoveries in science, Van Der Bie (2003) describes this phenomenon of new insight as the creative moment in which a new pattern enters man's consciousness that subsequently causes a new ranking order of known facts and observations within the context of this pattern.

In other words, we can conclude that even in reductionist methodology there is a holistic moment in which holistic patterns arise in the researcher's mind that organize the already existing knowledge parts into a new whole.

A non-atomistic holistic approach

The critical analysis of several aspects of both the reductionist view on matter, its organization, its relationship to psycho-social aspects of man, and some aspects of reductionist methodology with regard to the generation of new hypotheses demonstrates some of the shortcomings of reductionism and opens the gate towards a non-atomistic holistic approach of nature. With this we mean an approach that is also holistic in an ontological sense, thus accepting the status of living organisms as whole beings. Every time we mention holism we mean with this term the non-atomistic interpretation of holism. The acceptance of the existence of whole entities at a specific ontological level implies that we should use a holistic methodology as well. This we can find in pattern detection and pattern recognition, which play an important role in hypothesis generation, creative thinking, and pattern application. This topic of cognitive handling of patterns is also central in another way of gaining and using knowledge – often neglected in the discussion on scientific methods: namely the methodological role of expertise. However, as the methodological use of expert knowledge serves as a holistic methodology that is able to obtain knowledge from the level of the whole, we shall explore the topic of expertise and the holistic methodological role of pattern recognition and pattern application in handling the level of the whole of organisms.

Reflection on expert knowledge, pattern recognition and pattern application

Adequately diagnosing and solving unique complex and context-specific problems can be performed by experts on the basis of so-called tacit knowledge, craftsmanship, the 'clinical look' or 'breeder's eye' (e.g. Snoek, 1993; Glas, 1997; Robertson, 2001). Experienced workers seem to have learned, consciously or unconsciously, to handle prevailing laws and situations, and in doing so have developed self-regulation skills based on valid and practical, useful knowledge ('appropriate conclusions and correct predictions'). Self-regulation can be defined as the adaptive use of skill across changing personal and environmental conditions (Boekaerts *et al.*, 2000). Expert knowledge is represented at an intermediate level of abstraction and is called the 'moderately abstract conceptual representation': a compromise between different abstractions like comparisons in the disciplines of physics and chemistry and concrete specific problems (Zeitz, 1997). The key element of expert information processing is the intuitive recognition and application of a pattern ('Gestalt') (e.g. Van Der Laan, 2006).

Although there are differences in approach, the various scientific explanation models agree that pattern recognition is a process of matching between (e.g. visual) stimuli and information from memory. There are three kinds of theories that try to understand the phenomenon of pattern recognition: (1) template matching theories, (2) feature detection theories, and (3) prototype theories (Lund, 2001). None of these theories, however, is able to explain all phenomena. This is true in particular for the influence that context, expectations and experience have, although many examples indicate that pattern recognition is influenced by these (Robertson, 2001). Lund (2001) describes that the influence of context, expectation and experience seems to be explained best by 'top-down' theories of perception, in which recognition is supposed to take place from the whole ('top') to the parts ('down').

What exactly matches what?

An important next question presenting itself is: What exactly matches what? Two examples will be presented to illustrate this. When somebody sings a melody and subsequently sings it five tones higher, a song is produced in which none of the notes of the first melody returns a second time. It is clear that in both melodies not a single element is the same. Nevertheless, we immediately recognize that exactly the same melody is sung in both cases. Another example concerns the fact that people are able to recognize patterns they learned in a specific domain in *another* domain, which is the case, for example, in many scientific discoveries (Van Der Bie, 2003). The explanation is that – in the recognition of the melody or a pattern in a new domain – what exists *between* the parts or in the specific relationship (e.g. in space and time) between the parts (e.g. the tones in the melody) is recognized. This theory is confirmed by research results concerning the development of self-regulatory skills by experts, in which, as was said earlier, pattern recognition is central.

