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CLASSES AS CLUSTERS
Peirce on Evolution and Classification in Biology

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That classifications are useful seems evident. Human beings are classifying animals or, as has been said, to classify is human[1]. Perhaps not only humans but all living creatures have to classify what appears in their environment into bright and dark, food and foe, and many other categories in order to find their way around in the world[2]. This is what has been said about the concept of human nature or the species «Homo sapiens»: that the concept has organizing, descriptive, and explanatory functions can also be said for the concept of class or species in general. And it is this multi-functionality that makes concepts like «category», «class» or «natural kind» philosophically contentious[3].

Therefore, although classifications are useful, their possible objects (classes) are not so easily acceptable in their existence. For it seems that when humans are in contact with the world by perceiving or acting, they are only meeting concrete particulars. They see *this* cat, they eat *this* carrot. Humans do not encounter the natural kind of *Feliformia* or eat *Daucus carota* as such. Thus, the philosophical question arises from an empiricist standpoint: how are generalities given to humans, if they are given to them at all? Or are they just constructs by which they try to organize the many particulars and perhaps similarities between them that are given to humans? In what sense can humans refer to generalities and with what justification can they claim that generalities are real? These questions are well known in philosophy as the «problem of universals».

1. A Well-Known Story About Organisms and the Problem of Universals

Since the time of Plato and Aristotle, the observation of the fact that living beings reproduce themselves in stable patterns has had far-reaching consequences. To experience that frogs beget frogs and humans beget humans was to experience stable complex patterns in nature. How was this stability possible? The terms *εἶδος* (species, idea), *γένος* (genus, kind) and *μορφή* (forma, shape) were introduced into philosophical terminology in order to tackle this question. The stable form of organisms was passed on over the generations. The similarities between parents and children are obvious. It seems that generalities must be accepted to exist as that, which is passed on in order to explain these similarities among individuals of different generations,

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[1] See G. C. Bowker, S. L. Star. *Sorting Things Out. Classification and Its Consequences*, MIT Press, Cambridge 2008.

[2] See N. Luhmann, *Social Systems*, Stanford University Press, Stanford 1995.

[3] M. Kronfeldner, *What's Left of Human Nature? A Post-Essentialist, Pluralist, and Interactive Account of a Contested Concept*, MIT Press, Cambridge 2018.

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although they cannot be observed independently from the particular individuals. Thus, the problem of universals is tightly connected with the observation and understanding of reproduction in animals and plants. One might say that the stability of the structures of the living over the generations motivated the postulation of universals and that all new thinking about reproduction in the organic realm had consequences for how philosophy dealt with universals.

Plato discussed in his dialogue *Sophistes* the question if what is real is what is «omnitemporally stable»[4]. He believed that only the eternal that exists in an immaterial mathematical sphere of immutable entities can be real in an emphatic sense. Aristotle criticized this view by claiming that there is no such realm and that forms must always be instantiated in material particulars[5]. But Plato and Aristotle agreed that the forms must be eternal. In their theory of definition, one looks for the species to which an individual belongs to identify the essence of this individual. And this essence is eternal. They differ in their answer to the question «what mental capacity gives us access to universals». Aristotle thought it is the capacity of abstraction that leads to the illusion of a possible independent existence of the universals. Plato believed in a special type of intuitive, mathematical knowledge, that allows humans to have access to the realm of the abstract. These Platonic and Aristotelian theories about the reality-status of universals in general and species in particular dominated western thought over the centuries.

Charles S. Peirce takes a different and definite stance on this topic. He criticizes harshly the anti-platonic philosophies of conceptualism and especially nominalism that existed before evolutionary thinking and got a new «push» from Darwin's theory. The view that universals are merely mental or linguistic constructions became more and more fashionable in the 19th century – a position Peirce opposes on many occasions. Peirce thinks that classes can be real. But at the same time, he develops a very special understanding of those universals that troubled philosophers thinking about the natural world since ancient times: they are not eternal and they are not sharply definable; they are clusters, objects with fuzzy edges. But according to Peirce, these characteristics – i.e., the fuzziness and the historical plasticity of classes – must be accepted if one accepts a theory of the evolution of species without believing that this theory proves the unreality of these generalities. It is with respect to this last point that he sees himself in agreement with Charles Darwin, the scientist who supposedly ended the career of natural kinds in the understanding of the living for many other philosophical interpreters of his theory.

