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*Commentary*

# Selection for Function: From Biological Persistence to Socioecological Systems

Michel Tibayrenc

MIVEGEC (UMR 5290, Infectious Diseases and Vectors: Ecology, Genetics, Evolution and Control), University of Montpellier, French National Centre for Scientific Research, Institute of Research for Development, 911 Avenue Agropolis, BP 64501, 34394 Montpellier Cedex 5, France; michel.tibayrenc@ird.fr

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**Abstract:** Selection for Function (SF) offers a complementary perspective on evolving systems whose organization can persist or be reconstructed without reproduction as an integrated unit. This editorial examines its relevance to biological persistence, disease, and socioecological systems. Building on earlier accounts of persistence-based selection, SF directs attention to the causal properties that allow some configurations of components and interactions to endure more successfully than alternatives. Its application requires an explicit focal level, independently identifiable organizational configurations, and a testable contribution of function to persistence. Examples from tumors, microbial communities, and disease-associated social arrangements illustrate both its potential and its limits. Persistence alone does not establish selection, and similar outcomes across biological and social systems need not arise through similar mechanisms. SF is therefore best approached as a comparative framework whose value depends on the explanatory or predictive contribution it makes alongside established evolutionary accounts.

**Keywords:** selection for function; differential persistence; Darwinian selection; socioecology; disease biology; functional organization

## 1. Introduction

Natural selection is usually expressed in the currency of reproduction. Biological entities vary, some of this variation is heritable, and those variants that leave more descendants increase in frequency. Yet biology also contains entities and configurations that change, persist and appear to be filtered over time without reproducing as clearly identifiable units. Prebiotic networks, multispecies communities, biofilms, symbioses, ecosystems and some higher-order tumor structures are examples in which the boundaries of the reproducing individual—and sometimes reproduction itself—become difficult to define.

In a recent Perspective, Thomas et al. [1] ask whether such cases may benefit from an additional conceptual lens: Selection for Function (SF). Their proposal does not challenge Darwinian selection. Rather, it asks whether differential persistence of functional configurations can sometimes represent an informative form of evolutionary filtering alongside differential reproduction.

## 2. From Reproduction to Persistence

The recent formulation of SF builds on Wong et al. [2], who sought general principles of evolving systems extending beyond biology. The broader idea that differential persistence can itself constitute a mode of selection is not new: Van Valen [3] distinguished selection for persistence, expansion and reproduction; Bouchard [4,5] developed evolutionary accounts centered on differential persistence; and work on Gaia has explicitly explored natural selection through survival or persistence without reproduction [6–8]. Thomas et al. [1] therefore do not

introduce persistence selection *de novo*. Their contribution is to connect these earlier strands with Wong et al.'s function-centered perspective and to ask when the differential persistence of functional configurations is the most informative level of description in biology.

Rather than treating Darwinian selection as a special case nested within a more general SF principle, they favor a non-hierarchical interpretation. Darwinian selection and SF are viewed as complementary perspectives that may become informative at different organizational levels and timescales. This positioning should be read as a distinction between explanatory lenses, not as a claim that Darwinian thought historically ignored survival or persistence.

Darwinian selection remains the natural framework when identifiable lineages reproduce with heritable variation and differential reproductive success. SF may become useful when the focal entity is instead a dynamically assembled configuration whose persistence varies, although the configuration itself does not reproduce as a coherent lineage.

Operationally, an SF focal unit can be defined as a coexisting or repeatedly generated configuration of components and interactions that can be individuated by a specified organization and putative function, without requiring parent–offspring continuity at that focal level. Persistence can then be measured as the duration of an instantiation, robustness or recovery following perturbation, and/or recurrence or reconstitution of the same organization across independent instantiations. SF is most informative when alternative configurations can be discriminated, the relevant function and its causal contribution to persistence can be specified, and differential persistence occurs while reproduction or heredity at the focal level is weak, diffuse or absent. Conversely, when well-defined heritable lineages reproduce and differential reproductive success already accounts for the phenomenon, Darwinian selection remains sufficient and SF should be regarded, at most, as a complementary description [1].

The distinction is particularly interesting in multilevel systems. Individual cells within a tumor undergo Darwinian evolution: they divide, mutate and compete. Yet tumor persistence may also depend on higher-order configurations generated by interactions among cancer cells, stromal cells, immune cells and spatial niches.

These configurations need not reproduce as conventional individuals to influence how long the tumor system persists. The two perspectives may therefore operate simultaneously at different organizational levels rather than being mutually exclusive: Darwinian selection can alter the components, while SF provides a lens for examining the persistence-based filtering of some of the higher-order configurations those components generate.

Clonal growth is a useful boundary case. In aspens, corals, sponges or bryozoans, modular expansion can be described as growth, reproduction or persistence depending on whether the focal unit is a module, genet or colony. Such cases reinforce the need to state explicitly both the unit being followed and the mode of selection under consideration, rather than assuming that persistence and reproduction are always cleanly separable.

