Historical Explanation and Biological Systematics

The central hypotheses of systematics (the science of biological classification) are cladograms: tree diagrams that represent the history of biological taxa. The cladogram in figure one depicts species of the genus *Bassaricyon*, a taxon within the raccoon family.

Since the 1980’s systematists have debated what, exactly, cladograms depict. One common view is that the cladogram presents a preliminary hypothesis about a network of past events. Branching of vertical lines (evolutionary lineages) represents speciation events; horizontal lines are events of acquisition of characters (a, b, and c). On this view, cladograms need not make commitments about the nature of causal transactions between depicted events. Causal transactions may be specified by a more complete hypothesis, an evolutionary history or scenario, which describes the relationship between depicted events in terms of evolutionary theory. Scenarios describe speciation events as instances of adaptive radiation, genetic drift, or some other causal transaction type.

This view was presented particularly clearly by Ridley (1986) and by O’Hara (1988) and underlies ongoing discussion about whether systematists assume the truth of evolutionary theory. In this paper, I critique the philosophical assumptions underlying this view of systematics hypotheses. I argue that systematics provides a compelling counterexample to a common, but ultimately mistaken, view about what it means to reconstruct the past.
The above description of the nature of cladograms exemplifies what I will call the *network reconstruction model*. The network reconstruction model holds that science aims to reconstruct parts of a causal network by forming hypotheses of token nodes and the causal connections between nodes. Nodes are spatiotemporal particular entities understood as instances of types. The links between nodes are causal transactions, describable by laws about respective types. Nodes are usually understood to be *events*; my arguments hold for any causal ontology that admits only spatiotemporal particulars understood as tokens of types.

Many philosophers of science have (tacitly) adopted the assumptions of the network reconstruction model. The model underwrites Hempel’s description of the covering law model, which set the framework for much 20th century discussion of explanation and the status of the historical versus experimental sciences. A covering law explanation offers a series of events by which the state of affairs (“the occurrence of a particular instance of a given kind of event” – Hempel 1965, p. 423) described in the explanandum comes to pass, with causal laws guaranteeing the succession of each event in the series. Both the explanandum and the conditions cited as part of the explanans are typically conceived as token spatiotemporal particulars that are instances of types (Hempel 1965, p. 231-233).\(^1\) The causal laws cited in the explanans describe relations that will obtain (necessarily or probabilistically) between tokens of these types. Covering law explanations are positive hypotheses of the nodes and links in the causal network in which the phenomenon of interest is embedded.

On Hempel’s view, scarcity of (or lack of) historical laws presents an epistemic problem for the historical sciences. Hempel (1965) proposed that historical scientists offer explanation sketches that match the covering law form but utilize only probabilistic and often imprecise causal regularities that are best viewed as promissory notes toward proper causal laws.

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\(^1\) More strictly, both the explanandum and explanans are sentences that describe the spatiotemporal particular tokens and laws.

I do not address the issue of whether subsumption of laws by more general laws fits the same covering law model, as Hempel (1965, p. 247, p. 273) proposed.
Some philosophers argued that historical scientists construct historical narratives as a distinct form of explanation that need not involve causal laws. A historical narrative proposes a connected series of events in light of which the event to be explained falls into place. Proponents of the covering law model object that the “falling into place” must be cashed out as a deductive (or inductive statistical approximation of a deductive) relation between the antecedent events and the explanandum, and that this relation must be explicable as a general law. On this argument, historical narrative explanations are simply covering law explanations with implicit general laws (Ruse 1971). The argument turns on this point: if not in terms of implicit causal laws, how do historical narratives represent the connections between events such that the connections render the explananda expected?

This argument presupposes that explanations must utilize rules of inference that apply to entities understood in terms of the network reconstruction model. Each token event that figures in a historical narrative explanation is unique, and is non-repeatable if for no other reason than its unique space-time stamp. However, covering law proponents assumed that explanations must latch onto these events as instances of types. Proper rules of inference utilize types; causal laws (and weaker, law-like generalizations) describe relations between types that are grouped together via properties that a theory deems causally relevant. Causal laws of this form can only be applied to unique events if those events are understood as token instances of types delineated by a scientific theory.

Thomas Goudge (1961, pp. 74-78) argued that the network reconstruction model does not fit historical narrative explanation, and that the implicit-law argument fails.² For Goudge, an individual causal relation may hold between antecedent and consequent, and in recognizing this individual relation we are not committed to any general causal law (Cartwright 1989; Harré and Madden 1975). Goudge claimed historical narratives can meet Hempel’s (1965) criterion that successful scientific explanations render the explanandum expected, and may encode much causal content, without citing causal laws.

