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Adam P. Kubiak
Maria Curie-Skłodowska University, Faculty of Biology
& Biotechnology, Lublin, Poland

Rafał Wodzisz
John Paul II Catholic University of Lublin,
Faculty of Philosophy, Lublin, Poland

Scientific essentialism in the light of classification practice in biology– a case study of phytosociology

Abstract. In our paper we investigate the difficulty that arises when one tries to reconsiliate essentialist's thinking with classification practice in the biological sciences. The article outlines some varieties of essentialism with particular attention to the version defended by Brian Ellis. We underline the basic difference: Ellis thinks that essentialism is not a viable position in biology due to its incompatibility with biological typology and other essentialists think that these two elements can be reconciled. However, both parties have in common metaphysical starting point and they lack explicit track of methodological procedures. Methodological inquiry involves less demanding assumptions than metaphysical, and therefore it is justified to analyse abovementioned discrepancy between Ellis and other essentialist in this context. We do it by bottom-up investigation which focuses on the practice of taxonomists in the particular field of biology. A case study helps us to discover four characteristics of biological typology practice: impossibility of algorithmization, relativity, subjectivity and conventionality. These features prove non-realistic and therefore anti-essentialistic character of biological classification. We conclude by saying that any essentialism related to the notion of biological kind cannot be regarded as justified by scientific enterprise of creating typologies.

Keywords: scientific essentialism, realism, taxonomy, clustering, subjectivity, philosophy of biology, phytosociology, vegetation.

Esencjalizm naukowy wobec czynności tworzenia klasyfikacji w biologii – studium przypadku fitosocjologii

Abstrakt. W naszym artykule zbadaliśmy trudność powstającą w obliczu próby pogodzenia esencjalizmu z praktyką tworzenia klasyfikacji w naukach biologicznych. W tekście przedstawiliśmy różne odmiany esencjalizmu ze szczególnym uwzględnieniem wersji bronionej przez Briana Ellisa. Zasadnicza różnica między dyskutowanymi stanowiskami polega na tym, że zdaniem Ellisa nie da się pogodzić założeń esencjalizmu z praktyką tworzenia typologii w biologii, natomiast zdaniem innych esencjalistów jest to możliwe. Jednakże, obydwa podejścia charakteryzuje filozoficzny punkt wyjścia i brak wyczerpującej analizy metodyki tworzenia klasyfikacji. Analiza metodologiczna wymaga mniej angażujących założeń, niż analiza filozoficzna. Dlatego przyjrzeliśmy się bliżej wspomnianej rozbieżności pomiędzy podejściem Ellisa i innych esencjalistów przez pryzmat praktyki taksonomów w konkretnej subdyscyplinie biologii. Przy pomocy studium przypadku odkryliśmy zestaw czterech własności epistemicznych charakterystycznych dla praktyki klasyfikacyjnej: niealgorytmizowalność, względność, subiektywność oraz konwencjonalność. Te własności świadczą o nie-realistycznym, a zatem również antyesencjalistycznym charakterze klasyfikacji w biologii. W konsekwencji stwierdziliśmy, że żadna odmiana esencjalizmu, w której wykorzystywane jest pojęcie biologicznego rodzaju naturalnego nie daje się uzasadnić w odwołaniu do tworzenia biologicznych typologizacji.

Słowa kluczowe: esencjalizm naukowy, realizm, taksonomia, grupowanie, subiektywność, filozofia biologii, fitosocjologia, roślinność.

Introduction

Scientific essentialism is a position grounded on realistic assumption about objectively and independently existing world. According to scientific essentialism science determines what we ought to agree on. We wish to track the objective features of science and check their significance in the light of scientific practice. When one thinks of biological essentialism, their thoughts would naturally recall philosopher's stormy debates on biological natural kinds and their classification. For this reason, we decided to descend from philosophical upland into biological lowland i.e. classification practice, to take a closer look at the philosophical problem from the perspective of scientific activity. Such an approach requires selection of a particular discipline as an illustration. The case study approach in this paper has been chosen because in different areas of biological investigation researchers operate with different types of kinds which need to be observed and explicated *in situ* (Love 2009, 53). At the same time, we treat our case study as a background for explication of how are the more general procedures and numerical tools for classification in biology functioning in terms of essentialists' demands for scientific realism. The field of biology, chosen here as the case study is phytosociology[1]. Phytosociological classification practice has many characteristics common with other disciplines of biology. I a nutshell, it is a branch of biology that is concerned with the classification of vegetation. In Central Europe, this is referred to as the Braun-Blanquet's approach (Zürich-Montpellier school) (Cf. Poore, 1955). It is an approach that attempts to define hierarchical vegetation types and hence create a typology. In this, it resembles the typological basis of organismal systematic. Specialist features of the given approach (e.g. cutoff points of particular species' land cover classes) are irrelevant for our discussion, because they do not limit our arguments concerning classification tools to the problems of this particular approach only[2].

