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GENUS AND FAMILY : CONCEPTS AND NATURAL GROUPINGS [1]

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A little over two hundred and fifty years ago Linnaeus (= Linne) began to maneuver his concepts of animal arrangement into Aristotle's logic of classes. Twenty-three years elapsed between the publication of his first and tenth editions of « Systema naturae ». The tenth edition (1758) is the acknowledged starting point of zoological nomenclature. Often forgotten but highly significant is the fact that he spent those intervening twenty years orchestrating the then known animals into the world of philosophy.

Linnaeus' genius was conceiving that science and philosophy can blend and that theology, though highly influential to his concepts, was not the all controlling unit. He was influenced by Aristotle's logic of classes, Plato's " essence " and Thomistic theology. This may be best explained by simplistic definitions:science attempts to delimit what is true; philosophy seeks to define truth; theology, which Linnaeus was unable to completely escape, intervenes in as much as the demands of faith supersede delimitation and definition. Understand, Linnaeus was polarized by the sixteenth century observation : *philosophia ancilla theologiae* (philosophy is the maid-servant of theology).

To a large extent, and unfortunately so, science has come to limit the genius of Linnaeus to « creating » the binomial system of nomenclature. Binomial nomenclature was extant hundreds of years before Linnaeus; his proposal established the binomial as unambiguous. The names and groups he offered are not important. The introduction of an unambiguous binomial nomenclature and the logic of classes and its application to biology are important because for the first time the diversity of living organisms was organized in a manner that revolutionized human thought. However, Linnaeus' philosophy remained Aristotelian and he was dedicated to the application of Aristotle's system of logic to classification (Tuxen, 1973). Later generations up to and including Darwin succeeded in excising Linnaean philosophy from Linnaeus' proposal while retaining the essence of a rigid hierarchy of categories and an unambiguous binomial nomenclature.

Darwin's contributions encouraged us to use our abilities to see what everyone else has seen and yet think beyond this neurologic limitation. It is this that spotlighted Darwin. Wallace, hindered by theology, was unable to take the step beyond seeing what others had seen to the realm of thinking what others had not thought. As a result Darwin's thesis on the origin of species has influenced biology for over one hundred years and Wallace is remembered for presenting a similar hypothesis that his theology would not allow him to expand.

Linnaeus provided the grist upon which Darwin and others worked. However, Darwin and others were leaders in initiating the shift from the concept of a utilitarian classification based on the procedures of logic that primarily functioned as an instrument for identification, to the much broader interpretation that the diversity of organisms resulted from evolutionary divergence (Mayr, 1969). Thus, there was a major shift from identification to classification and the process of reasoning became inductive rather than deductive. Recently, in nematology, there has been an inclination to revert to deductive reasoning in the formulation of classifications (Andrássy, 1976; Fotedar & Handoo, 1978; Siddiqi, 1986). In these classifications the categories above the species are based on an *a priori* arrangement of morphologic characters rather than on natural groupings as interpreted through known biology.

Linnaen classification has not been without opposition and criticism. Attacks on the system generally arise from an inability to comprehend a rigid hierarchy with an inherent need for arbitrary ranking. The assignment of intractable values to ranks within the hierarchy would paralyze the system into a desinence that would preclude improvement. Perception of the intrinsic subjectivity of the system allows for the incompleteness of our knowledge of relationships and presents us with the opportunity to test alternate models of relationship, thus maximizing information. Systematists should accept and welcome the fact that the system will forever remain provisional.

There are seven basic categories that prevail in the modern interpretations of Linnaeus' hierarchies. All are not those proposed by Linnaeus (classis, ordo, genus, species, and varietas) but those that new knowledge demanded. After more than two hundred years only five (genus, family, order, class and phylum) permit us to place a species with any degree of accuracy. Even these did not satisfy our need to more accurately portray relationships; therefore, over the years more precise

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designations were imperative and the prefixes super- and sub- were attached to the basic categories.

