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The value of a metaphor: Organizations and ecosystems

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INTRODUCTION AND BACKGROUND

Many years ago Peter F. Drucker warned that the most dangerous thing in times of turbulence and change is not the change itself, but to operate with yesterday's logic. Thirty years later, we now increasingly hear the drum beat and alarm siren signaling that organizations of all types can no longer survive using frameworks developed during the Industrial Revolution. These outdated frameworks are often understood as being underpinned by a manufacturing logic, goods-dominant logic, and/or neoclassical economics. All of these logics essentially view economies and organizations as machines that can be engineered to maximize profits and create wealth.

The development of a new operating logic and corresponding frameworks are required. One apparently quite viable framework is centered on ecosystems and ecological thinking and its application to organizations and business. The implication is that an *organizational ecosystem* functions much as a *biological ecosystem* does, and exhibits desirable properties that are similar to what one would see in nature. Yet this framework has developed without input from ecosystem ecologists, leading to the question of whether organizational ecosystems exhibit biological features at all.

The consensus is that more rapid change and turbulence have in large part arisen because all human actors and the organizations that they create are increasingly interconnected, through the explosive growth of information technology and especially through the rise and spread of the Internet. This has resulted in a move from a world that was underpinned by what some refer to as a broadcast or push model, wherein one or few actors (often thought of as industry and government) broadcast information or push products to many unconnected actors (often thought of as customers), to a many-to-many, actor-to-actor world in which actors pull from and collaborate with each other. This evolving and emerging world is one of mass collaboration, co-creation, and open business models. This emerging many-to-many world, what some refer to as a network economy, is flattening organizations and economies and democratizing governance and innovation.

Searching for a fresh lens or metaphor for this dramatically altered world has often resulted in turning to biological ecosystems for insights, theory and perspective. Biological ecosystems involve separately functioning compartments that are linked by flows of resources and information, so, at least at a superficial level, the parallels are clear. As a result, it is increasingly easy to witness a lexicon that includes business ecosystems, innovation ecosystems, education ecosystems, health care ecosystems, and service ecosystems. Furthermore, entire initiatives specific to the creation and enhancement of ecosystems involving human organizations have recently emerged. The Innovation Ecosystems Network (IEN) at Stanford University is one such example.

However, if the ecosystem metaphor is to be useful, both in illuminating how networked systems function and in generating intriguing questions for further investigation, it must be examined critically. For instance, as we expand upon in later sections of this paper, both biological and organizational ecosystems involve multiple actors that interact both positively and negatively as pairs and as groups, and flows of resources that can either form or develop out of these interactions. Furthermore, in both cases, the system as a whole and its various components can show a wide range of resilience in the face of external challenges. However, it is critical not to extend this metaphor too far. As we will discuss, there are important differences between biological and organizational ecosystems. In particular, one likely lure of the ecosystem metaphor to management audiences is the misguided belief that nature designs systems such that they exhibit long-term stability across interconnected structures. Conversely, there are similarities between biological and organizational ecosystems that have not been sufficiently

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recognized. If we are to learn something about organizational systems from biological ecosystems, then, it is critical to distinguish three categories: meaningful similarities, superficial but potentially misleading similarities, and fundamental differences between them.

In this paper, we consider the relevancy and implications of the principal constructs of biological ecosystems for the development of an operational framework appropriate to changing and ever more interconnected organizational environments. We first clarify the concept of a biological ecosystem as it is currently understood in the discipline of ecological science. We then discuss how it can or cannot be applied as a lens for viewing human-created ecosystems: business, innovation, healthcare, education and others. To accomplish our objectives, we first identify and unpack a set of principles of biological ecosystems that are relevant to the conceptual development of an organizational ecosystem framework. Second, we outline our understanding of the general properties of organizational ecosystems. Third, we synthesize the similarities and differences between biological and organizational ecosystems. Fourth, we conclude by raising a set of questions that should be addressed as we move forward in the development and application of the ecosystem metaphor within various organizational settings, and by practitioners that include executive leadership, public policy officials, and organizational scientists.

