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Natural classification and Pierre's Duhem historical work: Which relationships?

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1. Introduction

The concept of natural classification is a constitutive part of Pierre Duhem's philosophy of physics, as seen by the fact that he considers it to be the aim of physical theory, or, in the words of Vuillemin, a form which the "physical theory *strives for*" (Duhem, 1991 [1906], p. xviii) (my italics).¹ For Duhem, physical theory is a system written in the language of mathematics whose aim is to organize experimental laws. As a mere classification of experimental laws, theory is restricted to the sphere of the phenomenon, and any explicative power in the sense of explanation of causes is denied to it. Yet, with natural classification, Duhem proposes an endpoint for the historical evolution of physical theories whose status differs radically from the status of their present form: the physical theory "will end by being an image of *the ontological order of things*", "a sort of image and reflection of *the true order* according to which the realities escaping us are organized" (1991 [1906], p. 31) (my italics).

As a matter of fact, natural classification presents itself as a goal which is ideal in both senses of being the best possible theory and

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¹ For Maiocchi, without the idea of natural classification "all of Duhem's scientific work would be meaningless" (1990, p. 389); Martin stresses the importance of this concept as "a permanent feature of his thinking" (1991, p. 31). These are views with which we certainly agree, especially on account of the reassurances about the relevance of natural classification made by Duhem himself in 1915 (Duhem, 1915, p. 84), when most of his historical work had already been published. We consequently disagree with De Broglie, who minimizes its role in Duhem's philosophy by referring to natural classification as a mere expedient "to mitigate the rigor of his scientific positivism" (Duhem, 1991 [1906], p. ix) (my italics). On the other hand, his reckoning of Duhem's position as being "a very personal one" (Duhem, 1991 [1906], p. x) can only reinforce the need to understand the meaning and significance of natural classification in his works.

unachievable, since, for Duhem, access to essences lies beyond the capabilities of human nature: "such a theory, like everything that is perfect, infinitely surpasses the scope of human mind" (Duhem, 1996 [1893], p. 68). This ideal is described solely as a *limit* to the physical theory and, like the mathematical notion of limit, the physical theory *tends* towards natural classification without actually ever reaching it.

This qualification, however, does not change the fact that an ideal theory goes beyond the domain of an organization or a classification and has ontological status. To regard physical theories as aiming at natural classification and at the same time as being the mere product and working tool for the theoretical physicist exposes a certain duality in their status: metaphysical/ontological in the first case, simply formal in the second. Taken separately, as disconnected from each other or representing different periods in Duhem's career, for example, these contrasting views could very well be thought of just in terms of the debate between realism and antirealism in science, and a number of scholars have looked at them from this angle.²

The difficulty, though, lies precisely in the fact that Duhem holds both views *jointly*: current theory as mere organization of experimental laws, without true value, and ideal theory as faithful representation of the transcendental order. We are thus presented with a situation where two opposite philosophical perspectives coexist, a contrast that seems to jeopardize the coherence of Duhem's system. Further investigation into this problem will involve examining his more general views about the nature of physical theory in order to identify the reasons behind the postulation of natural classification; as we will emphasize, this includes history. From this investigation the principle of unity of the physical theory will emerge as a central pillar of natural classification.

The presence of history in Duhem's philosophical thought is beyond question. In spite of that, natural classification is not even mentioned in his historical work. Although one may not expect an

² Some scholars sought to place Duhem's ideas at different intermediate positions in the realism/antirealism debate. McMullin (1990), for example, classifies him as structural realist, Lugg (1990) as convergent realist, and Needham (1998) as moderate realist. Niiniluoto (1999), on the other hand, sees Duhem at one extreme of the debate and considers his "To Save the Phenomena" as "part of his own campaign for instrumentalism" (1999, p. 146), incidentally, without making any reference to natural classification.

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epistemological/metaphysical concept to be part of a historical analysis, or that a historical reconstruction offers irrefutable proof of certain epistemology, the silence here is intriguing. In fact, this concept, fundamental for Duhem's epistemology, carries an implicit historical character since it is taken as the aim of the evolutive process of any physical theory.

Duhem's historiography is continuist; it does not allow for leaps or ruptures. Although the principle of historical continuity may be one methodological choice among others, we begin with the assumption that it provides necessary support to the concept of natural classification. Nonetheless, like Agassi, who finds it necessary to narrow the question "is the history of science continuous?" down to the more specific question "in which respects is it, in which not?" (1973, p. 625), this paper also discusses the meanings of historical continuity for Duhem.

The first meaning is the one peculiar to Duhem, namely, continuity of structure, which will be briefly revisited in this paper. However, given the fact that physical theories rely on concepts to convey their empirical meaning, conceptual continuity and rupture along history also need to be addressed. We do not intend to make a comprehensive analysis of Duhem's historiographical work here. Instead we will analyze conceptual continuity by means of an example, one that formed the "main axis" of the Duhemian investigation into medieval science (Brenner, 1990, p. 200), namely, the idea of impetus in the context of its connections with the concepts of inertia and force, within which there is a conceptual leap that poses a problem for the thesis of historical continuity. Inspired by Friedman (2001, 2008), we propose the idea of "continuous transformation" as a way to also give some kind of continuity to concepts and therefore preserve the place of natural classification in Duhem's system.