There are various models describing the stages in the development of self-regulation skills in expertise (Schumacher & Czerwinski, 1992; Glaser, 1996; Boekaerts *et al.*, 2000). Taking together these three models, we can conclude that this development is closely related to the development of expertise, based on the internalization of a model. That model in turn is based on knowledge of systematic connections or relationships of the system. A match occurs between this internal knowledge (in the memory) on the one hand, and on the other hand any specific form in which these relationships appear. At the stage of '*self-regulation*', after all, we are dealing with an 'adaptive use of skill across *changing* personal and environmental conditions'. In other words, we are dealing with the possibility to recognize a universal pattern in whatever specific manifestation (during the knowledge acquisition process) and the application of a universal pattern in whatever specific manifestation (during the knowledge acquisition process).

In conclusion, we may state that both pattern recognition and pattern application require a match between the universal connection in itself on the one hand, and the specifically perceived connection between specifically perceived 'data points' on the other. In philosophical terms, a 'match' occurs between the universal and the specific, in which the universal appears and ensures the connection.

The holistic methodological role of pattern recognition and pattern application in handling the level of the whole of organisms

Goethean phenomenology (Seamon & Zajonc, 1998) is a methodology that studies both the underlying lower levels of organizations (the composing parts and their interactions) and the higher level itself with the aim to arrive at 'correct' knowledge or understanding of the level of the whole of organization. It is a methodology that fulfils the criteria of a scientific method (Baars, 2005). It is based on specifically trained judgement skills of the researcher. By using the phenomenological approach, the factual knowledge obtained through reductionism is placed in a larger perspective. Then, the researcher arrives at the level of wholeness that is responsible for the cohesive organization of the organism in time and place.

Several researchers successfully performed studies that demonstrated levels of wholeness in for example plants (Bockemühl, 1985; Bockemühl & Järvinen, 2005), mammals (Schad, 1971), physiology (Van Tellingen, 2003) and immunology (Van Der Bie, 2006). In all studies it was demonstrated that the level of wholeness determines the relationships between the parts at the underlying lower levels of organizations. By means of pattern recognition the researcher is able to recognize the universal level of wholeness as the organizing principle in whatever specific manifestation at the underlying lower levels of organizations. By means of pattern application the researcher can organize the conditions of lower levels of organizations in such a way that the level of wholeness can serve as the organizing principle of the composing parts in time and place.

Concluding remarks

A central focus within the thoughts on integrity within (organic) agriculture is formed by the (non-atomistic) holistic concept of the non-reducible wholeness of organisms and by the methodical role of expert knowledge and craftsmanship. The breeder's eye that enables the experienced breeder to catch this level of integrity in understanding and using it in his (breeding) activities, may serve as an example. The non-atomistic concept of integrity states that organisms are self-organizing entities in which an ontological level of wholeness is responsible for the interconnectedness and the balanced harmony of its parts, for its characteristic species-specific nature, for its functional and morphological wholeness, and finally for the balance struck with its species-specific environment. This ontological level of wholeness can be distinguished from the level of the 'parts' of the organism.

In this article our aim was to develop and present a philosophical underpinning of a non-atomistic, holistic concept of integrity of organisms. To that end we drew up critical analyses of several aspects of reductionist ontology and methodology, demonstrating some of the shortcomings of reductionism. For this we were inspired by the ideas of Oost (1999), who states that existing theories may fail:

- on internal conceptual grounds: logical inconsistency, use of ambiguous concepts;
- on external conceptual grounds: a theory "does not fit in" with other theories;
- on empirical grounds: a theory does not fit in with reality.

Reductionism 'does not fit in' with the different theories on the organization of matter but also does not match with several empirical facts concerning the organization of matter. Furthermore, the analyses at both the ontological and the methodological level demonstrated the need for the acceptance of the existence of a level of wholeness that can be distinguished from the level of the parts. Besides this negative evidence for the importance of holistic approaches, positive evidence can be found in what is known about pattern detection, recognition and application. This philosophical underpinning may serve as a first step towards a wider acceptance of this concept of integrity: not only in (organic) agricultural practice, but also in science.

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