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Intuition or fixed criteria – about standards in species description

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ABSTRACT. The principles of taxonomic descriptions as well as factors which most commonly influence the correctness of description are discussed on the background of species definition and ICZN recommendations.

A narrow systematic group – Parasitengona terrestria (Acari) – was adopted as the model, but the problems discussed can be extrapolated to many invertebrate taxa, especially those which are clearly polymorphic. The starting point in a taxonomist's work should be variation recognised within the taxon. Making descriptions objective should consider unification of scientific techniques and selection of an adequate, possibly extensive set of diagnostic characters. Unified standards of description should aim at maximum limitation of error; the sources of the latter can be recognized mainly by experience and broad overview of the group, but not by routine or intuition.

Key-words: description standards, species-level taxa, variability, Parasitengona terrestria, Acari.

I. INTRODUCTION

Contemporary descriptions of new taxa, in the absence of clearly defined criteria, display a great variability of standards adopted by different authors. Regretfully, natural selection has not got its application here – thus imprecise, unclear, sometimes misleading descriptions, however formally in accordance with the International Code of Zoological Nomenclature (ICZN), become firmly fixed in the literature.

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What do we expect from the 'present day' taxonomic description? The problem seems too obvious to merit a more extensive discussion. Already MAYR (1969) in his "Principles of systematic zoology" gave a precise for a description of a new taxon. The ICZN Code, improved every few years, specifies how a new taxon of specific, generic and family level should be described. But..... have all the scientists who describe new taxa and also editors who accept papers read the "Principles...." and have they at least perused the Code? Hundreds of taxonomic publications seem to deny it. The problem is very wide and here we focus exclusively on species-level taxa. The generic and higher level taxa require a separate discussion.

II. MATERIAL AND METHODS

Our discussion is based on information contained in papers dealing with the theory of zoological systematics, in many acarological publications, as well as on unpublished data. An experience of over a dozen years has encouraged us to express our opinion regarding the currently applied standards of taxa description within Parasitengona terrestria and to propose a consistent model of description. Since we do not intend to personally criticise some authors and glorify others, we do not cite all the original papers, from which we borrowed examples, in the References.

III. RESULTS AND DISCUSSION

SPECIES CONCEPT (DEFINITION)

As stated by SCHUH (2000) "systematists deal with recognizable or diagnosable taxa, be they at the minimum level (usually called species) or at some more inclusive level. Whatever they are called, if they are recognizably distinct, taxa at any level form valid units for systematic analyses".

Views on what the species is have changed through time. Among the dominant ones there is MAYR'S (1969) biological concept: a species is a group of actually or potentially interbreeding populations, reproductively isolated from other such groups. At the same time we should be aware of the fact that the degree of morphological difference does not constitute an appropriate species definition (MAYR 1996).

The International Code of Zoological Nomenclature regards species as a category immediately below the generic level, and the basic category of zoological classification (ICZN Code 1999).

In accordance with the above criteria, it can be assumed that species is a smaller or larger group of individuals which differ among themselves (not only with respect to morphology) to a certain extent. The extent to which they differ determines the range of intra-specific variation and only after the variation is recognised within the taxon, one can start the taxonomist's work.

CRITERIA OF A VALID DESCRIPTION ACCORDING TO ICZN CODE

In the development of the principles underlying the ICZN Code a remarkable statement was posed: "irrespective of when and where they were published, names and the descriptions of new taxa would be permanently accessible and could be consulted most easily".

For the purpose of the present discussion we do not intend to refer to the regulations that applied to older descriptions (i.e. published before 1931). However, the regulations that apply to currently published descriptions say: "… every name published after 1930 must (…) be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon (…)" (Art. 13.1.1).

RECOGNISING VARIATION

According to LINCOLN et al. (1998) variation can be defined either as "the divergence of structural and functional characteristics within a group, in particular those not attributable to differences in age, sex or life history stage" or as "the spread or dispersion of values about the mean".

Among the 18 forms of variation within the single population mentioned by MAYR & ASHLOCK (1991), some become significant in the context of studies on Parasitengona terrestria, thus further we will regard them as a starting point in the discussion on the standards which should be met when describing new taxa.

