Ludwig von Bertalanffy's Early System Approach

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What I will talk about

- Influences on Bertalanffy
- Questions from biology
- System theory of life – basic concepts
- Examples
- Mathematics and epistemology
Ludwig von Bertalanffy (1901 – 1972)
Some Influences on Bertalanffy

**Philosophers:** Schlick, Reininger, Vaihinger, Heraclitus, Cusanus, Leibniz, Goethe, N. Hartmann

**Scientists:** Weiss, W. Köhler, Lotka
II. Die Sternwelen

A. Fechners Lehre
B. Kritik
C. Weiterhilfe

III. Zur Theorie der Lehre von den übergreifenden Integrationen höherer Ordnung.

IV. Die Freiburger Wege der Welt

V. Psychologische Indizien

VI. Psychologische und soziologische Indizien

VII. Das Kulturbewusstsein

VIII. Schluss

Fechner und das Problem der Integrationen

Ein Versuch zur induktiven Metaphysik.

Von

Ludwig von Bertalanffy.
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Biological problems at the beginning of the 20th century

Bertalanffy noticed a key problem in biology:

**Vitalism vs. mechanicism**

(Élan vital vs. machine concept)
“Mechanicism”

... can be refer to a complex of four approaches:

- An “analytico-summative” approach
- Physicalism
- Determinism
- “Reactivism”

(Pouvreau 2005)
Mechanicism vs. vitalism

The conflict between “mechanicism” and “vitalism” is essentially metaphysical.

Bertalanffy's "organismic biology" was an attempt to overcome the conflict.
Core problems in biology

Order and organisation
in the organism

Wholeness [Ganzheit] is a primary attribute of life
System theory of life – the basic aim

“Wholeness” [Ganzheit] should be liberated from metaphysical connotations to rather approach at an organismic theory.

Wholeness $\neq$ holism
Relations

The “whole” is the sum of the “parts” together with their relations.

This is hard investigate in detail.

The search for integral laws might be more adequate, at least at the moment.
Physicalism is not enough

Biology needs to be seen with different methodological perspectives:

- Physico-chemical
- Ganzheitlich or organismic
- Teleological
- Historical

(Bertalanffy, 1928)
Causality and finality

“What in the whole denotes a causal equilibrium process, appears for the part as a teleological event.”

(Bertalanffy 1929a,b)
General organismic “principles”

- The organized system as an “open system” in “flux equilibrium” [*Fließgleichgewicht*].
- The “striving of the organic Gestalt for a maximum of formness [*Gestaltetheit*].”
- The principle of primary activity.
Basic concepts

- Wholeness
- Open system in flux equilibrium
- Hierarchy and hierarchisation
- Primary activity
- “Conservation” of the integrity
System-definition (Bertalanffy)

A system is a complex of elements in interaction.

(Bertalanffy 1945)
Some fields of application

Morphology  Evolutionary theory
Physiology  Genetics
Biocoenosis  Ethology
Morphology and physiology

Growth in an open systems is a function of assimilation and dissimilation

Connecting (dynamic) morphology, developmental biology, and physiology by means of exact quantitative laws
Mathematical Modelling

dµ/dt = A(µ) − C(µ)

µ ... mass
A ... assimilation
C ... dissimilation

dµ/dt = a\mu^m − c\mu^n
Biocoenosis and ecosystems

There is a wholeness of components that are interacting.

The equilibrium in a biocoenosis also involves a sort of steady state [Fließgleichgewicht] of units on a higher level beyond the individual.

(Bertalanffy, 1941a)
Homology

Classical view: homologous organs stem from similar dispositions [*Anlagen*]

Bertalanffy's dynamic developmental homology concept: Not the material from which the organ originates is decisive, but rather the organizing relationships through which the material is imprinted [*geprägt*]

(Bertalanffy, 1941a)
Cell theory

Within cell theory multicellular organisms appear as an aggregate of building blocks termed cells.

In the multicellular organism, however, the single cell plays another role than in the unicellular organism, i.e., it is a part of a unit of higher order.

Seen physiologically, life is not the sum of single cell performances. Those cell performances are also joined together to a unity on a higher level.

(Bertalanffy, 1934a)
Darwinian selection

... appears to be “analytico-summative” (selection and summation of single modifications of separated traits) and “reactivist” (to the environment).

Darwin’s theory is based on small changes of properties of an organisation and presupposes the organisation.
Systems in the Theory of Evolution

Rupert Riedl

Macro-evolution and genes

Interconnectedness of genes

Superimposed genes

Feed back between genotype and phenotype
Riedl's system approach
Genetics

The whole organism emerges \([\textit{wird hervorgebracht}]\) out of the whole genome.

Genes are certain differences in the genome that account for different traits.

Not the single gene itself creates a wing of this or that form.
Dissertation von Paul Weiss.

F. K. H. P. Dr. hans Pizibam In Reformation.

Dr. Pizibam.

Heiss, Paul.

Rippe, Rippeimmermann. Einflüsse äußere Faktoren von Rippe, Rippeimmermann der Vanessiden.

5298
Butterfly experiments
Field “laws” as special cases of system “laws” in embryology

1. Every field has axial structure, which leads to heteropolarity in at least one axis.

2. When material is separated from a field-bearing system, the field is contained in the remainder in its typical structure.

3. When unorganized but organizeable material meets a field area, then it is included.

…

(Weiss cited in Bertalanffy 1932)
System-definition (Weiss)

“As a system we want to define each complex that, when parts of it are modified, displays an effort to stay constant with regard to its outside.”

(Weiss 1925)
Similar concepts of Weiss and Bertalanffy

- “Wholeness” as a key concept for understanding living systems
- “Hierarchical” or stratified organisation
- Dynamic understanding
- Primary activity
- “Conservation” of the integrity of a system
Further similarities

- Biology as an autonomous discipline
- Searching for laws of “higher order”
- Generalisation of the system approach
Systems beyond the living

“It is an urgent task for the future to raise man's sights, his thinking and his acting, from his preoccupation with segregated things, phenomena, and processes to greater familiarity and concern with their natural connectedness, to the 'total context'.

To endow the epistemological foundations for such a turn of outlook with the credentials of validation by modern scientific experience, is thus a major step toward that goal.” (Weiss1977)
Lieber Lutz!


Herzliche Grüße von uns beiden
Dein

Konrad Lorenz
## Systems in Ethology II

### Part One   Methodology

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Epistemology

- Organismic biology as scientific program
- Objectivity through a perspectivist epistemology
- Perspectivism ≠ realism
- Not fundamentally opposed to constructivism
- (difference to cybernetics in the world picture)
Way towards a General Systemology

With concepts, epistemology, and some formal methods developed in theoretical biology

and

formal similarities in different fields

the way was free to develop a general approach
Conclusion

Already before extending the systems view it was introduced on several levels of biology

Bertalanffy's system thinking was comprehensive, taking into account philosophical as well as scientific considerations

Considering different dimensions (science, epistemology, ontology, world picture) is useful