BIOLOGICAL ECOSYSTEMS

Ecosystems thinking, which dates to early in the twentieth century, is a fundamental component of the science of ecology. In this section we unpack a set of key concepts and propositions that are currently understood to characterize the organization of biological ecosystems. Our goal is to develop a better understanding of what appear to be rather simple ideas, but that have potentially complex meaning and major implications for how we adapt the ecosystems metaphor to human organizations and networks.

The science of ecology studies relationships between organisms and the biological and non-biological components of their natural environments. Ecologists consider the organization of biological systems to form a hierarchy. In a given locale there are individual organisms, groups of organisms of the same species (termed populations), interactions between pairs of species (such as predation and competition), interactions among larger groups of species (termed communities), and interactions among communities and the non-biological components of their environments (e.g., air, water, and sunlight). In this paper we will subsequently refer to units encompassing biological communities and their non-biological inputs and outflows as *biological ecosystems*, to distinguish them from human organizational structures, networks and systems, which we refer to as *organizational ecosystems*.

Organization of Biological Ecosystems

It is critical to recognize that biological ecosystems are not assembled by forethought, or by an authoritarian hand. Nor are they "designed" to be resilient, or to maximize the success of their component parts. Indeed, *they are not designed at all*. Rather, *they are emergent properties* of individual organisms interacting in pairs, groups, and larger networks.

To understand biological ecosystems, it is important to appreciate that they are organized by processes that form a hierarchy: individual organisms interact with their environments and with each other, these interactions themselves interact, and what emerges is a set of intertwined networks of relationships. Organisms themselves are shaped by natural selection: those that perform well (as measured by survival and reproduction) are able to persist, and those that perform poorly are not. Interactions among organisms may lead individuals to perform well, such as when one organism is able to obtain a critical resource from another, but they may also lead to failure, such as when one is consumed by another. As a consequence, building upwards hierarchically, networks of multiple interactions may perform well, or they may perform poorly. Further, they may perform well in one context but poorly in another.

The following example illustrates how biological ecosystems are organized, how they function, and how complex they can be. Palmer et al. (2008) have studied an African savanna ecosystem with the goal of understanding how resilient it might be if faced with human-mediated extinction of its largest, most charismatic mammals. A key plant species in this system is an acacia tree. The acacia provides nectar to a group of highly specialized ants that, in return for this reward, aggressively attack other insects that feed on the plant. An additional, highly competitive ant species monopolizes plants but confers no benefits to them. Grazing activities of large mammals such as giraffes change the growth form of the acacias, however, in a way that favors the beneficial ants over the detrimental ones. Thus, mammals feeding on acacia (which would seem bad for the trees) indirectly favor acacia's beneficial ants. On balance, this is better for acacias, since small herbivores inflict greater damage than large ones like giraffes do. In this ecosystem, then, mammals, ants, and acacias are linked in a complex web of interactions. Experiments have shown that if mammals are excluded for several years, then acacias do worse. Acacias are such an important resource for other species in this ecosystem that a series of cascading extinctions has been projected if mammals were to be hunted to extinction: if mammals were extirpated, then acacia trees would grow large, benefiting harmful ants, which would lead acacia trees to decline precipitously in number, to the detriment of the entire ecosystem. Although this may sound extremely complex, it is an example of a relatively simple biological ecosystem that emerges from multiple interactions among a local group of species, some positive and others negative. It appears to be quite stable at present, but could be easily disrupted if certain species, such as large mammals, were removed.

Although biological ecosystems are structured by diverse context-dependent phenomena and interactions at lower hierarchical levels, the emergent system ends up with a number of predictable properties. These can be quantified and compared, both over time for an individual ecosystem and across different ecosystems. These properties are discussed below.