The conclusion of our argument resembles the conclusion of the standard pheneticist argument against essentialism, i.e. that it is impossible to reconcile essentialism with any biological classification outcome. Original character of our argument is due to the way we reach this conclusion. We intend to follow Alan C. Love's postulate to reconfigure "the discussion about typology away from metaphysical questions about essentialism and toward the scientific practice (or epistemology) of classifying natural phenomena for the purposes of empirical inquiry" (Love 2009, 52). The problems of methodological procedures for classification seem to be neglected by scientific essentialists, and they are not explicitly tracked by phi-

[1] Phytosociology is well established in European research (Cf. Weber et al. 2000). It's importance is provided by the fact, that it can be used as a framework for land management and monitoring (phytosociological nomenclature is one of the basis for the European NATURA 2000 network habitat-type classification (Cf. European Commission 2007)), as well as a basis for ecological processes analysis cf. (Penman et al. 2008). Further reasons for choosing the particular discipline are given in section 3.

[2] For further, precise description of the method Cf. (Kent 2012, 275-292).

losophers of biology. In this sense we depart from the generally accepted approach (based on metaphysical or scientific premises) and we formulate our conclusion with the use of 'non-standard', i.e. methodological premises.

We begin with the outline of contemporary essentialist thought with regard to the domain of biology. We underline the basic difference between essentialists who tend to think that essentialism and biological typology are compatible and Brian Ellis. He thinks that essentialism is not a viable position in biology due to its incompatibility between these two elements. Next we investigate the reason of this discrepancy from the bottom-up perspective of classification practice in phytosociology. A case study helps us to discover four characteristics of biological typology practice. These features determine the character of biological classification in the context of realistic assumptions of essentialism.

Revival of essentialism

Essentialist approach in philosophy underwent a revival after the critique in the 20th century (logical positivism). It occurred due to the work of such philosophers as Saul Kripke (1980) and Hilary Putnam (1975). However the situation looks like in general philosophy, it is not reflected in philosophy of biology. Philosophers of biology are quite convinced that essentialist's way of thinking with regard to biology is rather naive and reflects superficial understanding of the domain. Nevertheless according to some it does not have to be necessarily so. As Michael Devitt puts it "the children are right and the philosophers of biology, wrong" (2008, 345). According to this author (his other works include 2009, 2011) and some others (e.g. Samir Okasha 2002; David Oderberg 2001; 2007; 2011) valid arguments can be found to support essentialist's position. In this part of our paper we wish to reassess the position of essentialism in philosophy of biology by scrutinizing arguments of the above mentioned authors.

Okasha argued for a weak version of essentialism[3]. His claim is that it is impossible to make some intrinsic essence of an organism responsible for the membership in a given kind. The reasons for that claim stem from Ernst Mayr (1982) and David Hull (1965). Mayr claims that intrinsic essence requires of a kind that it will not change over time and that is contradictory with the theory of evolution (which requires change). Furthermore, according to Hull kinds are not individuated by any essential properties (e.g. genetic properties), because it turns out that different criteria have to be applied in different branches of biology to specify boundaries between kinds (Okasha 2002, 196). Okasha's answer to these difficulties was to argue for relational essence of a kind on the ground that "On all modern species concepts

[3] The author himself does not call his stance in that way. We introduced that name to indicate the discrepancy among the authors defending essentialism. For more comprehensive description of varieties of essentialism see (Dumsday 2012).

(except the phenetic), the property in virtue of which a particular organism belongs to one species rather than another is a relational rather than an intrinsic property of the organism" (2002, 201). According to him we can and should accept relational essences to save the species category, because that allows us to maintain essentialist's project, at least partially. However, this answer is not satisfying, because it gives up too much of an essentialist attitude and what is more it does not answer the explanatory requirement[4]. As Ereshefsky notes: "The problem with Okasha's relational essentialism is that if the relations that serve as the identity conditions for a species are not central in explaining the typical traits among a species' members, then such relations are not essences" (2010a).

This topic had been picked up by Devitt. He is arguing for the thesis that takes the subject matter a step further: "Linnaean taxa have essences that are, at least partly, intrinsic underlying properties" (2008, 346). The properties in question are 'largely' genetic properties. The main argument that the author formulates in favour of his thesis starts with the observation that we group organisms and make certain generalization concerning their physiology, morphology etc. Now, if we think of grounds for such generalizations it turns out that they are founded on "the very nature of the group"[5]. According to Devitt basic assumption that biologists make is: "similarities are to be explained by some intrinsic underlying nature of the group" (2008, 352-353)[6]. Therefore, this nature contains a mechanism responsible for the superficial appearance of a given organism and can be identified as its cause. That sort of explanation is called *structural* – in Philip Kitcher's terms (1984).

The third author defending essentialism in biology is Oderberg. First of all he notes that it is quite obvious that there are essential differences between species: "One does not need to be a professional zoologist to note essential differences between elephants and tigers, birds [...] and so on ad nauseam, to be convinced that there are, of course, essential differences between species." (Oderberg 2007, 211) and from that he draws a conclusion:

> Since there *are* essential differences, the question is not *whether* essentialism is true but how, as it were, to carve the biological cake, such as how metaphysically informed biology, and biologically informed metaphysics, can most accurately reflect the divisions in nature via taxonomy. (2007, 211)

[4] The explanatory requirement: citing a kind's essence is central in explaining the properties typically associated with the members of that kind (Ereshefsky 2010a).

[5] Assuming that the group lives in a certain environment.

[6] This answer is not satisfying for Ereshefsky: „However, we do not know which intrinsic mechanisms are mechanisms that cause an organism to be a member of a particular species. We need some way of determining which mechanisms cause an organism to be a member of one species versus a member of another species. Here we must turn to relations..." (2010a) Recalling relations takes us back to critique quoted in context of Okasha's views.