2. The Philosopher's and the Biologist's Natural Classes

With Darwin, classification got a new foundation. The stunning anatomical similarities between organisms could now be interpreted as the result of their evolutionary

[4] Platon, *Sophistes*, 248a4-13; Plato, *Sophist*, in Id. *Thaetetus. Sophist*, translated by H. N. Fowler, Harvard University Press, Cambridge 1921. Cf. W. Künne, *Die ‚Gigantomachie' in Platons Sophistes. Versuch einer analytischen Rekonstruktion*, «Archiv für Geschichte der Philosophie», 86, 3, 2004, pp. 307-321.
[5] Aristotle, *Metaphysics*, A. 987b7-14; Aristotele, *Metaphysics*, translated by H. Tredennick, Harvard University Press, Cambridge 1989.

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kinship. Zoological and botanical classification became evolutionary taxonomy and lost its museological flair. Before Darwin, classification was platonic insofar as it explained the anatomical similarities between organisms by reference to the supposed «participation» (μέθεξις) in abstract forms existing in a realm of eternal essences. If classification is understood as depending on the existence of such forms, evolutionary theory could be considered a threat to classification itself, since it produces a genealogy of these forms and shows them to be constantly changing. Then the question arises: How could such changing forms still be used to classify things in a reliable way? Only a nominalist understanding that took classes to be useful but malleable instruments for bringing order into the museum seemed to be left to those who accepted Darwin. But is it really plausible to believe classes to be mere constructions given the paleontological evidence about the similarity of organisms that had been extinct long ago with living ones? In fact, the business of classification experienced a boost after Darwin, because it was felt that evolutionary theory is not a threat to classification but gives more scientific backing to it than Platonism and Nominalism. Peirce might have also taken this boost to support his realism about classes.

From an early age, Peirce was interested in combining his classificatory interests with his genealogical or historical ones. He was not only an ardent student of the history of philosophy, but, as a reader of William Whewell's *History of the inductive sciences* (1837), he was also well aware of the history of the sciences[6]. Sciences drift, they come and go. Some disciplines disappear such as alchemy, new ones emerge such as evolutionary biology, others remain for thousands of years such as geometry. The fact that he knew that the sciences are changing and man-made – according to specific epistemic purposes scientists pursue – and are not the instantiation of eternal epistemic forms, did not keep him though from classifying them. One can find several different attempts to classify the sciences in the course of his work. They are driven by various philosophical interests and rely on different classificatory principles[7]. In 1902 he made yet another attempt. This time, it was supposed to be a «natural classification» that draws from the classification system of the anti-Darwinian naturalist Louis Agassiz, as it was presented in his *Essay on Classification* (1859)[8].

In this draft Peirce asks: what should a classification of the sciences cover? All the sciences that were ever practiced, or only those currently being pursued? All possible ones, including future ones? In order to answer these questions, he turns to different types of classifications and the question of what makes a classification a

[6] For a comprehensive study on this topic, see: T. Viola, *Peirce on the Uses of History*, De Gruyter, Berlin-Boston 2020.

[7] Peirce's classification of the sciences is part of a philosophical tradition that was characteristic of his time and was particularly influenced by Auguste Comte. For a contextualization of Peirce's classification of the sciences, see: C. Ambrosio, *The Historicity of Peirce's Classification of the Sciences*, «European Journal of Pragmatism and American Philosophy», 8, 2, 2016, https://doi.org/10.4000/ejpap.625.

[8] This classification is part of a comprehensive book project on logic, the *Minute Logic*. The classification of the sciences forms part of some *Preliminary Notions* on the topic. Our study draws on different variants of the text, only partly published.

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natural one. This leads to the very fundamental problem of what a natural species or a «natural class»[9] actually may be as the actual object of such a classification.

Peirce starts with a crucial observation: The opinion that there are no *real* natural classes is widespread, even among botanists and zoologists. These «students of taxonomic sciences»[10] adhere to the for Peirce abhorrent and dangerous nominalism[11], precisely this then fashionable view that generals like biological taxa are merely functional. T. H. Huxley is a famous example of such a view. Already in his review of *Method and Results* (1893) Peirce stated that Huxley belonged to the «sect of English nominalism»[12]. The thinkers he has in mind are philosophers such as Ockham, Hobbes, Berkeley and Mill. What unites them, says Peirce, is that they see generalizations as «a mere matter of convenience»[13]. This, however, is not the perspective of the scientist. A scientist will be guided in her investigations by the assumption that her classifications are aiming at «real facts»: «The scientific man (…) without theorizing about generals, implicitly holds that laws are really operative in nature, and that the classification he is so painfully trying to find out is expressive of real facts»[14]. Nonetheless, in 1902 he claims that the sciences need not concern themselves with the metaphysical status of natural classes but can simply treat them in «a purely experimental sense»[15] as mere units of experience. They can leave aside the question of whether what appears in experience as a class of objects also represents such a class *independently* from experience.