Properties of Biological Ecosystems

Key players

Biological ecosystems can contain hundreds or even thousands of species, but certain species play outsized roles in structuring them. Some have been termed keystone species: these are species linked to many other ecologically dominant actors. If they are removed, it is thought that the ecosystem as a whole would collapse (as would a structural arch if its keystone were removed). Within the ecosystem described above, both giraffes and acacia could be considered keystone species. Other species are called ecosystem engineers because their activities (although unpremeditated) create and modify habitats that other species rely upon. In ecology, this term is not meant to imply that there are any anticipatory design elements or a sense of agency in terms of creating a premeditated structure. The dam-constructing beaver is a premier example of an ecological engineer.

Interactions among players

Interacting species within biological ecosystems are linked by flows of resources and of information. These interactions range from highly specialized (i.e., one species alone can provide goods or services that another requires) to highly generalized, and from highly beneficial to quite detrimental. Mutualisms are interactions that benefit both sets of actors: these "plus/plus interactions" involve mutually profitable (or favorable) exchanges of goods and services. In the African ecosystem described above, acacias and the ants they feed and that protect them are an example of a highly specialized mutualism. Other interactions are profitable to only one actor. They are either neutral to the other actor (commensalism, or "plus/zero interactions"), or outright detrimental to it. Consumption of one species by another (e.g., giraffes eating acacia leaves) is an example of such a "plus/minus interaction." Finally, interactions may be detrimental to both actors (competition, a "minus/minus interaction"). Interactions that are "minus" for one or both actors have attracted by far the largest attention, and most ecosystem ecologists would argue that they are the most critical in shaping how biological ecosystems function. Mutualisms have attracted scant attention in an ecosystem context, although this is beginning to change.

Diversity, nestedness, and resiliency of healthy ecosystems

A major descriptor of the biological ecosystem is biodiversity, or species diversity. Technically, diversity is a measure that combines how many species there are with how individuals are distributed across species; commonly, however, it simply refers to the number of species present. The resilience of an ecosystem to perturbation (external induced shocks) was long thought to be related to species diversity, with more diverse systems showing higher stability, in part because at least some component(s) are able to withstand changing conditions. The generality of this phenomenon has been hotly debated in recent years, however; experimental studies give varying levels of support to this pattern, underlying mechanisms are still unclear, and the definition of ecosystem "stability" itself has been inconsistent (Ives and Carpenter 2007). More recently, resilience has been related to a feature known as nestedness. Within biological ecosystems, specialists tend to interact with generalists rather than with other specialists. This results in a nested network of species interactions. Nestedness has recently been shown to confer resiliency, in the sense that if one begins to remove species, a nested network takes longer to collapse completely (i.e., to result in species extinctions) than a non-nested one (Bascompte 2009). This feature has begun to attract widespread attention because of its obvious consequences for ecosystem conservation.

Ecosystems themselves can be subject to a kind of selection: those that have features that confer resiliency should be able to persist longer than those that do not. However, it is important to recognize the following. First, the rate of change in biological ecosystems can be quite slow. Thus, ecosystem degradation can be a protracted process that is difficult to recognize; it would not be surprising to believe that a given system was healthy and functional, when in fact it was on the verge of collapse. Thus, just because a biological ecosystem exists does not mean that it is healthy, functional, and persistent. Second, a biological ecosystem can be healthy, functional and persistent under one set of environmental conditions, but not under another. A major challenge that ecosystem ecologists face is to identify the conditions under which currently healthy systems can be expected to degrade. The general point here is that to some extent, one must look to exogenous conditions to be able to predict the fate of biological ecosystems. Third, even in stable, resilient biological ecosystems, many or even most species do not perform optimally. Most obviously, almost all species are eaten by at least some other species. If there were no predators, certain prey would certainly fare better, at least in the short term (e.g., until they exhausted their own resources). This would undoubtedly alter fundamental features of the biological ecosystem, potentially leading to its collapse. This is why most conservationists support the culling of rapidly increasing populations of herbivores such as deer, most of whose predators we have extirpated; if left alone, these species will denude entire plant communities, with long-lasting effects.