SF therefore overlaps with, but is not identical to, several established frameworks. Multilevel and community-level selection ask when higher-level entities exhibit the variation, heredity and fitness differences required for collective selection [9,10]. Niche construction concerns reciprocal modification of selective environments by organisms [11], whereas major-transitions theory examines how new higher-level Darwinian individuals and inheritance systems arise [12]. SF is potentially most useful before, beside or between these cases, when a higher-level functional configuration persists differentially without yet behaving as a coherent reproducing lineage. Nor is formalization precluded: Price-style covariance approaches can replace offspring number with persistence or retention measures [7], and recent Earth-system models explicitly quantify persistence selection among alternative biogeochemical configurations [8].

## 3. A Bridge toward Socioecology

This framework also raises a broader question relevant to socioecology and disease. Human health emerges from nested systems involving genes, cells, organisms, pathogens and microbiomes, as well as behaviors, social networks, institutions, economic constraints and environments. Persistence matters at all these levels.

In infectious disease, pathogens evolve through Darwinian processes, while transmission opportunities may also be sustained by persistent social or ecological configurations: mobility networks, housing conditions, healthcare organization, antibiotic-use practices or inequalities in access to care. Here, the focal persistent configuration is not the pathogen itself but the social or ecological arrangement that repeatedly recreates the conditions for transmission. This distinction matters because persistence of an environment is not automatically the same process as persistence of the biological entities evolving within it.

Similarly, cancer evolution occurs within organisms whose exposures, treatment access, behavior and social environment influence disease trajectories.

This does not imply that social institutions simply undergo Selection for Function in the same causal sense as biological systems. Social persistence may involve learning, cultural transmission, incentives, institutions, power relations and historical path dependence.

But SF raises a useful comparative question: when a complex configuration persists, what causal processes make that persistence possible? The shared outcome—persistence—does not imply shared mechanisms.

## 4. A Warning from the Social Sciences

The notion of "function" has a long and sometimes controversial history in sociology and anthropology. Functional explanations became problematic when they turned circular: a structure exists because it performs a function, and its function is inferred from the fact that it exists.

SF faces a similar risk, but the relation between persistence and function need not be circular. Philosophical work has shown that selected-effect accounts of function can be generalized beyond standard reproductive selection to include persistence-based sorting [13], while broader naturalistic accounts of teleology likewise explore function outside strictly organism-centered reproduction [14].

The empirical safeguard is therefore to specify the relevant configuration and alternatives, and to identify how a proposed property causally contributes to differential persistence rather than simply inferring function from the fact that the configuration remains. Persistence alone shows retention; an informative functional claim requires an independently testable causal link between organization and that retention.

This is precisely where dialogue with the social sciences may strengthen the framework. Concepts such as institutional inertia, path dependence and historical contingency provide useful reminders that persistence can have many causes other than selection.

The goal should therefore not be to reduce social systems to biological ones, but to develop a comparative causal science of persistence. This comparison also resonates with McShea's [15] argument that human societies may be shaped more strongly by selection for stability and growth than by reproductive selection, while remaining importantly different from fully individuated biological lineages.

## 5. Disease as a Hierarchy of Persistent Systems

This perspective may be especially useful in disease biology. A resistant bacterial clone may spread through Darwinian selection. A hospital environment favoring repeated transmission may persist because of infrastructure or organization. A prescribing practice may persist through professional norms or incentives.

Likewise, tumor clones evolve genetically, while the persistence of the tumor as an integrated system may depend on ecological interactions occurring at a higher level.

Using the single word "selection" without specifying its mode could blur important distinctions. Van Valen's [3] taxonomy is useful here: persistence, expansion and reproduction can all be treated as modes of selection, but they need not share the same causal architecture. The informative questions are therefore what reproduces, what persists or expands, at what organizational level, and through which mechanism.

This may be one of the main contributions of Thomas et al.'s [1] proposal: SF encourages researchers to specify the organizational level at which persistence occurs rather than automatically forcing every evolutionary explanation into a reproductive framework.

## 6. Persistence and Darwinian Reasoning

Whether SF ultimately becomes a distinct evolutionary framework, a useful heuristic or simply a new language linking several existing ideas remains open. Its value will depend on whether it generates explanations or predictions that cannot be obtained as easily from existing evolutionary theory.

Thomas and colleagues wisely avoid presenting SF as a replacement for Darwinian selection. Nor should SF be read as supplying an idea wholly absent from Darwin: survival and persistence were already embedded in the "struggle for existence" [16], and later authors made persistence an explicit mode of selection. The more modest—and potentially more interesting—claim is that differential reproduction and differential persistence need not be the same variable, nor operate at the same organizational level, and that foregrounding this distinction may clarify the trajectories of complex biological systems.

The central question is therefore deceptively simple:

When a complex system endures, is its persistence merely the consequence of selection acting on its components, or can the persistence of the configuration itself become an explanatory level in its own right? For evolutionary biology, this question probes the boundaries of reproduction-centered evolutionary explanation rather than the boundaries of Darwinian thought as a whole. For disease biology and socioecology, it also encourages us

to examine how persistent biological configurations become embedded within equally persistent ecological and social ones—without reducing one level to another.

That is a conversation worth pursuing.

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**Use of AI and AI-Assisted Technologies**

During the preparation of this work, the author used Mistral Emmi to polish the English. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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