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Original Paper

Need for Morphological Study in Natural Sciences

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Abstract

The importance of morphological study is emphasized in natural sciences. In morphological studies, one synthesizes all the available observed facts, sequencing them in terms of causes and effects under a specific principle. It can provide not only an opportunity of breakthrough, but also the foundation of a significant theoretical research. It is the stage where creativity and innovativeness can most clearly be displayed.

1. Introduction

There are three ways to study in natural sciences by (1) observation (including analysis), (2) morphology and (3) theory. In general, most researchers in natural sciences tend to specialize in one of them or two, namely (1) or (3) or both. Morphology (2) is mostly avoided. Those who can do all three sufficiently deep are rare. I am not aware of anyone who has done in all three in natural sciences.

It is often the case in natural sciences that a new field begins based on an "unexpected observed fact"; Stage A. The identification of a highly ionized ion atoms (Fe^{IV}) in the 1940s (unexpected high temperature of the solar corona of more than one million degrees) is an example. A new field can also begin by "unthinkable idea", but it will be discussed later. Such an event is followed by many observations to prove or disprove the first "unexpected observation"; meanwhile, researchers find a variety of observations related to the first observation; Stage B.

After this stage, theorists begin to join in explaining *each* observed facts (not the phenomenon as a whole). Then, a few observers or theorists attempt to synthesize all the observed facts together as a distinct phenomenon; Stage C.

If any one of such syntheses appeals to many researchers, it will be established as a *model* by both observers and theorists. This stage is followed by a long period, during which a very large number researchers try to improve the model (the beginning of a paradigm); Stage D. Many fields in natural sciences go through more or less all these stages (A to D).

2. Stagnation Period

After going through all these stages, however, the last stage (D) does not mean that the first "unexpected finding" is basically understood (because natural phenomena extremely complex). However, this particular paradigm stage continues by supposing that the 'remaining' problems would be eventually solved under the principle of the paradigm.

Depending on the fields, this stage can last more than a half century. The high temperature of the corona (more than one million degrees) and the cause of the solar wind are good examples.

It is my own view that this stage (D) may often become a stagnation period in the development of a field, but most researchers do not realize it. The paradigm becomes like a textbook or a generally acceptable theory, and researchers believe that any remaining problems (like an exercise problem at the end of each chapter of textbook should be solvable); if not, they may feel they are not capable of solving, although the textbook (paradigm) may be incorrect or out of date.

3. Learning the History of One's Field

Many fields in this stage D spend a long period. One could recognize this situation, if one takes a little time to learn the history (A to D) of one's field. In fact, if young researchers can learn the history of their field at an early period of their career, they may recognize that important tasks ahead may be different, depending on which stage of development the field is, so that one might find a *timely* innovative contribution. If one wants to make a career on the chosen field, it is essential to learn its history.

4. What Is a Morphological Study?

In this stagnation period, one should try to synthesize or resynthesize a large number of available observations *(not theories).* This new synthesizing is to sequencing all the observed facts from causes to effects. This is my definition of a morphological study. A morphological study is most useful and effective in a fully developed paradigm. A premature morphological study confuses the field. Similarly, a premature theory based on a premature morphology is most confusing.

A solid morphological study should be conducted under a basic principle as quantitatively as possible. For example, in space physics, most observed phenomena are manifestations of electromagnetic energy dissipation processes, so that a morphological theory has to be established on the basis of a sequence of processes from the electric power generation to its dissipation. Without the basic principle, the resulting morphological study is simply confusing. A morphological study is often criticized as "cherry picking", but so long as it is based on the principle, it is possible to defend.

An opportunity of new morphological study is when one finds several contradicting facts during the synthesizing, which disagree with the paradigm. In this situation, one should try to make a new synthesis (resynthesis) with these observed facts and others (even including facts in the present paradigm). This requires a new way of thinking. Since it is different from the present paradigm thinking, it may become "unthinkable idea". This situation is somewhat analogous to the case, in which one is trying to solve a puzzle of cat, but find pieces which do not fit with the cat puzzle, and eventually one discovers that if one consider a dog puzzle, many pieces seem to fit better. In a paradigm, one is not supposed to consider different puzzle or even prohibited to do so.

Thus, actually, we go back to Stage A of "unthinkable idea". In many fields in natural sciences, such an event has been repeated during the course of their developing period. As mentioned earlier, every field has gone through this sequence (A-D) a few times in its history. This is actually one of the ways natural sciences develop and advance in stepwise. This is also the situation where creativity and innovativeness in research is most clearly judged.

Many researchers avoid a morphological study (2), because many observed facts are interrelated (including feedback), and even several facts appear to be contradictory to each other under a particular paradigm. It is not easy to consider a cause-effect relationship among various observed facts. Most researchers avoid this cumbrous effort.

5. The Importance of a Morphological Study

Nevertheless, it is important that some researchers take *morphological study (2)* as their priority research project. A solid morphological study can be developed into a morphological theory. In natural sciences, I believe that *any worthwhile mathematical theory must be bases on a solid morphological theory*. Thus, *a solid morphological theory can be the basis of a new significant theory. Theoretical studies based on a morphological theory can also quantitatively and logically scrutinize a morphological theory, making the advance of the field concrete.*