

COMMENTARY

Human Niche Construction and the Rural Environment

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Ecology is usually defined as the study of relationships between organisms and their environment. On basic ecology courses, students learn that environmental factors may be composed of other living organisms, e.g. predators, or they may be abiotic, e.g. water. Resources constitute a special category of environmental factors as they are consumed by the organisms and thereby, at least temporarily, made unavailable to others. Resources are ultimately in limited supply, causing competition within or between species. Competition is an interaction often considered to be of paramount importance in ecological systems.

The environment may also refer to factors which are not consumed, despite being potentially important; for example, temperature or pH. In order to encapsulate the totality of resources and all other environmental conditions necessary for maintaining populations of an organism (usually a species), ecologists use the term 'niche', a somewhat vague but useful concept with many different operational definitions (Chase and Leibold, 2003). Thus, from an ecological perspective, we can say that the environment restricts the distribution and abundance of species, supplying them with resources, but also presents challenges that have to be overcome. These challenges may involve other species or the abiotic environment. Over evolutionary time-scales, natural selection mediated by the environment results in species adapting themselves to their resource base and to the environmental conditions.

This sketch of concepts in ecology and evolutionary biology suggests that *the environment is considered as external to the focal organism*. Generally, organisms are not seen as causal agents for significant evolutionary changes in the environment (Kendal et al., 2011), with a few exceptions – for example in the theory of coevolution – or when dealing with large-scale phenomena, such as global cycles of oxygen and carbon. The causal chain acts from the environment to the organism. Surprising as it might seem, considering well-known cases where organisms have drastic effects on their own living conditions (think of beavers, or spruce trees), it was not until quite recently that a formalized theoretical framework

for a dynamic relationship between organisms and their environment was developed (Lewontin, 1983; Jones et al., 1994; Odling-Smee et al., 2003). This framework, termed 'niche construction theory', envisages the environment as partly constructed in terms of feedback-loops intertwined with the niche-constructing agent, usually a species.

Homo sapiens has been considered as the ultimate niche-constructing species (Smith, 2007). Currently, the global environment has been transformed to such an extent that it has been estimated that humans exploit approximately a quarter of the global net primary production (Doughty, 2013). Although the current impact has reached unprecedented levels, due to globalization and an ever increasing speed of change in landscape management (e.g. Rotherham, 2013), it is well known that early in history humans already actively influenced the environment in many ways to promote resource availability, for example by manipulating fire regimes (e.g. Bliege Bird et al., 2008) or by domesticating wild plants and animals (e.g. Smith, 2011). These activities imply that humans acted as an agent in constructing their own environment, as well as influencing the environment of other species.

Moreover, studies in social history (here used in an inclusive sense for disciplines concerned with aspects of human history) have been influenced by a view that the environment is external to the human society. One example is the idea that regional variation in early human cultures reflects adaptation to the resource base provided by different environments (e.g. Clark, 1969). Externalization of the environment is implicit in interpretations of early agricultural development, one that was driven by resource shortage resulting from population pressure (e.g. Jarman et al., 1982). Of course, these scholars were aware of a dynamic relationship between the human society and the environment and so rejected simplistic environmental determinism. For example, when discussing the cause and effect problem between population pressure and technological innovation, Jarman et al. (1982, 22) concluded that "(...) the two processes no doubt (were) reinforcing each other". However, preference was given to the impact of resource availability as a causal factor, as they continued to state that "The longer prehistoric perspective suggests, however, that we may most usefully view the impact of sustained population pressure as the more potent factor."

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Smith (2012) provides several recent examples of how the environment is considered as an external factor to the human society, in what he termed “uni-directional adaptation theories” of agricultural development, based on optimal foraging or climate change. The externalization of the environment is likely to reflect a ‘divide between human and nature’, an influential idea with deep roots in western history. In this tradition of ideas, humans are placed outside nature, either as the crown of creation in the Great Chain of Being (Lovejoy, 1936), or as a destructive force threatening the harmony of nature (Kricher, 2009). As Widgren remarks (2012, 120): “Simplistic understandings of the negative role of humans, civilizations, and world systems on their environments still play an important role in popular science and survive in part of the academic literature on environmental history.”

The view that the environment is external to human society, and acts as a more or less static set of factors that humans have to adapt to or overcome, was strongly criticized by Erickson (2006, 2010) in his studies of the Bolivian Amazon. Amazonian forests have previously been regarded as basically untouched and pristine in nature. The impact on nature by indigenous people was considered negligible, and over the millennia elapsed since the arrival of humans in South America, the tribes inhabiting Amazonia would have become ‘adapted to’ the natural environment. Opposing this view, Erickson argued that pre-Columbian inhabitants in Amazonia created a cultural landscape with agriculture and water-management. The activities performed by people created niche opportunities for wild species, not only species that were utilized by people but other wild species. These activities included opening light gaps, cultivating, fertilizing, weeding, and altering water conditions. Over large areas natural vegetation was replaced by anthropogenic biota and the landscape structure was altered. Erickson (2006, 267) concluded that: “Amazonian peoples did not ‘adapt to’ and were not ‘constrained by’ or ‘limited by’ the natural environment in Amazon, but rather created those very environments in which they lived and thrived. This domestication of the landscape was an intentional act (...)”.