² Goudge considered the deductive-nomological model and the atomic chain of events models separately, without explicitly spelling out the connections between them. As I see it, Goudge’s key arguments about both models hinge on the atomic model.
Goudge argued that historical narrative explanations should not be modeled as reporting atomic events in causal chains with causal laws describing links, because such a model obscures the role of scientific background knowledge in the historical explanation. Goudge’s point is that the network model itself suggests that atomic events and their descriptions cry out for causal laws to secure connections. The network model is itself a necessary source of the problem that Ruse describes. We can resolve the problem by understanding each component of the explanation as interconnecting with the whole scientific corpus in a way that cannot be captured by atomic nodes and chains.

Though the covering law model has lost its hegemony in philosophy of science, many philosophers and biologists retained the network reconstruction model. O’Hara presumed the network reconstruction model in his discussion of the concepts chronicle and history: “a chronicle is a description of a series of events, arranged in chronological order but not accompanied by any causal statements, explanations, or interpretations.” (O’Hara 1988, p. 144). Event \( p \) happened, and then event \( q \) happened, etc. “A history, in contrast to a chronicle, contains statements about causal connections, explanations, or interpretations.” (O’Hara 1988, p. 144). O’Hara argues that cladograms depict segments of the ideal chronicle: the complete series of events in biological history.\(^3\) Causal explanation requests are answered by histories, which provide information about the causal connections obtaining of the events in the chronicle.

O’Hara intended his distinction to answer the charge that systematics presumes the truth of the theoretical content of evolutionary biology, yet also claims to test this same content, presenting a circularity problem (Sokal and Sneath 1963; Schuch and Brower 2009). In the remainder of this paper, I argue that the network reconstruction model is inadequate to capture the practice of systematics. I first present a philosophical problem with the model in general, and then argue descriptively that systematics avoids the network model.

\(^3\) O’Hara also uses the chronicle-narrative distinction to explore issues of perspective and objectivity in the historical sciences (O’Hara 1992), and in discussing these issues appears to shift the essence of the distinction away from causal content.
Explanations that presume the network reconstruction model are vulnerable to the *relevance problem*: descriptions of events and event transactions may fail to explain, if the descriptions fail to capture properties that are relevant relative to the explanation request. The problem arises because, on the network model, properties can only provide explanatory relevance via reference to the events and processes as tokens that figure in causal transactions describable by causal laws. But properties can be explanatorily relevant or not (and to degrees), and this relevance may not line up with the properties’ role as referents to events or processes as tokens of types. Properties may serve two distinct roles in causal explanations: providing explanatory relevance and securing reference to the entities that are relata of causal transactions. Models of explanation cannot assume that the same properties automatically fulfill both roles.

Twentieth century explanation debates involved a pattern of one author proposing a model of scientific explanation, only to be confronted with a counter-example. The counter-example fits the proposed model of explanation, yet an appeal to intuition reveals the example explanation to be faulty. The model is altered or replaced; but soon a new counter-example is offered, and the cycle proceeds.

The counter-examples exploit the relevance problem. For example, Hitchcock’s (1995) blue chalk case offers an explanation that meets the formal requirements of Salmon’s causal-mechanical model, referring to the operative causal entities and supporting the appropriate counterfactuals, yet fails to secure explanatory relevance. Hitchcock argued that this failure occurs because explanatory relevance comes from *properties*. The failure in Hitchcock’s blue chalk explanation results from the explanatory irrelevance of the property that Hitchcock uses to group entities for a causal law: “all systems that contain blue-chalk marks exhibit conservation of linear momentum.”

Hitchcock (1995, p. 310) tersely noted that a critic might object that the proposed law is faulty, and responds simply that other examples in the literature contain similarly simplistic “laws”. There is nothing formally wrong with the law about conservation of linear momentum in objects that have blue chalk marks, and the law does hold in the world. The objection is that no actual scientific theories would
ever formulate laws on the basis of such formally acceptable but intuitively inane properties as “has a blue chalk mark”.

The relevance problem also arises when the proposed grouping is scientifically sound, but drawn from a scientific domain not appropriate to the explanation request. For example, we are unlikely to find a relevant explanation of the geographic distribution of *Bassaricyon* if we attempt to reconstruct a network of past dispersal events in terms of laws about craniodental morphology: “Entities with skull length larger than 200 mm are more likely to disperse when land-bridges form”.

Such cases rarely arise in science precisely because scientists address the relevance objection head-on. Science simply does not proceed by casting about for possible connections between entities in the world that can be grouped in whatever ways are logically permissible. In turn, our intuitions about what groupings are inane are shaped by the structure of the world presented by current science. Causal content is already considered as scientific groupings of entities are formulated, in such a way that the causal content cannot be conceptualized solely as independent, atomic links between entity types.