Thus, on the one hand Peirce seems to suggest that biologists and other scientists are, at least implicitly, realists about generals. On the other hand, he also points out that they don't have to position themselves in the debate on the status of natural kinds. They can remain agnostic instrumentalists in their use of the terms 'class' and 'natural kind' and leave it to scientific metaphysics (which he himself sought to establish) to determine the ontological status of the possible objects of their classificatory terminology. He therefore opts for a division of labour: the sciences classify things according to their accurate investigation of the similarities and differences of the objects of their study, but it is philosophy that decides according to its own criteria how the adjective 'real' should be used and if it should be applied to «classes» or not. What, then, is Peirce's metaphysical proposal in 1902?[16]

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[9] C. S. Peirce, *The Essential Peirce. Selected Philosophical Writings*, edited by Peirce Edition Project, Vol. 2 (1893-1913), 2 vols., Indiana University Press, Bloomington 1998, p. 116. Hereafter cited as 'EP 2'.
[10] *Ibidem.*
[11] For an overview see: P. Forster, *Peirce and the Threat of Nominalism,* Cambridge University Press, Cambridge 2011; C. Davini, *Continuità e generalità: l'anti-nominalismo pragmatico di Charles S. Peirce*, «Rivista di Filosofia Neo-Scolastica», 114, 2, 2022, pp. 459-481.
[12] C. S. Peirce, *Charles Sanders Peirce: Contributions to The Nation*, edited by K. L. Ketner and J. E. Cook, Part Two: 1894-1900, 4 vols., Graduate Studies, Texas Tech Press, Lubbock 1978, p. 19 (CN2:19, 1894).
[13] *Ibidem.*
[14] *Ibidem.*
[15] EP 2:117.
[16] Prompted by William Whewell's and John Stuart Mill's discussion of the topic, Peirce had already begun to address the problem of «real kinds» in the 1860s. However, our discussion is limited to Peirce's proposal for a realist conception of natural classes in the *Minute Logic*. For a detailed account

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3. Purpose and Quasi-Purpose

One way of understanding a class is to regard the members of a class as objects that owe their existence to the fact that they fulfil *a common purpose*. Thus, the class of lamps can be formed after having observed different objects that serve to illuminate something. It is obvious that this class formation depends on human interests and on the human activity of producing artefacts that help to achieve the ends they seek. Despite this reference to human interests and the human activity of production, Peirce wants to call such a class a «real» and a «natural»[17] one. This view has to do with both the way he uses the predicate «real» and with his definition of a natural class. In Peirce's use of the concept, what is said to be real is the way it is, regardless of opinion. However, this also applies to other generals, such as the class of all red things: the members of this class have in common that they are red, regardless of what the classifier or anyone else thinks about them. But if the real general is a *natural* class, they will also share a special kind of commonality: natural classes, Peirce suggests, are those whose members owe their existence to the same final cause[18]. One must be aware though that this claim does not imply the reverse suggestion: individuals that share structures that serve a common purpose do not necessarily belong to the same class: birds have wings for flying and so do some beetles. That does not make them members of the same natural class, because the genealogy of bird-wings is independent from the genealogy of insect-wings. The same problem – i.e., how to fly – has been solved twice on two different evolutionary pathways. In the end, as we will see, Peirce merges final causes and genealogy in order to define his natural classes. In other words: one can find among the members of a natural class a common purpose. But this purpose might also be fulfilled by different structures in different classes. In modern biology this is captured by the description that the wings of birds and of beetles are homologies. In the case of artefacts, this final cause is easy to identify. It consists in the purpose with which we are familiar through using them: lamps of all kinds share the common feature that they owe their existence to the purpose of illumination. However, for Peirce, there are also final causes that are not related to human purposes, «final causes other than those that center in human brains»[19] . Where there is no human purpose there may be «an evolutionary agent that acts like a purpose»[20]. In this case, Peirce also speaks of «*quasi-purpose*»[21]. Peirce's use of «quasi-purpose» is telling for his endeavor to separate final causality from

on Peirce's realism over the course of his writing, see: R. Lane, *Peirce on Realism and Idealism*, Cambridge University Press, Cambridge 2017. For a systematic discussion of his early understanding of natural kinds see: F. Bellucci, *Neat, Swine, Sheep, and Deer. Mill and Peirce on Natural Kinds*, «British Journal for the History of Philosophy», 23, 5, 2015, pp. 911-932, and M. W. Olesky, *Realism and Individualism. Peirce and the Threat of Modern Nominalis*m, John Benjamins, Philadelphia 2015.