- *age variation*

This form of variation pertains to both the complicated life cycle (in Parasitengona terrestria mites the cycle comprises four inactive and three active stages, including the heteromorphic larva) and the age-related differentiation of metric characters within the same development stage. A considerable problem within polymorphic groups is a tendency to describe new taxa based exclusively on one development stage. What is more - it is often a case in some groups, that only one of the development stages has good taxonomical characters or it is more easily available for collection. In such cases, the ratio of described species is always „in favour" to that stage.

Recently, the thorough studies of „species by species" clarified the situation within some taxa and led to the synonymization of larvae with postlarval forms in certain families of Parasitengona terrestria. It is just a tiny bit of what should be done in this group of mites. The scale of the problem may be illustrated by the case of the family Trombidiidae. Among 234 species presently assigned here – 155 are known only from postlarval forms, 49 – exclusively from larvae, whereas only 30 - from both (MĄKOL 2000a).

Another problem is the age-related differentiation of metric characters within the same development stage. A phenomenon existing within Parasitengona mites and called neosomy (additional production of cuticle within the same stage) obviously constitutes one of the factors which can have an impact on the variation.

· *variation resulting from periodical changes in climatic conditions*

The group especially likely to be subject to periodical changes under the effect of climate includes first of all the species wintering over at egg stage. Prolonged incubation period combined with low temperatures may result in a greater variation in some structures (especially in larval stages), compared to the species of short, spring or summer, incubation. The latter was also confirmed by laboratory experiments on e.g. *Podothrombium filipes*, *Trombidium holosericeum*, and *Sucidothrombium sucidum* (MĄKOL 2000b, MĄKOL & WOHLTMANN 2000, MĄKOL & GABRYŚ 2002).

· *teratological variation*

Teratologies – structural alterations under the effect of external factors (mechanical, physical, chemical), resulting in sharp morphological distinctness of individuals - are most often manifest as asymmetry of the structures concerned. In forms which undergo metamorphosis, injuries to earlier stages may result in symmetrical anomalies in subsequent stages (MAYR 1969). The border between teratology and anomaly is not clear, what is more, some authors use both terms interchangeably.

Unfortunately, in literature there are examples of descriptions based on one individual showing teratological characters. This is a completely erroneous habit, which is clearly stated in the ICZN Code (Art. 1.3.2). What is more – limited knowledge of intra-specific variation may be an obstacle to recognising teratologies.

Hitherto studies on terrestrial Parasitengona revealed that teratologies are much more often and more clearly pronounced in larvae, which develop from eggs that are subject to extreme conditions, e.g. during overwintering phase (MĄKOL 2000b, MĄKOL & GABRYŚ 2002).

· *secondary sexual characters*

Reproductive biology patterns obviously have an impact on the presence of secondary sexual characters. A clear sexual dimorphism occurs in several species of Parasitengona terrestria and is not related to any special taxonomic group. The differences may pertain to the shape of the body, structure of dorsal setae (e.g. *Erythraeus cinereus*), variance in leg structure (e.g. *Sphaerotarsus*), or structure of leg setae (e.g. *Balaustium*). The presence of characters significantly sex-correlated in adults, testifying to a strongly pronounced sexual dimorphism, was stated for *Trombidium holosericeum* (MĄKOL 2000c).

The specific biology of reproduction in Parasitengona may be reflected in biased in time mass appearance of females and males. In some species of *Podothrombium* the differences in phenology are so distinct that, together with strongly pronounced sexual dimorphism, can constitute a ‘false’ background for a statement about different specific affiliation of the two sexes. Unfortunately, even in the recently published papers authors do not seem to make enough effort to determine the sex of adult specimens, thus the knowledge of secondary sexual characters, especially within some mite taxa, is still limited.

· *reproductively different generations (sexual and uniparental strains)*

From the taxonomic point of view, parthenogenesis may be an obstacle in proper interpretation of the species. It was found that some species of Erythraeidae - *Abrolophus miniatus, Balaustium murorum* - display a geographic parthenogenesis. In the northern area of their range, only females occur, whereas in the case of *Balaustium araneoides* it was found that all specimens deposited in BERLESE Acaroteca are males. They are similar to *B. murorum* but they have quite different setae on legs IV. It is well possible that *B. araneoides* is the male of *B. murorum* and not only parthenogenesis but also sexual dimorphism were the reason for separating specific affiliation of the two.