With no sense of the purpose of Linnaean hierarchy some other terms have been introduced and have, not unexpectedly, become the subject of confusion because they do not convey relationship nor do they add to perception of nematode biology. The terms referred to are : biotype, race and pathotype. On the other hand some terms that have received a notable degree of acceptance are : tribe, between family and genus, and group between genus and subgenus. However, as useful as they are, they have not warranted recognition by the International Commission of Zoological Nomenclature for inclusion in the rules for " binomial (trinomial) nomenclature ". It is not surprising that these perceptive additions amplify the ability to express relationships within the two most informative categories in the hierarchy of classification; i.e., the genus and family. Both additions are designed to expand our ability to cope with new knowledge of relationships without the need to overinflate the basic categories. This simply means that genera do not have to be raised to families or families to orders. Thus further illustrating the genius of the Linnaean-Darwin-Mayr philosphy of classification and perhaps, with an affordable degree of magnanimity, Aristotle's legacy to biology: the gift of the logic of classes.

This disquisition set-out to address the logical consequence of purporting to understand and accept that a classification and ranking in a hierarchy reflect relationships. From the foregoing statements it should now be evident that the backbone of a sound classification is entrenched in our perception of the genus and its projected concept - the family.

Linnaeus in 1737 gave lasting advice in his dictum : " Its the genus that gives the characters and not the characters that make the genus. " Though it would be highly desirable to have characters or even a single character that unequivocally designated categorical rank, we must accept the fact that such does not exist (Mayr, 1969). Therefore, it also follows that taxonomic characters that prove generic distinctions do not exist. It is also true that non-arbitrary definitions at the categorical level of genus and above are not possible to give.

Systematics can only florish in the realm of flexibility; it is a science of concepts and realities or pragmatically, definitions and descriptions. Absolute definitions would stifle future knowledge because in the world of the absolute, freedom to express new information concerning relationships could not exist. Many scientists find this situation difficult to accept and even more difficult to work with. It is among these scientists that there is an expressed dissatisfaction with the Linnaean hierarchy. It has even been suggested that category names be replaced with numbers (Løvtrup, 1979). Numbers are only unit expressions of mathematical concepts and a false faith or faith in a rigid system based on numbers cannot escape the reality that taxa are based on zoological realities. Categories, no matter how depicted are concepts; however, they are concepts based on natural occurring units.

The most objective of all categories remains the species, for a further discussion of the objectivity and definition of the species see Maggenti (1983). The species category differs from all other divisions in the hierarchy in that it signifies singularity, distinctness and difference (Mayr, 1969). Categories above the species are collective concepts inasmuch as they have the function of grouping and ordering by de-emphasizing differences between species and emphasizing affinities among groups of species. Mayr (1969) states : " Even though an operational definition for the higher categories does not exist, nor for the rank which they signify, they do have an objective basis because a taxon placed in a higher category (if correctly delimited) is *natural*, consisting of descendants from a common ancestor. " Since there is no operational definition of the genus I will adopt Mayr's pragmatic definition: " A genus is a taxonomic category containing a single species, or a monophyletic group of species, which is separated from other taxa of the same rank (other genera) by a decided gap. " In general, the size of the gap is inversely proportional to the size of the taxon. This is a schooled observation and not a rule.

In view of the fact that there is no operational definition of the genus and inasmuch as there is no distinctive single or group of characters that *a priori* make a genus, then its circumscription must be sought elsewhere. Since strict morphology cannot delineate the genus then the alternative to understanding the affinities among species must lie in their biology and ancestry. The latter, obviously, refers to their phylogenetic development from a common ancestor, and in this context a genus will have common features that facilitate recognition. Therefore, one of the features of a genus is that it embrace in the hierarchy a collective assemblage of species that comprise a phylogenetic unit. Even though the genus is a phylogenetic unit there need not be a single species which is immediately ancestral to all species in the genus. A genus can be derived from several species in a genus in which the ancestral species were grouped. It is not required that a new genus be proposed for each ancestral species.