[17] EP 2:117.

[18] Cf. *ibidem*.

[19] C. S. Peirce, *Of the Classification of the Sciences. Second Paper. Of the Practical Sciences*. Autograph manuscript Box: 79, Houghton Library: https://id.lib.harvard.edu/ead/c/hou02614c01396/catalog. Accessed October 24, 2024, (MS 1343, 1902).

[20] *Ibidem*.

[21] *Ibidem*.

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intentionality or purposeful design. Not always does Peirce use the clumsy term 'quasi-purpose'. That could lead to confusion. But when he talks about the «working out» of a purpose in an evolutionary process of adaptation what he seems to mean in such context is «purpose without design or intention» i.e. quasi-purpose.

The term quasi-purpose may suggest the nominalist interpretation that such purposes are merely heuristic concepts used in the study of nature. This is how Kant treated the purposeful organisation of organisms. Kant in his third *Critique* believed that we have to consider organisms «as if» they were intentionally constructed[22]. This was plausible for him, since he had no other possible explanation for the observed purposes at hand. That speculative evolutionary explanations for the purposefulness of organisms existed before Darwin and Kant, e.g. in Lucretius and Hume, that were using chance, may indicate that chance was not a possible explanatory term for Kant[23].

For Peirce the situation is different. He knew of the evolutionary speculations of Schelling and Hegel, who developed dialectical philosophies of the evolution of nature and the development of concepts and consciousness before there was an empirically validated biological theory of the evolution of species[24]. Furthermore, since Darwin it became plausible that evolution can bring about purposes without there being intentions in the background. It becomes apparent in any functional analysis of an organism that organs are useful for the organism they appear in, for its survival and its procreation, although there was no constructing mind in its origin involved. This aspect of Darwinian evolution is reflected in Peirce's ideas about animal instincts. Instincts, according to Peirce, have as their quasi-purpose the survival of the species to which the animal belongs. He adopts a Darwinian framework when he claims that the quasi-purpose manifests itself in two ways: in self-preservation and in the individual's desire to reproduce and bring up their offspring[25].

How does the observation that evolutionary processes produce purposeful forms and purposeful behavior relate to the idea of final causes? At this point in his

[22] See I. Kant, *Kritik der Urteilskraft*, in Id., *Gesammelte Schriften*, edited by Preussische Akademie der Wissenschaften (Akademieausgabe), Vol. V, Berlin 1908, pp. 165-485 (KU AA 05:346).

[23] Cf. Lucretius *De rerum natura*, Book V; Lucretius, *On the Nature of Things*, translated by W. H. D. Rouse, revised by M. F. Smith, Harvard University Press, Cambridge 1924. G. L. Campbell, *Lucretius on creation and evolution: a commentary on* De rerum natura*, book five, lines 772-1104*, Oxford University Press, Oxford 2003. D. Hume, *Dialogues Concerning Natural Religion*, Part IV, edited with an Introduction by Norman Kemp Smith, Bobbs-Merill Educational Publishing, Indianapolis 1977, p. 162. W. B. Huntley, *David Hume and Charles Darwin*, «Journal of the History of Ideas», 33, 3, 1972, pp. 457-470.

[24] F. W. J. Schelling, *System des transzendentalen Idealismus* (1800), edited by H. D. Brandt and P. Müller, Meiner, Hamburg 2000. G. W. F. Hegel, *Phänomenologie des Geistes* (1807), edited by H.-F. Wessels and H. Clairmont, Meiner, Hamburg 1988.

[25] See MS 1343. Peirce's concept of instinct is more sophisticated and broader in its role than it may seem here. In the present context he distinguishes between three categories of instincts, depending on the *unit* they help to preserve: the individual, the family or kin group, and the race («suicultural», «civicultural», and «specicultural»). Instinct does not have to be innate per se but can also be acquired (cf. K. Boyd, D. Heney, *Peirce on Intuition, Instinct, and Common Sense*, «European Journal of Pragmatism and American Philosophy», 9, 2, 2017, http://journals.openedition.org/ejpap/1035).