But to give an answer for the stated question is to say what forms organisms have, because "nothing less than these [forms] can do the job essentialism demands, of explaining the distinctive and characteristic behaviour of organisms in a way that marks them off one from another according to their repeatable natures". (Oderberg 2007, 234). According to Oderberg what we ought to do is to study forms of living organisms. There lies the key to revealing the essence. Etymologically speaking 'morphology' is the study of forms. There is no coincidence and therefore the author claims, that "morphology creeps into virtually every major way in which species are identified in contemporary systematics" (Oderberg 2007, 235)[7].

The above points to a serious tension among essentialists alone (anti-essentialists left aside). There is no agreement on the 'essence of essence', and furthermore on the method that could be used for discovering it. Lack of unity among the defenders of the discussed stance does not prove its falsity. However it raises doubts and serves as a motivation for the argument we wish to draw. As a second premise we will use claim of another avowed essentialist – Brian Ellis, who with all his commitment argues for the impossibility of applying intrinsic biological essentialism to solve the species problem.[8]

What needs to be emphasized is that all of the above quoted arguments in favour of essentialism relay on the metaphysical considerations about species. Our aim is to change the direction of investigation by pointing it to more epistemological issues. Namely, we would like to focus on the actual practice of biologist's taxonomic work to show how anti-essentialistic this conduct is. Our investigation is not meant to resolve the problem whether organisms have essences and belong to any existing biological natural kind. Instead we would like to explicate why there is no sense of speaking of the 'proper' biological classification that would at best reflect objectively existing natural kinds structure or causal symptoms of essences. In consequence we want to argue that intrinsic biological essentialism should not be considered as 'scientific' in a sense that it is supported by result of specific biological classification practice (creating typologies). What we deem as potentially interesting, or original, is that this conclusion can be – as we try to show – derived from the set of premises, where the strength of the argument depends rather on methodological, than scientific or metaphysical assumptions. We think, that the former are minimalistic and therefore less demanding, than the latter which tend to be maximalistic.

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[7] Oderberg finds strong support in the views of Richard Mayden, although the latter thinks that morphology is appropriate, only as a „secondary species concept" (Mayden 1997).

[8] Understood either as a taxon problem or as a category problem. The distinction as in (Devitt 2008, 357-358).

Ellis' essentialism

Brian Ellis proposed an idea of metaphysics designed specifically for scientific realism, which he calls scientific essentialism. According to him this is the only appropriate metaphysics which grasps the dynamic nature of the world revealed by modern sciences. As he puts it, "scientific essentialism is proposed as a metaphysics for scientific realism which is compatible with [...] the evident dynamism of modern science" (Ellis 2001, 2). One of the main theses that builds this position describes the relation between the laws of nature and the natural kinds, which is significant in the context of our investigation. Ellis states that the natural kinds of processes are hidden behind the laws of nature and these are responsible for each pattern of reaction that we can observe. This thesis ascribes the central role in the process of explanation to natural kinds. The laws of nature hold only between natural kinds of substances, processes and properites. It also implies that the search for natural kinds is of primary importance in scientific enterprise. The importance of natural kinds requires good criteria for their distinction and Ellis provides them.[9]

The basic idea is this: if the domain of explanation consists of determinate natural kinds, then essentialist's explanation can be applied. The notion of natural kind wakens the immediate association with biological kinds. But according to Ellis the connection is pretty weak. Biological species are not natural kinds, but rather they form clusters of genetically similar (but not identical) beings.[10] Organisms within one particular biological kind display no perfect resemblance among each other which one should expect according to requirements posed by Ellis:

> The instances of each infimic species[11] of natural kind in the category of substances must all be essentially the same. For if they were not, then the species would have sub-species. (2001, 70)

Because Ellis rejects determination of kinds in the domain of biology, the idea that essentialist's explanation can be applied there should be left aside.

One stands in front of the following alternative: (A) either to admit that essentialism cannot have unified character throughout all of the domains of scientific investigation – for that simple reason that boundaries between biological kinds are

[9] The natural kinds have to fulfil the following requirements: objectivity – the distinctions between natural kinds are based on natural kinds essences; categoricallity – natural kinds build separate ontological category independent of human convention; intrinsicallity – natural kinds cannot differ only extrinsically; speciation requirement – two intrinsically different members of one kind must belong to two different species of that kind; hierarchy requirement – two kinds cannot overlap, there has to be some common genus if something belongs to two different natural kinds; essentiality requirement – essential properties and real essences help to distinguish natural kinds from other sorts of things. (Ellis 2001, 19-21)

[10] It has to be noted that Ellis' view has evolved in that respect, because in his previous book he wrote: „I accept T.E. Wilkerson's view that biological species are more or less salient clusters of intrinsically similar natural kinds…" (Ellis 2001, 170).

[11] "These are species that have no sub-species, and whose members are therefore essentially identical" (Ellis 2001, 3).

not as determinate as boundaries between natural kinds discovered by e.g. physics or chemistry, but that leaves us with pluralism of essentialist explanation; (B) or to argue for the determinacy of biological species. Ellis picked the first possibility, but others like Devitt (2008) and Oderberg (2007) give arguments to support the conclusion that biological kinds indeed are determinate.