As a phylogenetic unit the genus differs from similar and related assemblages by reflecting an ecological unit that is adapted to a particular mode of life; i.e., a valid genus occupies a niche. Because the genus occupies an ecological niche it makes an evolutionary statement that the individual species, making up the assemblage, cannot make independently.

Among parasitic groups, in our case nematodes, it should be easier to recognize genera (where the biology is generally well known) than it is among the so-called

freeliving genera (where the biology is seldom known). However, this does not seem to be the case among the plant parasitic nematodes nor the animal parasitic nematodes. Over the last twenty to thirty years the number of nominal genera in Tylenchina has increased at a logarithmic rate. The recent revision of Tylenchina (Maggenti *et al.*, 1988) has accepted a 46 % reduction in the number of genera in Tylenchoidea and a 58 % reduction in the number of genera accepted in the Criconematoidea. The philosophy employed by this team of researchers, Luc, Maggenti, Fortuner, Raski and Geraert (1987), was that outlined above: seek phylogenetic units, ecological units and a generic niche; these precepts were extended to their logical conclusion - the family.

The family being an abstract concept of a naturally occurring assemblage of taxa (genera) cannot be given a nonarbitrary definition and therefore, the only assigned definition is nearly equivalent to that given for the genus by Mayr (1969): " A family is a taxonomic category containing a single genus or a monophyletic group of genera, which is separated from other families by a decided gap. " Once again it has been generally observed that the gap is inversely proportional to the size of the family.

If the genus should occupy an ecological niche it follows that its logical projection, the family, of necessity must also occupy a well-defined niche or adaptive zone. The family owes its origin to the invasion of this zone by one or more founder species and to the subsequent active and adaptive radiation which follows a successful adaptive shift. Because of this the family is the category that should provide the most information among all the assigned ranks in the entire hierarchy. The available information on any assemblage of taxa decreases above and below the family level; therefore, it is a rank to be assigned with a great deal of caution and consideration.

Obviously, since there is no operative definition nor single or group of morphological characters that delineate a family, then family designation in any given phylum will be individualistic but the philosophy applied should be the same. In the class Insecta there are some one million species distributed among some 940 families or roughly one family for 1 060 species (obviously there are some smaller and some larger). In Nemata there are some 200 families for some 15 000 nominal species. Within Nemata this implies that a great deal of extinction has occurred and that what remains are clear-cut taxonomic isles. Any cursory attempt to work with the families of nematodes quickly convinces one that the differences between families are often so slight as to defy recognition or identification, when the opposite should be more often true. Careful consideration should be given to whether some of our superfamilies and perhaps even some suborders are not in reality families; it is often at this level in the classification of Nemata that well-defined niches or adaptive gains as well as evidence of extinction are most evident.

There are some broad features or generalizations that, though not generally applied in systematics to distinguish the family, are applicable to the family concept. Unequivocally, families are older than genera and often world-wide in distribution. In general, and this should be given serious consideration among nematologists, the family should have a general facies easily recognizable. The latter is easily verified by our ability to recognize some families under the dissection microscope; this should not be interpreted as a mechanism to recognize families.

It should not be surprising that as knowledge of taxa increases world-wide that family designations often require rethinking. World-wide families have a tendency to internally break into distinctive groups and it is to be expected that intermediate groups will be found and quite often relic groups discovered that cloud the issues. One only has to consider recent finds among the Heteroderidae to confirm this generalization. When this occurs we have two choices: the known families can be raised to superfamilies (the simplest solution, though more often than not the least satisfactory) or we can rethink the available information and expand our concepts by combining and reducing the number of families.

The heart of a classification is founded on the stability of its recognized families. Family stability is essential to a useful classification that affords maximum communication and in turn offers the greatest amount of information with maximum retrieval. Splitting, at any level within the hierarchy, makes information retrieval more difficult and in some instances impossible. The uncurbed addition of taxa without regard for their effects on other categories or their illogical placement within the system, can only result in the continued repression of nematological knowledge. It is imperative that we reexamine nematode classification and the philosophies that are being applied to determine the categorical ranks within the hierarchy.

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