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thought, Peirce offers an unconventional consideration of evolution[26]. Even if many are of the opinion that there can be no final causes in nature, i.e. in the realm of reality that is not determined by human interest, for Peirce there is no question that the process of evolution is to be seen as «the working out of a definite end»[27]. However, this working out does not have to occur through the foresighted planning of a mind (what Peirce calls «providential»[28]) but can come about completely independently of it (through «fate»[29], as Peirce says). A person sitting by a fire may plan a lamp in their mind, an object in which a fire can be protected from the wind and carried around. From this planning may then emerge torches, lanterns and finally, after many thousands of years, chandeliers. In this technical process, the purpose of variable and reliable lighting is increasingly worked out through the craftsmanship of man. If you look at the development of the horse's hoof in the evolution of natural species and visualize how the multi-toed foot becomes a single-hoofed foot over the course of time, how the foot lifts itself more and more from the ground, thereby increasing the length of the free leg and reducing the surface area with friction and adhesion to the ground, you can observe over many generations the working out of the purpose to create a leg and foot that is able to run very fast on hard grounds. As the lower surface of the foot becomes harder and harder by many nails growing together to form a single toenail, i.e. the hoof, one cannot help but get the impression that a foot is being developed here that can serve a flight animal for rapid locomotion on land. Like the chandelier, one of the horse's hooves appears to be *the ideal functional support for a specific purpose*. For Peirce, the *one* fact that this elaboration of a functional carrier for a purpose occurs in evolution, even if this process is not driven by mental planning but, as we say, by random mutations and selection through survival and reproductive success, does not alter the *other* fact that structures serving the fulfilment of purposes are created here.

While common purposes of classes of artificial objects can be anchored in human interests and are easy to be recognized (people have an interest in lighting aids to be able to see in the dark when the sun has set), the final causes of the natural classes of nature often remain occult[30]. In the method of identifying them, Peirce suggests using the concept of «clusters».

4. Vague Desires and Classes as Clusters

Peirce gives a definition of purpose that is central to the generality of the classes that are determined by it: «A purpose is an operative desire»[31]. By connecting purposes

[26] For further interpretations of Peirce's view of evolution see: M. R. Brioschi, *Does Continuity Allow For Emergence? An Emergentist Reading Of Peirce's Evolutionary Thought*, «European Journal of Pragmatism and American Philosophy», 11, 2, 2019, https://doi.org/10.4000/ejpap.1647; C. Davini, *Charles S. Peirce e la teoria dell'evoluzione di Darwin: alcune osservazioni su un possibile fraintendimento*, «Rivista di Storia della Filosofia», 76, 2, pp. 221-250.
[27] EP 2:117.
[28] *Ibidem.*
[29] *Ibidem.*
[30] Cf. EP 2:117.
[31] EP 2:118.

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to operative desires Peirce reaches out already to a possible group or cluster of objects that may possibly fulfill the desire without being as particulars intended by the desiring mind: «Now a desire is always general, that is, it is always some kind of thing or event, which is desired»[32]. Intentions refer to intentional objects: I intend to drink *this glass of water*. Desires refer to a vague group or cluster of objects: I need *something* to drink. The generality of the classes thus goes back to the vagueness of wishing or desiring: I seek something to eat or drink; I seek some truth about the metabolism of plants. If a glass of water or a cup of tea comes before my eyes, then my desire may «zoom in» on this concrete object, but the desire is first of all general. Therefore, according to Peirce: «Desires create classes, and extremely broad classes. But desires become, in the pursuit of them, more specific»[33].

The generality or vagueness of the initial wish or desire is also the reason why there can be a variety of objects that fulfil it: water or tea can quench my thirst. One or two hooves can fulfil the need to be able to run away quickly. Finally, needs vary according to the situation; as Peirce writes, they have an extension («a certain longitude»[34]). Thirst after a long walk has a different extension than thirst after a long day at the desk. In the first case, water may fulfil the need ideally, in the second, tea or coffee may be good because I also want to counteract mental exhaustion by drinking. On the hard steppe ground, the single hoof is a good foot for a quick escape. On the soft forest floor, where you can easily get stuck with such a hard, almost «pointy» foot, the cloven hoof may be a little more favorable. This allows the cloven-hoofed deer or pig to get through the forest easily, while the horse with its single hoof can flee quickly on the open and hard plain. However, both cloven-hoofed and one-hoofed animals can run faster than sole walkers.

There is the purpose of fleeing in the situation of the steppe and the purpose of fleeing in the situation of the forest. There is no function carrier that fulfils the purpose in *both* situations ideally, any more than there is a design of a lamp that can serve ideally to illuminate a small operating field and to light up a large room at the same time. In addition, in «the process of working itself out»[35], secondary and subordinate purposes may come up, which result from further requirements that arise in different situations. To illustrate this point, Peirce gives an imaginary example of prehistoric man:

> When primitive man first found that he needed clothing in winter, his original and principal purpose may have been to keep warm. But when he came to cut his garment, it may have occurred to him that its appearance would make some impression on those who saw him; and then he might adopt as a secondary purpose that of attracting his friends or that of scaring his enemies. Moreover, the attainment of a purpose usually involves the solution of

[32] *Ibidem.*
[33] *Ibidem.*
[34] *Ibidem.*
[35] MS 1343, 1902.