Finally, biological ecosystems emphatically do not evolve for the "greater good." That is, they do not develop such that some species (such as prey) fare poorly *in order to* increase the success of the higher-order organization (the biological ecosystem). Indeed, it is a well-established and widely accepted rule that evolution does not shape higher-order levels of ecological organization the way it shapes organisms.

In summary, while humans rightly value highly functional, productive, and resilient biological ecosystems, these features are best thought of as *emergent properties generated from the bottom up*, rather than purposeful and goal-driven properties that descend from the top. Furthermore, exchange among actors is motivated by individual wellbeing rather than by a drive to protect and enhance the collective condition of the ecosystem. In other words, exchange is self-directed rather community-oriented. These attributes illuminate an essential but not yet well recognized way in which biological ecosystems are fundamentally different from ecosystem-like structures that humans, in part more deliberately, design. We consider these structures next.

ORGANIZATIONAL ECOSYSTEMS

The use of ecological concepts by sociologists and organizational scientists to describe and study social arrangements is not new. For instance, human ecology is an established sociological framework that focuses on the interactions and structures that tie humans together as communities (what ecologists call populations, confusingly). Organizational ecology also merges biological concepts with economic and sociological principles in an attempt to better understand the lifespan of individual organizations. Although at least superficially "ecological" in concept, both of these well-established fields lie outside of the scientific discipline of ecology, which by tradition has given relatively little attention to human activities, except insofar as they disrupt patterns in nature.

The ecosystems metaphor is often used by scholars, business journalists and practitioners to informally describe the connections among organizations that share common or complementary features, and that motivate or facilitate some form of exchange of information and other resources. The metaphor can also be used to reference social structures that are comprised of loose and tight ties that enable or enhance the interactions among diverse organizations and actors. For instance, the innovation ecosystem metaphor is often used by scholars and practitioners to describe complex networks of actors, such as private industries, financiers, universities, and governmental agencies that are linked together through the pursuit of common technological goals and/or mutual economic gains.

Our current effort to develop a more clearly articulated conceptual framework from which to understand and study organizational ecosystems starts by providing a definition of an organizational ecosystem and introducing such a system in the context of the forest-based industry.

Organization of Organizational Ecosystems

Organizational ecosystems are comprised of diverse actors and organizations, which often enter into relationships and participate in exchanges based on a wide range of intentions. Organizational ecosystems in general are not anchored in pre-determined goals and agendas, although the individual organizations within do purposefully develop and pursue agendas. (We discuss the goals and agendas of individual organizations in greater detail later in the paper.) Instead, information and resource flows connect organizations within organizational ecosystems in spite of the presence of diverse and sometimes even competing goals and agendas. For instance, the forest industry includes market-offering and profit-seeking organizations. However, these industries are linked to other organizations that include social movement groups that campaign, litigate or lobby against them, as well as government organizations that tax these industries, regulate them via laws, and even occasionally incent them with state aid or subsidies. All of these organizations then connect to each other either directly or indirectly to create the forest products and packaging ecosystem. Thus, organizational ecosystems should be mostly understood as emergent phenomena that result from a tenuous balance between actor agency and social structure, rather than from purposeful engineering.

Advancements made leading up to and during the current information technology age have enhanced the communicative capacities of humans to the point that interactions are no longer confined by spatial constraints (other than when geopolitical constraints interfere with actor interface). This increased connectedness permits actors and organizations to interact in a variety of ways with little to no delay. In turn, planning and the diffusion of innovation at a variety of scales are improved. Such enhanced communicative capacities have fueled a growing trend in which diverse sets of organizations are engaging in system-wide design and planning at various levels and across expansive geographic distances. This observation leads us to raise an exception to our previous claim that organizational ecosystems are emergent and not designed, planned, or engineered.