In the philosophical literature on explanation, the assumption of the network reconstruction model enables the gap that underlies the appeal to intuitive inanity. Philosophers are able to imagine logically possible groupings that do not match the conceptual structure of the world that is shared by current science and readers’ intuitions. In generating examples of the relevance problem, the logically possible but conceptually faulty groupings are dubbed nodes in the causal network. This procedure is possible because of the presumed atomic independence of the network elements: any grouping can be plugged in as a node, regardless of the corpus of scientific background knowledge.

Systematics starkly illustrates the connection of background knowledge with theoretical groupings through its use of multiple, distinct scientific theories. A recent systematic revision of *Bassaricyon* utilized morphological, biogeographic, ecological, and genetic data (Helgen et al. 2013). Theories about these forms of data do not agree about what could possibly be an event or transaction in a causal network. Yet the evidence converged on a single, shared hypothesis about the evolutionary relationships of *Bassaricyon* species. This convergence does not make sense within the framework of the
network model: how can distinct theories converge on network segment hypotheses, without agreement about the network ontology?

Convergence is possible because cladograms are not hypotheses of parts of causal networks. A cladogram is a hypothesis of pattern that expresses facts of relationship. The cladogram constrains what past events might possibly have occurred, but should not be understood as an (approximate) hypothesis of what the past events actually were.

“Zooming in” on a cladogram shows that branch splitting cannot represent individual speciation events. In a cladogram, branch splits are always dichotomous, but viewed at sufficiently fine-grain, speciation is not a matter of dichotomous lineage splitting. While there is dispute about processes of speciation, few of the theorized processes result in a new species that contains all and only the descendents of a single parent (or pair of parents). The disconnect between speciation processes and dichotomous splitting diagrams would not be resolved if our methodology were improved to access the chain of events involved in lineage splitting at the finest, most precise level. Rather, at least some cases of speciation just do not follow the form of event chain transactions that would be imposed by the dichotomous cladogram.

The dichotomous branching structure of cladograms is imposed by methodological constraints on cladogram construction, rather than being discovered in the data (Rieppel 2010). Systematists adopt these constraints because they represent theoretical claims about the character of evolutionary relationships; they are not proposals about chains of events. Causal knowledge is involved in grounding these assumptions, but this involvement does not take the form of application of knowledge of law-like regularities to causal transactions between events.

Systematists sometimes reconstruct event chains for evaluation of the evidentiary status of individual specimens. The type groupings cited in such reconstruction are not used to link identified, token events within a chronicle. Rather, type groupings relate to methodological theories about information-preserving or destroying processes that affect the evaluation of traces as evidence. As Tucker (2004) argued, this form of historical reconstruction does not aim at event chains that are
themselves parts of the historical story of interest. The individual specimen is not itself represented in any historical hypothesis, and historical scientists have no direct interest in the events surrounding the life, death, and subsequent preservation of the individual.

For example, scientists utilized radiometric dating to estimate the age of “Lucy”, the type specimen of *Australopithecus afarensis*. Radiometric dating posits the existence of a chain of events of individual instances of isotopic decay, linked in a series from the present observation event to the past event of Lucy’s death. The hypothesized individual isotopic decay events are tokens relative to the type of event addressed by the causal theory underpinning the radiometric dating method. This theory includes causal laws that describe transactions between events of this type. The end result of the method is a range of possible ages, and this range estimate was supported through other dating methods. Further work utilizes the range estimate as a *fact* about the event of Lucy’s death. The reconstruction of events of isotopic decay does not itself figure in historical explanation, except as background material supporting the facts that are the direct material of historical theories and explanations.

Facts about the locality and morphological features of the original specimen of *Eoanthropus dawsoni* were initially thought crucial to hypotheses about hominid evolution. Reconstruction of the event chain leading to production and preservation of this specimen revealed these facts to be moot: the specimen, dubbed “Piltdown Man”, was produced by a hoaxer who doctored and paired an orangutan jaw with a modern human skull.

Morphological information, which has historically been at the center of systematics work, is not analyzed in terms of event chain reconstruction. As Wagner (1989) has pointed out, evolutionary biologists lack an account of the “copying” relation by virtue of which homologous morphology could be traced from descendent to ancestor (see also Brigandt 2002; Griffiths 2007). Such an account would be required in order to define the causal connections in a historical event chain about morphology. This has not deterred systematists from using morphological data, because systematists do not attempt to trace morphology through causal event chains. Morphological information is considered alongside contributions from other causal theoretic domains in reasoning about patterns.
A further task for philosophy of systematics is to address precisely how pattern hypotheses are formed and supported by disparate sources of evidence. This paper has argued that we must expand beyond the assumptions of the network reconstruction model as prerequisite to this task.


Rieppel, Oliver. 2010. The series, the network, and the tree: changing metaphors of order in nature. *Biology and Philosophy* 25: 475-496.