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> a problem. There are conditions that have to be fulfilled; and the fulfillment of these becomes a subordinate purpose[36].

Different situations will therefore lead to a vague desire being realized differently during development and will lead to different forms. Evolution is the sequence of such different situations. And each situation may lead to a form that fulfills a general desire in a special way created by this situation. Imagine that flight animals dared to move out of the forest into the open. With that movement a history started that included the transformation of the feet. Then the classification of feet into sole-, cloven-, and hoofed feet is an evolutionary taxonomy. We can find it as such in fact in many natural history museums. From this description it becomes clear how Peirce can arrive at the assertion that a natural classification (according to final cause) will coincide with the genealogical classification[37] .

But if I do not yet know the genealogy of a form and if the achievement of purposes is continuously «in the making» in the evolutionary process, how can I be in a position to recognize a natural class?

At this point, Peirce makes a methodological proposal that seems to anticipate tendencies in recent quantitative suggestions in biological taxonomy regarding «cluster kinds»[38]. He claims: «Clustering distributions will characterize purposive classes»[39], and proposes a *quantitative* rather than *qualitative* approach to identifying natural classes. The claim that natural classes should be both real and evolutionary requires a reassessment of both the concept and the method of determining classes. Concerning the concept: the idea that natural classes are defined by essential properties must be abandoned in favor of quantitative distributions of characteristics[40]. Concerning the method: instead of zooming in to «defining characteristics» of a class (to use a Whiteheadian term) one has to learn from broad empirical and statistical analysis what properties are how often to be found among the possible members of a class, i.e. which properties are statistically more central and which are more peripheral in the cluster.

It is therefore not a requirement for a natural class to have clearly defined boundaries. Instead, even within classes there are always individuals that deviate from the class characteristics that are considered essential. However, deviations in a statistical understanding of classes do not pose a problem for the description of classes. Instead of defining essential properties, Peirce's proposal aims to determine

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[36] *Ibidem.*

[37] Cf. C. S. Peirce, *Chapter II. Prelogical Notions. Section I. Classification of the Sciences (Logic II)*: autograph manuscript, February 13, 1902. Charles S. Peirce papers, Box: 27, Houghton Library, https://id.lib.harvard.edu/ead/c/hou02614c00452/catalog. Accessed October 24, 2024, (MS 426, 1902).

[38] See Ereshefsky's claim that essentialisms can be avoided by replacing platonic kinds by «cluster kinds» (i.e. by «homeostatic cluster kinds») in M. Ereshefsky, *Species, taxonomy, and systematics*, in M. Ruse (ed.), *Philosophy of biology,* Prometheus Books, New York 1998, pp. 258-259. See also: R. Boyd, *Homeostasis, species, and higher taxa*, in Roberts Wilson (ed.), *Species. New Interdisciplinary Essays*, MIT Press, Cambridge 1999, pp. 141-186; Id., *Realism, Anti-Foundationalism and the Enthusiasm for Natural Kinds*, «Philosophical Studies», 61, 1, 1991, pp. 127-148.

[39] EP 2:119.

[40] Cf. MS 426, 1902.

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typical properties using a statistical-diagrammatic approach: for this, he proposes a class formation that makes use of a «weighted mean of all the observable characters»[41]. This approach can merely be an «estimation»[42] and would still be preferable to the risk of a single definition of natural classes, such as species. In this way, classes can be recognized based on the distribution of characteristics that form clusters. This also blurs the boundary of the class.

This is an important observation of Peirce not only for its methodological consequences in the life sciences, but it also relates to his metaphysics. That classes can be real but must nevertheless not be understood as entities that can be sharply distinguished from one another, as discrete individuals with clear boundaries[43] shows that Peirce changes the classical metaphysical inventory of discrete particulars *vs* general universals. Nothing stays, we believe, in Peirce «in the end» discrete and isolated. But everything merges «in the long run» with some «neighbor-entity». In the terminology of his metaphysics this theory of «fusion» is called «synechism», derived from a continuity-theoretical conception of reality.

The problems of continuity are deep and difficult and appear in the sciences of mathematics (real and complex numbers, compactness), physics (particles and their fields) and biology (all living and extinct organisms exist in one genealogical continuous tree). It is possible on a very superficial level to imagine a continuous reality without gaps between its elements, where discrete elements are densely packed, sharing borders. But could such a continuous reality change, develop? From an evolutionary standpoint, clusters seem to us much more suitable for Peirce's synechism. A cluster can change, branch, and beget new clusters, the fuzzy borders of them can establish continuities among them without their centers losing their definiteness. Thus, to see natural kinds in biology as clusters might have suited Peirce's synechistic and evolutionary intentions. These are rather superficial observations. We cannot go into more detail here since the problem of continuity in Peirce is a topic on its own[44].