We arrive here at the crucial point. The reason why Ellis picked (A) has something to do with the complexity of beings in a given domain. Biological organisms are complex and as such their intrinsic characteristics cannot be easily tracked down:

> As we move to yet more complex systems, from biological organisms up to ecological or social systems, natural kinds analyses become much less interesting. There are no natural kinds that satisfy the strict criteria applicable to chemical kinds that can readily be distinguished, and there are no sets of intrinsic characteristics of ecological, economic, social or other high-level systems that could plausibly be used to define appropriate microspecies[12] (Ellis 2002, 32)

Ellis requires from biological species to be determinate to an accuracy of gene. Only genidentical species can be considered to be natural kinds with (at least partially) intrinsic essences. Being genidentical is so important for members of biological species, because otherwise we get arbitrariness and we want to avoid that. The other thing we want to avoid is the lack of causal mechanism, which would be responsible for the occurrence of superficial characteristics of an organism. Because biological kinds are not genidentical, therefore Ellis refuses to apply essentialistic explanation to the domain of biology.

This view developed by scientific essentialists gives us a good answer to the question, whether essentialist explanation is possible in theory of biology. It appears that the opponents of essentialism in biology, who tend to prefer essentialist taxonomies have been misguided, because according to scientific essentialism the biological classification project cannot be founded on the essentialists principles.

Vegetation taxonomy procedures and their problems concerning essentialism – case study

In the context of essentialism the debate about biological classification generally refers to evolutionary or/and developmental biology. It is established, that typological essentialism of natural kinds is incompatible with biological taxonomy of species, because species undergo substantial evolutionary change (Hull 1965;

[12] Kinds on genidentical organisms that could be regarded as subspecies of ordinary species. Called „micro" because „they are not species as we ordinarily understand this term, since no one such "species" could possibly contain both males and females" (Ellis 2002, 30).

Brigandt 2009).[13] According to Hull (1965, 319-322) taxonomists had two kinds of approaches in history: those who regarded phylogeny as representative for natural classification[14] and those who denied it any relevance to taxonomy. For the latter group, the unit of classification was the unit of identification, whereas for the former group the unit of classification was the unit of evolution. Phytosociological classification fits the latter approach in a sense that it does not take into account ancestry relation, and also does not use criteria of potentials or functional properties between the samples. For this reason phytosociology moves our considerations away from evolutionary and developmental perspective, while still being a case of classification in one of the domains of biological sciences. Secondly, phytosociological classification is not created in order to explain, but rather for the purpose of description – grouping outcome is here treated as a background for the further investigation aimed on explanation and prediction. For this reason it is not so easy to reconcile phytosociological clustering with essentialism by using the strategy proposed by Reydon (2009)[15]. Finally, vast majority, if not all, examples used during philosophical reflection on essentialism in biology, are of *animal*-, *cellulo*-, or *genum*-type, so contribution with the reference to plant biology might be a desirable one.

We assume that although there are different branches of biology, where different kinds of methods are used, there is a unifying factor, which justifies making general claim on the basis of single case study. Namely, inherent characteristics of classification methods (e.g. mathematical procedures) are common for separate branches of biology.[16]

Contemporary biological taxonomy of natural kinds is determined by computer grouping (clustering) – one of the methods of data mining. The goal of clustering is to discover the natural grouping(s) of a set of patterns, points, or objects. Often, a clear distinction is made between "clustering" and "classification" – the latter involves predefined training patterns and category labels (Jain, 2010)[17]. Our discourse concerns only clustering practice, because it is expected to describe objective patterns taken from nature[18]. Phytosociological taxonomy practice is representative for the framework of understanding natural kinds as homeostatic property clusters

[13] Even when this idea is accepted, it can still be shown, that Aristotelian essentialism, when abstracted from typology, can be successfully reconciled with developmental biology (Walsh 2006).

[14] Hull adhered to those in a radical form: "organisms belong in a particular species because they are part of that genealogical nexus, not because they possess any essential traits"(1978, 358)

[15] Reydon proposed a fixation of homeostatic property cluster theory (in terms of its inconsistence with essentialism) by adding extra criterion of kind membership: playing an interesting explanatory/causal role (which for him equals functional role) in the structured system.

[16] We claim that there are some universal methods of classification for the whole domain of biology, and the only reason why we are not giving an extensive justification for that is the complexity of that task. It would require – e.g. with means of consensual epistemology – to question the community of researchers if they accept our claim. The role of case study serves as a working example of how some of these epistemic procedures are functioning.

[17] In this text we will use terms "classification", "clustering" and "grouping" interchangeably.

[18] For a broader description of classification with predefined patterns Cf. (Kotsiantis 2007).

(Boyd 1991), which has been established in biological taxonomy even before Darwinian revolution (Winsor 2003).

The high degree of sophistication of numerical methods of grouping used in biology, suggests that they do not have any subjective, relative or conventional elements, and thus that the results give a true picture of the real objectively existing natural kinds, based on the real properties of objects belonging to these kinds. Whereas from the practical research perspective, it seems that the element of subjectivity and convention is significantly present in the creation process of generic biological classification. This can be illustrated with a case study in the field of geobotany, in particular with the numerical classification of so-called syntaxons, that reflects phytosociological vegetation types[19].