Starting with these two methodological principles, once they are made sufficiently clear, this paper will suggest a certain articulation between them as a way out of the apparent incoherence in Duhem's thought mentioned above. We will see that the subsidiary role played by natural classification in his historical narrative justifies its conspicuous absence from it. We will also see that the keeping of a tradition along history, if seen as a process of "additions of natural classification", preserves the analogical relationship between theory and reality and, therefore, makes the gap between a theory in progress and its aim a false problem.

2. The thesis of natural classification: context and justification

Duhem regards physical theory as a grouping of experimental laws. The goal of physical theories is to interconnect and classify the pieces of knowledge obtained through the experimental method: a physical theory is "a system of mathematical propositions, deduced from a small number of principles, which aim to represent as simply, as completely, and as exactly as possible a set of experimental laws" (1991 [1906], p.19).

Physical theory as a representation does not derive from experience; it is an invention, "an artificial construction manufactured with the aid of mathematical magnitudes" (ibid., p. 277) which were made to correspond to certain qualities without these magnitudes themselves stemming from observation. Therefore, it does not necessarily employ inductive reasoning: "physical theory is neither a metaphysical explanation nor a set of general laws whose truth is established by experiment and induction" (ibid., p. 277). Theoretical systems develop through rational procedures that involve correction, generalization and analogy. To these ingredients two complementary requirements are added: logical coherence, preventing contradictory theories to mix, and the principle of unity of the physical theory, which, far from just satisfying the principle

of non-contradiction, considers "to coordinate a set of experimental laws in the midst of a single theory" to be "better" and "more perfect" (1996 [1893], p. 67).

Duhem denies the kind of mechanicism of the English school.³ As a method, mechanicism allows different models to represent the same group of laws; these models are not required to be interconnected, although they represent the same phenomena. For him, since each model "is developed in isolation, with no concern for the preceding one, covering again a part of the field already covered by the preceding model" (Duhem, 1996 [1893], p. 63), the physics thus constructed results in an "incoherent collection of incompatible theories" (ibid., p. 67).

The fact that mechanicism fails to satisfy the principle of logical coherence does not make it absurd. The justification for denying mechanical theories, therefore, needs a stronger criterion going beyond the required internal coherence of each theory. This criterion is given by the postulate of the logical unity of physical theory: "logical unity is imposed on physical theory as an ideal to which it tends constantly" (1991 [1906], p. 294) (my italics). This principle is consistent with the ideal of logical coherence but surpasses its characteristic requirement of non-contradiction by assuming the unity of physical theory in the sense of *singularity* or *uniqueness*. Duhem is an ontological realist: for him, the entities and structures of the world are real, they exist apart from the observer. And, given the fact that the world is ontologically singular, its representation would not admit different, even if logically coherent theories; on the contrary, it requires the theory to show a uniqueness capable of mirroring the unity of the world, a feature which then becomes a condition of natural classification.

The ongoing tendency of physical theory to unity suggests that, if it organizes experimental laws progressively, if it should move towards a single theory rather than a divergent group of theories, its aim must be an exact classification of these laws. A theoretical system of this sort would be in a relation of positive analogy with the empirical world, it would classify experimental laws "in an order which would be the very expression of the metaphysical relations that the essences that cause the laws have among themselves" (Duhem, 1996 [1893], p. 68), namely, natural classification.

Natural classification appears then in a context where mechanicism is denied and the postulate of logical unity of theory provides the ground for its proposition. "Logical unity is a characteristic without which physical theory cannot claim this rank of natural classification" (Duhem, 1991 [1905], p. 297); Duhem's concept of natural classification is formulated "to justify the tendency of theory toward logical unity" (ibid., p. 297). In other words, natural classification is objectively a consequence of the principle of logical unity being accepted.⁴ As a principle, it does not require formal justification; it is a truth admitted by all, and it is "imposed" upon us.

For natural classification to be accepted, criteria such as "perfection of form", "simplicity", and "beauty" are added to the principle of logical unity (Duhem, 1996 [1893], p. 67). These are concepts alien to the sphere of rationality; Duhem himself

³ By mechanicism we mean here the method of employing models, either material or ideal ones, as a way to imitate the phenomenon and to represent the structure and properties of matter such as rigidity, elasticity, compressibility, etc. For Duhem, in a mechanical theory, "all physical magnitudes are composed by means of geometrical and mechanical elements of a certain fictional system" (1996 [1892], p. 12) and to mechanical explanations "understanding the nature of material things will be the same thing as imagining a mechanism that will represent or simulate the properties of bodies by its action" (1996 [1893], p. 55).

⁴ For Maiocchi, instead, this relationship takes place in the opposite direction: "coherence was *sustainable and justifiable* only by admitting that theories ... are also capable of reflecting an ever-perfectible and always 'more perfect' real arrangement" (1990, p. 388) (my italics).

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