The fuzzy edges of the class clusters lead Peirce to speak of «intermediate forms» in this context, which can make it difficult to categorize an individual being as belonging to one class cluster or another. The classic example of such an intermediate form is the platypus in Australia: it lays eggs and has a beak and forages for algae like a duck, but on the other hand it suckles its offspring with mammary glands and has fur like a mammal. So, is it a bird or a mammal? Peirce himself refers in this context to an ancient Egyptian unit of measurement as an intermediate form in the determination of grain quantities[45]. In this example a variation in the mass among artificial weights can be observed. Statistical analysis of this variation points to two values around which the weights vary. From this fact one might conclude that there had been two original prototype-weights that were copied with as much accuracy as

[41] *Ibidem.*
[42] *Ibidem.*
[43] Cf. EP 2:119.
[44] For a still excellent overview see: V. G. Potter, P. B. Shields, S. J. Shields, *Peirce's Definitions of Continuity*, «Transactions of the Charles S. Peirce Society», 13, 1, 1977, pp. 20-34.
[45] Cf. EP 2:199-200.

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possible to produce the great number of weights now actually found. But the copying was never perfect. Even if one never finds the prototypes, but only the varying copies of them, they are nevertheless real. The same applies according to Peirce to species and variations of species and intermediate forms. The fact that one finds variations and intermediate forms does not speak against the reality of the type of the species around which the variations vary. Thus, statistical analysis can help to identify the reality of a type from a cluster of variations.

5. Effective Causality and Final Causation

In his project of sharpening the concept of class, Peirce, as a friend of the theory of evolution, surprisingly also draws from the Aristotelian distinction between causality of effect and final causality. The final causality does not exert any compulsion or force[46], but it is still a «mode of bringing facts about» such that a result of this process of bringing about corresponds to a «general description»[47]. When has the process of the emergence of a car or a platypus, driven by causes, progressed so far that I can speak of the existence of a car or a platypus? I can only decide that if I know the shape of a car or platypus. A car without wheels is not a car and a platypus without a beak is not a platypus. Insofar as I see processes that are driven by forces coming to an «end», achieving a «result», I must do this by specifying a form that has been realized.

How this result is achieved is irrelevant from the perspective of the final analysis, for example, whether the car is assembled by human hands or by robots, the platypus by God or «comes about» through a phylo- and ontogenetic process that also includes coincidences: «The general result may be brought about at one time in one way, and at another time in another way. Final causation does not determine in what way it is to be brought about, but only that the result shall have a certain general character»[48].

The second part of the formulation is unusual: the final cause is itself brought about. The form that represents the result of a process at which it «stops» is realized by causes of action, but at the same time seems to be responsible for the process of development coming to a halt. In the embryonic development of an arm, for example, we speak of the sprouting of the bones. The upper arm consists of only one bone and «sprouts» into a forearm consisting of two bones, the forearm turns into a hand consisting of four grasping fingers and a thumb facing them. This process of sprouting is halted during development. The hand no longer develops into an 11- or 12-membered structure, or if it does, it is categorized as a polydactyly, a «malformation».

A final cause seems to us to be something like a «stopper» in processes driven by efficient causes that guarantee the achievement of a form. Final causes do not stand in a competitive relation to effective causes, to the contrary: they complement each other. It is not a question for Peirce, which power runs a process: whether

[46] Cf. EP 2:120.
[47] *Ibidem.*
[48] *Ibidem.*

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an effective or a teleological power. It is always effective causation that is responsible for a process to proceed. It is final causation that is responsible for the direction or tendency of this process and its finishing:

> If we are to conserve the truth of that statement, we must understand by final causation that mode of bringing facts about according to which a general description of result is made to come about, quite irrespective of any compulsion for it to come about in this or that particular way; although the means may be adapted to the end. The general result may be brought about at one time in one way, and at another time in another way. Final causation does not determine in what particular way it is to be brought about, but only that the result shall have a certain general character[49].