Problems with the realistic understanding of classifications are noticed by the authors of phytosociology handbooks. Although vegetation ecologists (including phytosociologists) usually lack philosophical background and they do not refer directly to essentialist position. Kent in his "Vegetation Description and Data Analysis" (2012) labels numerical classification approach as "objective" (Kent 2012, 307), but at the same time he explains that, what is actually being meant by this notion is something weaker:

> [...] although any one numerical method is objective in the sense of repeatability for one set of data, there is no unique solution or single classification of a set of data. As with ordination methods, the 'best' classification is one that enables a clear ecological interpretation to be made (Kent 2012, 308).

According to a different handbook "Przewodnik do badań fitosocjologicznych" [A guide to phytosociological research]:

> By making the transformation of data and selecting one measure of similarity from many possible and choosing classification or sorting algorithm we are far from objectivity. We simply choose such procedures which are the best according to our knowledge in terms of the nature and the purpose of research data. (Dzwonko 2008, 195)

Vegetation ecologists already in the 70's presented anti-essentialistic intuitions about biological classification in general. This view is reflected by following expression:

> […] in order to study vegetation, or any other biological phenomenon, it is necessary to create order, to identify small units which it is possible to study. It is important to recognize that any classification is only a working hypothesis, an *ad hoc* fiction necessary to advance scientific understanding, but whose usefulness is limited to the particular situation for which it was formulated. Unfortunately, the essential purpose of classification and its intrinsic limitations seem often to have been overlooked. (Miles 1979, 65).

[19] For the example of numerical clustering practice in phytosociology with the use of big set of data Cf. (Šibík et al. 2005)

Considering essentialism in general someone holding essentialist position does not need to be a realist (e.g. Consider Locke's nominal essences). But question about realism of classification is an important issue when one examines biological essentialism. Attempt to reconcile that kind of essentialism with the outcomes of biological research without realistic understanding of these outcomes seems to be futile.

In the following parts of our paper we track anti-essentialistic features occurring in particular stages of classification.

The stage of data selection

The problem with objectivity appears at the early stage of a grouping, when features that most accurately characterize the type of object are being selected. For example imagine describing phytocoenoses, for which the vertical structure of layers are taken into account, and participation of the given species in the layers is indicated. When we put that raw data into numerical table we have to decide how to treat the data describing these layers. Let us consider the following example: we selected two model types of treatment of the particular tree species that occurred in more than one layer in the sample:

(1) each occurrence was treated as a separate species, or

(2) only the layer where the occurrence of the species indicated maximal participation was considered.

The small set of model research data gathered by Łuczycka-Popiel (1981) was classified by us using the MVSP[20] program. Both types of treatment resulted with two different classifications (Fig.1)[21]. Moreover, none of them was consistent with the output classification which was made by Łuczycka-Popiel with the use of her expert knowledge, and without a computer. This state of affairs is revealing. Different classification outcomes of the same set of biological objects, are relativized to the selection of properties, or method of recognizing the problematic details of gathered data, which quite often, in a specialized method of the given discipline, turns out to be a subjective choice of the researcher.

[20] Multi Variate Statistical Package – one of the standard programs for performing digital classification and regression analyses in many scientific fields, used commonly in phytosociology. See: http://www.kovcomp.co.uk/mvsp/index.html. Several other programs are used by phytosociologists, e.g. SYN-TAX, STATISTICA, PAST, CAP. Cf. (Wysocki, Sikorski 2009). MVSP uses agglomerative clustering strategy – creation of a dendrogram starts with all the objects clustered separately, and then the most similar objects and/or clusters are successively combined until they all get into a single hierarchical group (Kovach 2007, 56).

[21] It is acknowledged, that groups of samples representing types of communities of the same syntaxonomic rank may be created with different values of similarity, e.g. accordingly to the type of community or species richness. The resulted dendrogram is usually regarded as the basis for the outcome and is interpreted without further testing the significance of group differences.

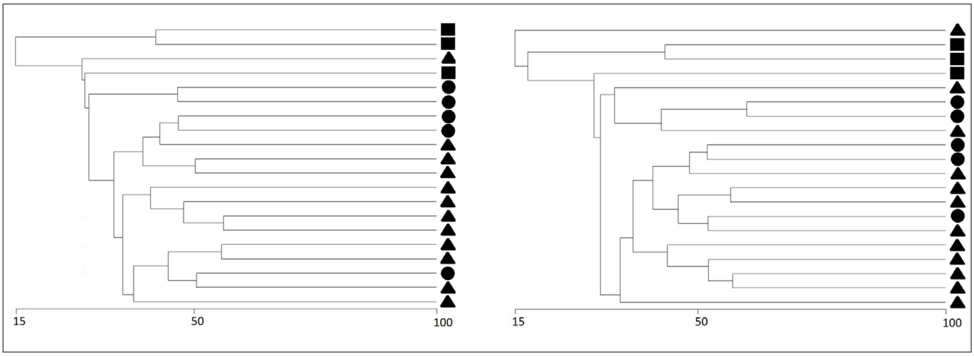

Fig.1. Case (1) on the left hand side - each occurrence was treated as a separate species, case (2) on the right hand side - only the layer where the occurrence of the species indicated maximal participation was considered. Each figure (square, circle, or triangle) represents different element of one of the three types of originally classified syntaxons (types of forests). Horizontal axis gives the value of "percent similarity" measurement – mean similarity between all possible pairs taken from two groups.[22]

The stage of data transformation

Another subjective element stems from the decision about the method of data transformation i.e. normalization of attributes. Agnieszka Piernik in "Zastosowanie metod numerycznych w ekologii" [The application of numerical methods in ecology] has written:

> There is no explicit answer to the question whether one should use transformation or the original data. Often, analyses are performed for both the original and the transformed data and then this result is selected which more precisely reflects the observed regularity of the nature (2011, 9).