· *continuous variation*

Disregard for continuous variation has led some taxonomists to describe an uncountable number of taxa, most frequently based on single specimens. For instance, in postlarval forms of Erythraeidae it is very common to give names to specimens based on the number of non-sensillary setae of the anterior part of crista metopica. As a result we have species called "*unisetum*", "*bisetum*", "*trisetum*", "*quadrisetum*", "*quinquesetum*", etc., whereas the intra-specific variation of this character is huge, which was confirmed by studies on extensive material. Similarly - within Microtrombidiidae and Eutrombidiidae there is a considerable variability in the number of specific palpal setae called basidonts. Again, we have a number of species called "*unispinum*", "*bispinum*", "*trispinum*" etc. One of the contemporary acarologists with a curious typological approach had a dilemma concerning a certain individual of *Eutrombidium* that had a different number of basidonts on the right and the left palp. Unfortunately, a lot of such descriptions appeared in the recent years, particularly relating to the larvae of Erythraeidae and Microtrombidiidae.

Among other types of variation there are also several that should be treated with special attention, however the conclusions concerning these sources of variation can be made after more extended studies on biology and ecology of particular 'taxa'. An environment-related (ecophenotypic) variation may result from conspecific individuals living in different habitats. Research should focus on the one hand on euryoecious species, on the other – on groups of species of minimal interspecific variation but inhabiting a variety of habitats. In case of host-induced variation it should be known if the parasites (larvae) show high selectivity towards host species (high host specificity) or if host selection (assuming that we are dealing with species of wider host spectrum) affects the variation within the parasitic stage (larva) and within the subsequent stages in further development.

SAMPLE SIZE

How many specimens to examine, how large a sample should be? According to MAYR & ASHLOCK (1991) a taxonomist who has adequate material for one species should not hastily assume that this makes it possible to be certain of the variability of related species.

The sample size should be in direct proportion to the degree of complexity of the studied taxon – thus, the more numerous the variation-determining factors, such as e.g. heteromorphic character of development stages, strongly marked sexual dimorphism, or phenological differentiation of males and females, the larger the sample should be. What is more, only the sample size that allows for a basic statistics of morphological characters (calculation of mean, standard deviation and variation coefficient) provides a contribution to the knowledge of the variation existing within the group. In any case metric characters on their own should constitute an only background for species description based on single specimens. Similarly – a descriptions based on a single specimen which is devoid of some essential structures, e.g. pedipalps or both legs I, may preclude future comparison with other, newly discovered species.

We analysed a hundred descriptions of new species in the papers of the author who has published the most new taxa in the last ten years and we found as many as 48 descriptions based on single specimens, 20 on two specimens, 12 on three specimens and only 20 on more. Moreover, some of the descriptions were supported only by metric characters. In the majority of such cases the starting point is the new taxon, there is no question of variation, or variation analysis is indefinitely postponed. Such procedures seem to relate to the – historical now – typological species concept. One of the results is an endless species list, whose verification borders on a miracle, considering the difficulties often implied in access to type materials.

Number of characters considered

Each of the variation-determining factors can constitute a source of possible error and – in turn – influence the correctness of taxonomic decision. Thus a long list of factors should be a sufficient argument in favour of analysing the largest possible set of characters.

A comparison of descriptions published at the turn of the 20th c. reveals drastically different numbers of characters considered by different authors when describing species which represent the same group of mites. Regretfully – according to ICZN Code – all such descriptions are regarded as valid.

In literature there exists a description of a new species based on one specimen lacking both legs I. Curiously, the author includes the species in the group distinguished by the presence of one specific seta on genu I and two similar setae on tibia I. In our opinion, there is also no excuse for such expressions as “gnathosoma badly visible”, “malformed” or “deformated” while it is exactly gnathosoma that has significant taxonomical features. It requires a minimum of professional ethics to abandon the description of a new taxon in such a case. In one of the analysed papers for seven newly described species (two of them based on two, and five of them based on one specimen) six had “gnathosoma badly visible”, “malformed” or “deformated”.