The hierarchical emergence and structure of organizational ecosystems vary according to the types and diversity of actors and functions that are nested and embedded within them. More specifically, organizational ecosystems can develop in one of two very distinct ways. They can develop from the top down, which is most often the case within centralized, government-controlled economies or where market monopoly may exist. Alternatively, organizational ecosystems can grow from the bottom up, as in competitive market-oriented economies where individual actors reject or accept market offerings, and with change movements that emerge within societies where actors have the relative freedom to socially or politically organize. This variation in emergence and development results in added complexity to the task of identifying, analyzing, and ultimately working within organizational ecosystems.

Regardless of hierarchical structure, organizations often form networks around common or complementary cultural features. For example, organizations in the forest industry and those in the paper and packaging industry share a common logic and worldview that centers on the market application of certain natural resources. However, ties can also be formed between organizations that form out of competing logics. For instance, social movement groups that seek to prevent deforestation share an ecosystem with organizations comprising the forest and paper packaging industries. Thus, organizational ecosystems emerge through the complex formation of ties between organizations that are underpinned by logics and worldviews that are sometimes complimentary, but other times competing. This contradicts the common misunderstanding that organizational ecosystems are built exclusively upon harmonious relations shared by member organizations. In spite of the broader conditions that lead to the emergence of organizational ecosystems, the individual organizations within have purposeful goals and agendas that are likely to vary across the system. In particular, an individual organization can purposefully act to achieve a defined goal such as realizing a return on investment, capturing a share of a market, electing a politician, or advancing a social cause. However, the purpose of a singular organization and those of organizational ecosystems should not be viewed as being rigid and fully predetermined, with well-defined goals and outcomes. In particular, once nested within a network of other organizations (i.e., an organizational ecosystem), an organization is likely to work to achieve a different purpose or multiple purposes. For example, competitive systems create externalities that cannot be attributed as purposeful or structured. To return to the forest and packaging industries example, no one in the paper and packaging industry set out with the goal of contributing to the alteration of natural habitats. However, as the negative effects of deforestation on the environment increase, and pressures of environmental activism groups build, that encourages companies to become more engaged in conservation efforts. The primary point here is that organizational ecosystems should in most cases be viewed more as organic structures that develop over time, rather than as intentionally designed and engineered mechanical systems.

Organizational ecosystems are not static. Those that do not evolve over time for the greater good of society are put in jeopardy of being eliminated or becoming obsolete. For example, institutions can intervene and eliminate organizations ecosystems that are causing more harm than good. For instance, a government regulatory agency could shut down an entire forest industry if that industry is carelessly destroying woodlands.

Properties of Organizational Ecosystems

Key players

As is the case with their biological counterparts, organizational ecosystems contain a diverse range of actors and organizations. Certain organizations emerge as keystones, upon which ecosystems then become dependent. In the case of the forest industry ecosystem, companies that harvest lumber could be considered keystone players, in the sense that without the raw materials supplied by such businesses, other forest industries would not be able to operate. Other industries also act as keystones, highlighting the fact that a single ecosystem can contain multiple keystones.

Organizational ecosystems also include engineers that create, shape, and modify the conditions under which other organizations operate. In the case of the forest industry, governments can be considered engineers, in that they shape and enforce the policies that frame and regulate how the industry is to operate. Organizational engineering, which is performed by humans, also has influence beyond local settings. Specifically, humans learn, adapt and replicate innovations, which expands the impact of organizational engineering across multiple settings.

Interactions among players

Interactions, which are linked by flows of resources and information, also vary as a function of the benefits they produce and the harm they cause. Just as in biological ecosystems, mutualisms can exist in which both parties benefit from exchanges of goods and services. For example, lumber suppliers and paper product manufacturers engage in mutually beneficial exchange interactions. Interactions can also sometimes benefit one organization without having any discernible impact upon another (commensalism). The effects of competition within an organizational ecosystem can be either beneficial or harmful depending on the circumstances. This potential to benefit from competition is influenced by norms, rules, and institutions, which are social phenomena not found within biological ecosystems. Perhaps one of the most influential institutions has been voluntary exchange systems between human and organizational actors; in short, institutions in which actors are not forced to exchange with another actor, but have relatively free choice.