Additional issue to consider at the stage of data transformation is the various importance of different individual species. Without taking it into account, the classification made at the given level of the hierarchy will bear greater randomness. Identification of and ascribing the importance to a species requires knowledge of their ecology. Species having a wide range of ecological spectrum, as well as incidental species uncharacteristic for the given type of forest, will have smaller importance. The biologist knows the order of the importance of species, but at the same time she may not know what exact "values" of importance should be ascribed to a particular species, so that it would reflect the structure of data in the best way. So, to some extent researcher proceeds by trial and error in a search for a set of values that would give a result more or less accurate to the classification based on her direct

[22] In this figure, as well as in fig. 2 below UPGMA method for metric scales (Unweighted Pair Group Method with Arithmetic Mean) has been used.

examination of the structure of the given vegetation data.This issue is demonstrated in our attempt to achieve – with the use of TWINSPAN program (Hill 1979)[23] – a classification that would be adequate to Łuczycka-Popiel's. We obtained such an adequate outcome after several trials of giving different rank degree to the set of species that are regarded by the phytosociologists as characteristic for the given three types of forests. The last problem that we would like to mention here is that classification regarding intensity of the feature (species abundance) often leads to representation of lower syntaxonomic units, whereas classification regarding only presence/lack of the feature – to higher units[24].

It seems that the use of information technology becomes a partial manipulation of the data in order to confirm the expectations of the researcher. In the search for an outcome that would most accurately resemble researcher's view of the investigated reality, she sometimes must conduct by trial and error, and her final decision is made on the basis of tacit knowledge[25] and pre-scientific intuitions[26]. In our case the set of data was small (18 samples), however, the preliminary direct evaluation made at the beginning is constrained when the set of data is larger. Then a decision for the way of data transformation, for instance, in the case of ascribing the above mentioned ranks, becomes more subjective, or simply haphazard.

The stage of choosing a measurement procedure

Another example of relativity in the researcher's procedure arises when the measures of similarity (distance) are selected. This point was noted by János Podani: "Classification and ordination methods do have their own limitations, of which compatibility of a procedure with a type of data is of primary concern" (2006, 114). That problem is apparent for example in the disagreement among methodologists about whether phytosociological data is rather of ordinal or ratio type[27]. We carried out the classifications based on the Łuczycka-Popiel's data, using the

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[23] That program allows to ascribe ranks to the species. It works with different framework than the MVSP. Classification is in this case performed with the use of divisive technique. It means that top-down divisions of set of samples into two classes on the basis of the identified factor species characteristic for the given level of division are repeated (Cf. Gauch 1982, 201).

[24] Clustering thus is often made with the use of both data representations (quantitative and binary), where both outcomes are compiled according to the rule of *strict consensus partition* (Podani 2000).

[25] On the idea of tacit knowledge, see (Polanyi 1966).

[26] Intuitive ontologies, such as similar folk taxonomies across the world, with believe that category-specific forms have its hidden species-typical essences, is believed to influence scientific cognition (Cf.de Cruz, de Smedt 2007).

[27] According to what scientists think about the nature of the given data, they propose different programs as appropriate. For example Podani sees phytosociological data as non-metric, utterly rejects using some methods, such as UPGMA (Podani 2005). On the contrary, van der Maarel (2007) disagrees with Podani's view, and claims that classical phytosociological scales comes closer to a metric after some simple transformations, which he himself proposed.

MVSP program. For the measurements we used two different sample similarity factors:

(i) "percent similarity" and

(ii) "cosine theta",

Two outcomes differed from each other (fig.2). These were also different from the Łuczycka-Popiel's results.

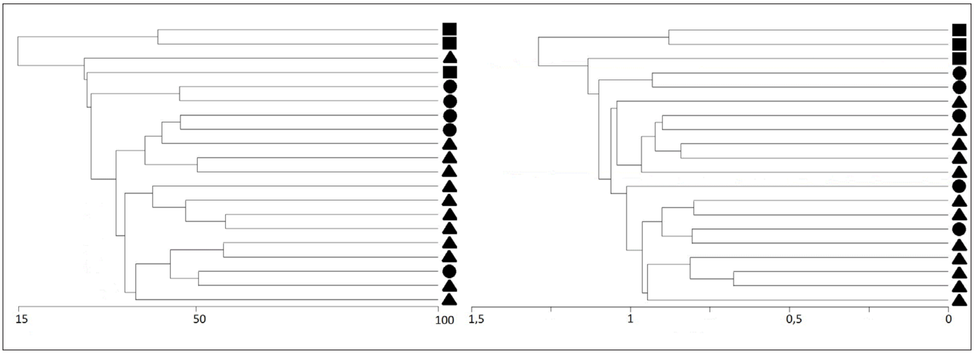

Fig.2. Clustering outcome with the use of "percent similarity" measure – on the left hand side, and "cosine theta" measure – on the right hand side. Layers in both cases treated as in (1).

The difficulty of the decisions about choosing a program and procedures for the creation of clusters lies in the need of getting familiar with expertise mathematical knowledge, and that is demanded from biologist.