TECHNIQUES (METHODS) APPLIED

Modern research techniques view diagnostic (morphological) characters with different degree of precision. Characters observed in optic microscope in light field, with phase contrast or differential interference contrast, in spite of the same range of possible magnifications, may give a slightly different picture of the morphology and function (e.g. sensillary/non-sensillary setae) of particular structures. Much more drastic differences in character interpretation are those between optic and scanning microscopes. The answer to the eternal question of applying SEM, boiling down to whether or not the analysed structures are within inter- or intra-specific (individual) variation should not be a problem for a person who has experience in studies on a particular taxon. No doubt, SEM allowed a precise characteristics of morphological structures, moreover, in many cases it rendered it possible to correct an erroneous interpretation based on optic microscope studies. For this reason the technique should be commonly used in taxonomic studies, as supplementary to light microscope examination.

Biochemical techniques, especially the DNA sequencing method, increasingly available and popular in the recent years, though extremely precise, because of its high costs and obvious difficulties which may be implied in obtaining material for such studies, seems to be nowadays more applicable to taxa of higher than specific rank.

Another problem in acarology is the existence of several nomenclature systems which use different names for the same morphological and anatomical structures. Attempts at unifying the terminology, among others for Prostigmata (KETHLEY 1990) have failed.

The prevailing systems in descriptions of Parasitengona terrestria mites are „GRANDJEAN'S system" and „SOUTHCOTT'S system", in many instances modified by authors, resulting in appearance of new terms for the same structures. Priority principle should be applied to the existing systems of description – earlier proposed systems, assuming that there are no objective reasons to criticise them, should be a starting point for further improvement of the description formula.

IMPORTANCE OF ILLUSTRATIONS

"The old saw is true: One picture is worth a thousand words, especially in taxonomic papers" (MAYR & ASHLOCK 1991).

It is sometimes difficult to make an adequate and objective verbal description of certain structures. Generally, the authors may be divided into those who make decent drawings and those who make indecent ones. Unfortunately, many editors of scientific journals do not have adequate regard for the quality of illustrations, which results in a huge number of absolutely useless splodges.

The significance of a drawing in the description of a new taxon is often overlooked by the authors. The approach of one of them should be a warning: when asked why scutum was described as 1.5 times as wide as long (whereas the drawing showed it almost as wide as long), he answered: "a drawing is just of supplementary value".

IV. CONCLUSIONS

The aim of this paper was neither to discuss a new species concept nor to analyse systematics schools, such as evolutionary systematics, phenetics or cladism. We assume that the description standard, which should aim at avoidance of subjective approach, is independent of which school a scientist adheres to. Unfortunately, it seems that for some authors just intuition constitutes the starting point (it happens that also the only one) when describing a new taxon, however one should be aware that intuition may fail. Such an intuitive attitude seems to be more justified when it is positively correlated with author's experience (not assumed with respect to the results - as risky routine).

Standardisation of descriptions should thus include:

– treating variation, recognised within a group, as a starting point for the description of the new taxon;

– examining the largest possible series of specimens – only then can variation be perceived; avoidance of describing new taxa, esp. when no within the group variation is recognised, based on single specimens;

– considering not only morphological characters but also data on biology, ecology, geographical range and – if possible – molecular data;

– including in the description the largest possible set of characters – the description should not disregard the so called "less important" characters, however priority should be given to those which are important from phylogenetic viewpoint;

– with respect to morphological characters: for metric characters it is recommended to give the range of variation (min - max) and the variability coefficient, for meristic characters – range of variation;

– adopting a unified (at least for a given taxon) description formula; avoidance of coining new terminology, which would result in a long list of synonymous names referring to the same character;

– attachment of best quality illustrations, being in accordance with commonly accepted standards existing in the particular group;

– avoidance of using incomplete specimens as a basis for the description; in a case of the absence of an important structure, when only one specimen is available, no description should be attempted.

A possible control of standards may be proceeded by introducing of on-line data bases that would contain not only the name, but also history of the taxon and its properties illustrated in a graphical form.

Each description should be exact, reproducible and objective. Thus the most important properties of scientific nomenclature – uniqueness, universality and stability – listed by MAYR & ASHLOCK (1991) should also constitute an indispensable guideline for the commonly accepted formula of description, even though one should be aware that "the solutions adopted by specialists in one group of organisms may be quite different from those applied in another" (SCHUH 2000).

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