Of course, the guarantee here is not complete; malformations can occur. Peirce chooses a somewhat brute example from the context of action to illustrate this point. I may intend to shoot an eagle. I want to produce the final result of turning an eagle flying freely in the sky into a dead eagle lying on the ground. To achieve this, I pull the trigger of my rifle when I have aimed at a point in the eagle's flight path just in front of its head. After pulling the trigger, everything goes according to plan: the cartridge explodes, leaves the barrel of my rifle and flies in the direction of the eagle according to the laws of ballistics. But the sly eagle may suspect what's going on, may have spotted me aiming, even though it hasn't yet heard the bang of the cartridge, and tilt away from its flight path by suddenly closing its wings. Then the bullet from my cartridge can miss it and the target cannot be reached. The fact that I can use the blown bullet at all to shoot an eagle is due to the fact that, like the flying bullet, it behaves according to the rules of chemistry (in the case of exploding black powder) and ballistics (in the flight of the projectile). This means that the cause of action, which I use to achieve my purpose of killing the bird, itself realizes a form, that of a regularity, or more precisely: many forms, many laws of nature[50].

All reality is formed, according to Peirce, in this way, it realizes patterns: the blow of the trigger on the cartridge compresses the black powder and causes it to explode – this process realizes a form and arrives at a goal: the explosion of the cartridge. All forms need forces, compelling interactions, to be realized. Peirce refers here even to the transmission of a semantic form: I cannot absorb political information unless a printing press, in which many forces are at work, prints a newspaper that I can read, unless air vibrations produced by the voice of an informant penetrate my ear and produce corresponding vibrations in it, and so on. Form and causes of action are inseparably intertwined because there are no lawless (unformed) causes of action and no forms that are not realized by compelling forces in the world[51].

[49] *Ibidem.*
[50] Cf. *ibidem.*
[51] Cf. EP 2:121.

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Natural species cannot produce themselves as ideas. I can think up an animal species (the Heffalump), but I cannot produce it if I do not have the necessary compelling forces, causes of action, at my disposal. For Peirce, «natural class» is a concept that unites the compelling with the ideal: the Latin *nature*, *physis* in Greek, both refers to the process of production: being born (*nasci*) and growing (*phy*). The concept of species refers to the ideal form, at the realization of which the corresponding causal processes of generation reach their goal or end[52]. For Peirce, inheritance is the transmission of a form that is dependent on compelling forces but is not itself a compelling force. Darwin and Mendel knew the process of inheritance, Mendel even knew its regularities, but they did not know the mechanisms underlying this process (like DNA, meiosis, mitosis, transcription, translation, etc.) They knew that the offspring must resemble the parents and grandparents, but they did not know how exactly this transmission of similarities over generations comes about in an effective way.

Peirce's revival of final causes in 1902 is remarkable, given that the loss of teleology had been seen as a core feature of Darwinian theory by both supporters and critics of the *Origin*. The loss of a purposive nature was still a great fear of early critics. For example, Francis Bowen, Harvard philosopher and teacher of Peirce and some of his pragmatist fellows, complained in his review: «Mr. Darwin openly and almost scornfully repudiates the whole doctrine of Final Causes. He finds no indication of design or purpose anywhere in the animate or organic world»[53]. However, it is precisely the entanglement of final cause and purpose with planning intention that Peirce questions. It seems to us that Peirce had a deeper understanding of Darwin's theory than Bowen, who could not yet think of purposes independently from design. Bowen is perhaps a good example of a philosopher unwilling to take up the possible intellectual challenge that a new theory in the empirical sciences might present to philosophical thinking. The opposition to modern atom-theory by Ernst Mach or of some Kantians to Einstein's Relativity theory would be cringeworthy examples that occurred because of a similar kind of intellectual conservatism.

6. Final Remark

Peirce's approach to evolutionary theory, we now understand, is a very sophisticated one. Different from many of his contemporaries he sees evolution compatible, as we just saw, with final causation and with the advancement of classification. Peirce is very cautious in «throwing away» philosophical theories and concepts inherited from past thinkers. He continues to investigate the value of the differentiation between efficient causation and final causation, and he holds on to the importance of accepting the reality of classes in the light of the new revolutionary developments that occurred with Darwin in biology. He is also not opposed to these developments because they challenge so much of established philosophical thinking as Bowen and

[52] Cf. *ibidem*.

[53] F. Bowen, [Review of:] *On the Origin of Species by Means of Natural Selection*, «North American Review», 90, 1860, p. 475.

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many others after him were. Peirce sees clearly the empirical evidence and philosophical relevance of the new evolutionary theory. But he also believes that philosophical thinking that was developed before Darwin can adapt to this new paradigm. His new conception of classes as clusters is such an adaptation. Thus, he is a rare example of a philosopher who could fearlessly understand new developments in the sciences and apply them to his philosophical conceptions in such a way that the developments in the sciences can be better understood and that his philosophy can advance.

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