> The deliberate and effective use of these methods [modern methods of numerical classification] requires knowledge of the underlying theories which are usually contained in the textbooks, this knowledge cannot be replaced with the manuals designed for computer programs (Dzwonko 2008, 217).

In fact, getting familiar to an adequate extent with the theory of these textbooks often requires the advanced knowledge and the ability to use the conceptual apparatus and methods of mathematics, and as such it is unaffordable for practising biologist. Moreover, familiarity with mathematical tools available for plant ecology is constrained not only by growth of their mathematical sophistication, but also by increasing number of programs. A mathematician finds himself in analogous situation: in order to choose the proper method she would have to familiarize himself with the meaning of the data assigned to it by the biologist, also she would have to properly understand biologist's research goals in the perspective of a given biological theory. Rapid development and deeper specialization in the fields of mathematics, computer science and biology, make such an interdisciplinary approach difficult. Even if the biologist would be able to choose more or less appropriate mathematical methods for the classifications she carries out[28], in his practice she will have to accept the loss of some kind of accuracy.

The role of a theory

Ellis claims that when the level of complexity of the subject under investigation rises, than the obtained division becomes less natural and the intrinsic character of the given kind is less apparent (Ellis 2002, 32). As it seems Ellis presupposes that if we define basic units of classification at the higher level of organization, then it has negative influence on the observation accuracy. An example akin to Ellis' thesis is reductionistically oriented Adam Łomnicki's critique of phytosociologists. The author suggested that the negligence of accuracy and realism of investigation stems from the unrealistic ideal of „superorganism" that is present in phytosociology:

> [Systemic approach of modelling biocenoses in analogy to organism] moves ecology away from the science and from precise measurements of investigated phenomena and so it falls into the arms of philosophy. The philosophy that is not bad, because descended from Plato, but unfortunately least useful for ecology as a science (Łomnicki 1978, 250).

Let us leave aside the question of whether model of phytocoenosis really do reflect ideals of „superorganisms", or if application of Platonism has negative influence on precision or practicality of ecological models. The point is that the abovementioned problem is not genuine for phytosociology. Biology concerns itself with life forms that are units of higher level of organization. What is more, the aforementioned problems of taxonomy will occur in practice of biology in general, since there are analogical procedures of numerical classification in other branches of biology. The only difference is that in them instead of species occurrence (when the sample is plot), there are gene occurrence or other features (when the sample is population, a specimen or a cell) – for classifying program it does not matter what in reality is represented by numbers in the matrix. Whether it is category of relation, gene, or morphological property as Okasha, Devitt and Oderberg respectively advocate, is irrelevant.

Attitudes of biologists vary from reductionist to holistic according to different theoretical frameworks and models that they use. Framework adoptions are made on the basis of the philosophical assumptions[29], as well as according with scientific

[28] There are of course some more or less successful particular interdisciplinary guidelines for practicing ecologists, such as Jongman's et al. (1987, 180-183), where chosen features (ex. sensitivity to dominant species) of the similarity/distance measures that are most commonly used in ecology are presented, or Gilliam's & Saunder's (2003) comparative review of CANOCO, PC-ORD and SYN-TAX – versions of analytical software packages used widely by ecologists for ordination or classification.

[29] For the overall presentation of the problem of holism-reductionism and standpoints cf. Rosenberg (2007).

convenience – in terms of practice and goals[30], what is concisely confirmed by Reydon:

> [...] Scientists entertain particular ontologies because these make sense in the context of particular theories – more specifically, because the kinds included in these ontologies can serve as the bases of generalizations, explanations, predictions, etc. (Reydon 2009, 726).

In phytosociology one of the most important assumptions is the understanding of plant communities as highly integrated assemblages occurring repeatedly over the space and being distributed within the habitat gradient discontinuously (Clements 1916).[31] Any accepted assumptions may be conditioned by the given goals, as well as inversely. Methodological pluralism in plant syntaxonomy speaks in favour of epistemic relativity of created classifications[32], therefore it might be better to treat those classifications as conceptual conventions, in which the judgment about their adequacy in respect to the objective metaphysical hierarchy of nature is suspended[33]. At least science itself does not provide the answer which convention would be the most adequate, since “the taxa recognized by different systems of classification may be natural in different respects” (LaPorte 2004, 27)[34].

Conclusions

Our explication of scientific grouping practice demonstrates with regard to the case study at hand that the selections of essential features, transformation method, or measures of distance are partially dictated by the subjective or even random choice. They are also driven by conventions dependent on convenience of researcher and her evaluation of the input data in the light of her research goals. The outcome is also relative to researcher’s background theory, which determines her plans and conducts of research and provides interpretation of these outcomes. It is particularly important if we take into account that the numerical methods abstract from

[30] For example, approaches of higher level of organization, such as phytosociology, can be more cognitively relevant and more practical, as they allow to embody the emergent properties and recognize the specificity of phenomena – those that yields in reductive descriptions – and they make larger scale predictions available. For example of methodological argumentation for antireductionism in ecology, cf. (Trojan 1988, 257-263).

[31] Contrary idea stems from Gleason (1926). The followers of this idea believe that the variation in species composition is of continuous character, where associations are understood as collections of species distributed accordingly to their individual reactions on gradient change and random spread which is a result of fluctuations and disturbances.