Erickson (2006, 2010) thus described this process as a domestication of the landscape, referring to the similarities with the domestication of wild plants and animals. However, the concept of ‘domesticated landscape’ is only one of the many different terms that scholars in social history have used to describe how pre-industrial human societies have intentionally modified the environment in order to promote their resource base and living conditions (Smith, 2011). Although the idea of a bi-directional and dynamic relationship between human society and the environment is thus, in a general sense, not unfamiliar, niche construction theory has the potential to unify these different terms and provide a conceptual framework founded in social history, ecology and evolutionary theory.

The key elements of niche construction theory are quite simple (Odling-Smee et al., 2003, 2013; Laland and O’Brien, 2012). Niche construction is defined “as the process whereby organisms, through their metabolism, their activities, and their choices, modify their own and/or

other species niches” (Odling-Smee et al., 2013, 8). There is a relationship between the altered environment and the niche-constructing species, influencing the niche construction activities and, in turn, influencing the environment, and so on in a continuous feed-back loop. In biology, this process may be coupled with natural selection, providing opportunity for rapid evolution on time-scales similar to the ecological processes – so called eco-evolutionary dynamics (Pelletier et al., 2009). Empirical support for such dynamics is still quite limited, but this may partly reflect the fact that this topic has been largely overlooked by biologists (Schoener, 2011; Eriksson, 2014).

For human societies there is a much wider range of potential outcomes. There are some convincing examples of how human niche construction has resulted in evolutionary changes in the human species; for example, evolution of adult lactase persistence in cultures based on dairy farming (O’Brien and Laland, 2012). However, the chief significance of niche construction is in relation to cultural development, including the potential for cultural evolution (Mesoudi, 2011). Boyd et al. (2011) proposed the concept of ‘cultural niche’, analogous to the ecological niche but based on other mechanisms, among which knowledge transfer within and across generations is the key component in a developing culture: “Cultural evolution operating over generations has gradually accumulated and recombined adaptive elements, eventually creating adaptive packages beyond the causal understanding of the individuals who use them” (Boyd et al., 2011, 10923). The concept cultural niche acknowledges that environment also incorporates socio-economic factors, religion, power relationships etc. The implication is that of a niche construction process operating at several levels, initially related to the human cognitive capacity *per se*, but ultimately manifested as the means by which humans construct and utilize their environment.

There are only a few recent examples where niche construction theory has been explicitly used in studies on the human-environment interaction; for example, regarding the initial phases of domestication of wild plants and animals (e.g. Riede, 2011; Smith, 2011), and the development of agricultural practices (O’Brien and Laland, 2012). The effects of human niche construction on the distribution of species and the composition of plant communities have been discussed in the context of Scandinavian seminatural grasslands (Eriksson, 2013). These grasslands and grassland-forest mosaics, pastures and meadows are the product of human management from the time infield-outland systems started to appear (Berglund et al., 1991a; Eriksson and Cousins, 2014). Although reciprocal interactions between human society and the environment are superficially obvious, and are implicit in many treatments of land use history (e.g. Gaillard et al., 1991; Berglund et al., 1991b), a closer examination based on human niche construction theory has yet to be performed. For example, management relating to hay-making, pollarding, distribution of pastures and use of temporary arable fields has clearly had large direct impacts on the composition of plant and animal communities. These impacts have influenced the availability of resources, in turn affecting

developing management regimes and thereby feeding into knowledge transferred across generations. This cultural niche construction process has had long-term impacts on the human society, the rural landscape and on plant and animal community composition.

However, processes such as the one described above have been treated in narratives of landscape history. Actually, one of the best (to my knowledge) accounts illustrating such feed-back processes is an article (in Swedish) by Mårten Sjöbeck, initially published 1927, but reprinted to become more accessible four decades later (Sjöbeck, 1966). In this article, Sjöbeck described how people inhabiting forested landscapes in southern Sweden constructed, utilized, and perceived their environment, at a time when their many-centuries-old management system were at the brink of ultimate disappearance. In Sweden, Sjöbeck was a pioneer in understanding the intimate long-term relationships between humans and the environment, in conflict with the then prevailing view of farmers as destroyers of natural forests. Sjöbeck's insights led him to understand that the agricultural system incorporated all parts of the landscape, even those that for a naïve visitor could be interpreted as "nature"; as Sjöbeck remarks in his concluding paragraph: "For the old people our concept of nature did not exist".

In conclusion, the coupling of human societies and environment suggests dynamics incorporating the potential for both biological and cultural evolution. Human niche construction implies that human societies are neither adapted to a static environment nor respond deterministically to environmental factors. Instead, landscapes can be regarded as domesticated, being that the general features of the environment are created by humans, not only influencing numerous wild species but also, by feedback processes, influencing human society. Human niche construction theory has the potential to provide a conceptual framework for research capable of opening new frontiers in the intersection between biology, social sciences and the humanities.

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