ON THE WAY TO THE OPTIMAL SUPRAGENERIC CLASSIFICATION OF AGGLUTINATING FORAMINIFERA

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ABSTRACT. Foraminifera with pure organic or agglutinating walls are classified according to the basic postulates for natural systems of classes. These postulates are (1) consistency of properties used for classification of objects (2) equal degrees of homogeneity if groups instead of individuals are used. The presence of natural categories can be ascertained using measures of homogeneity within classes.

The analysis of recent agglutinating and organic walled Foraminifera resulted in phenetic and phylogenetic systems widely different from each other. The phenetic system shows natural categories, easily transferable into a Linnean hierarchy. The phylogenetic system leads to complete reconstruction of the commonly used suprageneric system of Foraminifera.

1. Introduction

The last years have brought more and more publications on the system of organisms and its theoretical and biological bases. Three distinct schools of thought claim to be capable to produce the "natural" system and each uses a number of arguments to defend its own positions, leading to controversies about the basic means, aims and contents of such a system and which properties of organisms it should represent. In most discussions maximum weight is laid on the phylogenetic structure of such a system (Eldredge and Cracraft, 1980; Nelson and Platnick, 1981; Wiley, 1981), but additional criteria are used by those adherent to an evolutionary system, mostly based on morphological similarities (Mayr, 1969; Bock, 1977). A third group using mathematical methods work almost exclusively with morphological informations to classify organisms by considering various indices of similarity in form and shape (numerical phenetics, Sneath and Sokal, 1973; Abbott et al., 1985).

The quest for the optimal system will be a futile one as long as the basic question - "What is an optimal classification?" - is not truly answered. If the criteria of an optimal system of classes are widely known and accepted, then a natural system of organisms could be specified, e.g. for the agglutinating Foraminifera.

The system of organisms is a special case of a system of classes, which uses organisms as objects of classifications (Hohenegger, 1989). The quality of a class system depends heavily on the accurate definition of the following three sets (Opitz, 1980):

1) the objects of classification
2) the properties used for the classification of objects
3) the classes or groups as results of classification
The objects used for classification should be gathered into distinct classes such that members of a class should possess a maximum homogeneity of their properties.

A system of classes is called "natural", if the degree of homogeneity within the classes is higher compared to that between the classes, otherwise it is called "artificial" (Hohenegger, 1989). Only natural class systems can be used in a prognostic way; since the properties are homogeneous a typology of class members can be given.

The next question is: How can homogeneity be quantified? The objects of a classification are related to each other by their properties. These relations - the simplest is of binary form - depend on the structure of the set of properties. Sometimes no relations hold between the objects, if the values of properties are yet classes, e.g. if colours are used for classification. Such properties are called "classificatory characters" and no computations of similarities for classification is necessary.

Thus if relations between the objects with regard to the used property exist, an assessment of the type of relations is necessary. In the case of the organismic system two types of relations are the most important:

1) transitive relations - used to describe phylogenetic dependencies.
2) symmetric relations - used to describe similarity in form.

Classifications based on transitive relations use the number of relations present as a measure of cohesion (e.g. how many genealogical steps are necessary to find a common ancestor, compare Farris, 1967). Classifications based on symmetric relations additionally use measures of the intensity of the relation (e.g. form A is much more similar to form B than to form C).

Properties can be of a singular type, but mostly they can be divided into several subproperties (e.g. characters). The usage and weighting of such characters is a theme of discussion and controversy.

The following three points, often neglected, are of great importance for all systems of classes:

1) The structure of the system of classes is determined by the type of relations between the objects. The hierarchy or pseudohierarchy (see Opitz, 1980) of the system of organisms is caused by the presence of genealogical dependencies or relationships between organisms which leads to a hierarchy of ranks (parental and filial generations), leading to a hierarchical system of classes. Since morphological and ecological characters are also inherited to some degree, the genealogical relationships also determine the hierarchical structure of evolutionary and numerical phenetic systems.

2) During the process of classification the properties used must be constant. This simple and very basic postulate is usually neglected. Often diverse characters are used to describe the similarities in form, so that the determination of homogeneity becomes an impossible task. This postulate of consistency is of special importance within classes of equal rank (classes with equal degree of homogeneity), which are called "categories" in biological systematics. Only under fulfillment of this postulate can the "naturalness" of categories be tested and ascertained, which is often a matter of doubt in biological discussions (Mayr, 1982).

3) The consistency criterion is of utmost importance if the objects of classifications are groups and no longer individuals. If these groups (e.g. genera, families) are based on an already existing classification using other properties than the secondary classification, then the same degree of homogeneity in the property used for the primary classification within