[32] That is not a subject of our discussion. Processual element present in the existence of the nature makes it more difficult to formulate classifications adequate to the observed state. Especially in plant taxonomy change of natural clusters follows in perceptible way within few decades, in particular in such phytocoenoses as meadows, whose change is driven in immerse extent by the human influence (Cf. Kącki, Śliwiński 2012). Example proposal of actualized regional classification of meadows can be found in (Kucharski 2004).

[33] It might be seen as an argument in support of metaphysical pluralism (Cf. LaPorte 2004).

[34] LaPorte formulates a criterion of gradual naturalness of kinds, and he identifies it with their explanatory value.

the semantic content of the analyzed data. Hence, different classification methods which would be used for analysis of the same set of the numerical input data can give different, but empirically adequate results. These observations bring us to the conclusion, that biological classification activity and its outcomes have four inherent characteristics:

– it is partially relative,
– it is partially subjective,[35]
– it cannot be fully algorithmized,[36]
– it is saturated with conventions.[37]

The presence of these features leads to the relaxation of the realistic assumption of biological classification. Considering our case study, it can be expressed as follows: “In fact, associations and other types of plant communities are not discovered, but singled out or created on the basis of the conventionally accepted criteria” (Dzwonko 2008, 56). Such a finding corresponds to the Love’s views:

> Typologies are elements of particular methodological approaches; typological thinking is a form of scientific reasoning utilized for the purpose of understanding a specific aspect of living phenomena (in the case of biology) (2009, 59).

Four identified epistemological qualities of biological classification cause a discrepancy between taxonomy practice and scientific essentialist view. We draw the conclusion that the occurrence of the discussed discrepancy is independent from the particular biological theory that would be taken into consideration. It is also independent from the definition of a natural kind. As we tried to show in our case study the above follows from the fact that the more fundamental source of this discrepancy is the nature of biological classification procedures, which makes them inconsistent with essentialism[38]. These procedures are by no means specific to phytosociology, but widely and similarly applied in many different fields of natural and social sciences. Therefore the generality of our conclusion about biological classification is founded, although we use only single case study. What is more, these four above mentioned unrealistic qualities of biological classification appear regardless of what category will appear in the headline of the matrix containing the numerical

[35] The first two follow especially from 3.1, 3.2 and 3.3.

[36] This follows from the presented existence of indispensable human character of decisions specific to every stage of research (such as these referring do tacit expert knowledge, or to interpretation of the numerical outcome).

[37] This follows from 3.4, as well as from the above quotations from: (Kent 2012; Dzwonko 2008; Miles 1979; Piernik 2011).

[38] Inconsistence of essentialism and scientific practice is not exclusively the problem of biology with its „integrating” approach, but as well of the most “analyzing” branch of physics. It seems that it is extensive problem in interpreting elementary physical particles as essentials, considering the fact, that there is difficulty in identifying them as individuals and in identifying them in space and time (cf. Castellani 1998 *passim*). Whether it is a problem of a nature of a particles, problem within a theory, or a problem of measurement apparatus - that’s a different question.

research data. Whether it is category of relation, gene, or morphological property as Okasha, Devitt and Oderberg respectively suggest.

At the same time, it seems reasonable to argue that possibly objective kind-unit structures, on different levels of organisation, are observable in the pre-scientific understanding. The results of scientific classification can differ from the classifications based on the common knowledge and it is difficult – taking into account the problems mentioned above – to judge which one has a greater value of truth and objectivity. Problem of reconciling essentialist view with biological classification is actually not only[39] the matter of specific nature of biological "kinds" (i.e. high temporal changeability, or heterogeneity of individuals) but it is even more the matter of nature of classification tools and research practice.[40]

Our discourse brought us to acceptance of the claim that human decision – with its cognitive limitations – determines the non-realistic character of biological classification, what Ellis expresses in the following words:

> to achieve a classificatory system that is valid for past times as well as present, we must decide on how to divide this spectrum [of biological creatures] [...] However, if we have to make such decisions, then the distinctions become *our* distinctions, not nature's (2002, 29).

It is not clear why Ellis so easily reconciled with this result. Even though it is surprising in the light of his general requirements about objective natural kind structure of the world. Nevertheless when one gets the bigger picture and sees essentialism "as a metaphysical research programme – a possible framework for testable scientific theories" (Popper 2005, 195) and less as an accurate assessment of contemporary capabilities of science, the relaxation made by Ellis becomes more comprehensive. In the context of our results Ellis' scientific essentialism seems to represent appropriate philosophical account which gives its credit to both methodological requirements of biology and realistic requirements of essentialism.

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[39] Metaphysically orientated researcher could argue that it is only the matter of the specific nature of biological kinds. Because of epistemological orientation of our research we refuse to accept such a strong claim.

[40] We think that impossibility of algorithmization, subjective, relative and conventional elements are indispensable for scientific practice. One could raise the objection that scientific enterprise is developing all the time, and therefore in the future it might reach the point when these elements will indeed become dispensable. Once one get acquainted with the methodological standards of biological classification and with practice of doing taxonomically-oriented research, then he will have to admit that it is fairly unrealistic to get rid of theses inherent characteristic. Nicholas Rescher expresses similar thought: "Perfected science is not a realizable condition of things but an idealization that provides a useful contrast-conception to highlight the limited character of what we do and can attain" (1999, 145).

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