Diversity, nestedness, and resiliency of healthy ecosystems

Organizational ecosystems are nested structures. Currently, *nestedness* is observed mostly through overlaps in the functions and priorities of the various actors and organizations that together comprise an ecosystem. Less often is the case of actors and organizations being completely nested within a larger organization. For example, a small-scale paper manufacturer that sells its products to only one retailer is nested entirely within that retailer. The movement toward horizontal organizational structures as well as the connectedness made possible through information technologies has made complete nestedness an exceptional rather than standard arrangement.

The degree of nestedness positively affects the resiliency of an organizational ecosystem. The more nested an ecosystem becomes, the more likely it is that contingencies will be created that need to be acted upon in the event an actor or organization fails somewhere within. In other words, organizations have within ecosystems "back-up plans" that become apparent only when an associate fails or otherwise becomes unavailable. For example, the numerous overlaps of actors and organizations in various forest and forest-related industries create an entangled structure that through redundancy acts to enhance the resiliency of the overall ecosystem. For example, a manufacturer of paper products is likely to have relationships with multiple raw material processors. In the event that one processor fails, the manufacturer can continue to operate through existing partnerships with alternative processors. Thus, the nestedness of organizational ecosystems works to help prevent actors and organizations from individual and systemic failure.

Embeddedness is the binding of an organizational ecosystem through economic and non-economic arrangements of exchange that are made between actors and organizations. Accordingly, exchanges of various types act as the "Velcro" that fastens actors and organizations together to form the nested structures that are organizational ecosystems. Exchange typically occurs between specialists and generalists rather than between specialists, similar to the interaction patterns observed in biological ecosystems. Exchange also occurs within a cultural context, and thus is as much a social and/or political arrangement as it is an economic process. Accordingly, exchange is guided by both economic and non-economic institutions. For instance, the regulation of economic exchange is partially governed by law, and partially by social contracts and norms of exchange and behavior. In the case of the forest industry ecosystem, regulatory agencies and environmental activist groups represent institutions that are embedded in the system and influence economic and social exchanges that are centered on issues of carbon reduction and overall conservation.

The forest industry provides an example of how diverse organizations become linked through exchanges and embedded in nested networks. Forestry and packaging firms are likely to become a part of an ecosystem that is centered on technological innovations, with the intent of enhancing opportunities to better serve customer needs and grow profits. Activist groups and non-profit organizations, however, are likely to join the same ecosystem with the hope of advancing social or political change through gains made by technological applications. Governments are also likely to enter this ecosystem through taxation of property, revenues, profits or incomes of citizen actors in order to acquire the resources needed to provide public services.

The resiliency of an organizational ecosystem and the diversity of its membership are likely to be positively related. Specifically, enhanced diversification decreases dependency on any one particular function or organization. For instance, an organizational ecosystem may adapt to an unanticipated perturbation by removing or marginalizing an organization that is no longer critical based on some profound change, and/or introducing or promoting another organization that is suddenly essential to the wellbeing of the system.

Despite having certain degrees of resiliency, otherwise healthy organizational ecosystems can suffer or even fail when change occurs. The time it takes for an ecosystem to degrade or fail can be brief or lengthy. Thus, a seemingly healthy ecosystem can in fact be losing the capacity to persist without showing noticeable signs of degradation. Unlike species in biological ecosystems, organizational leaders do have the potential to forecast future conditions and create strategies and structures (e.g., institutions) designed to decrease risk and increase uncertainty. Of course, there is no guarantee that such proactive planning will prevent degradation. In particular and as previously mentioned, those organizational ecosystems that do not evolve for the greater good of society will be in jeopardy of being eliminated or becoming obsolete.

The preceding presentation of the properties of biological and organizational ecosystems provides a platform from which to begin to provide form to the vague and undefined ecosystem metaphor that is increasingly used by organizational leaders, corporate consultants, journalists, and even in some cases scholars. In the next section, we identify the similarities and differences in the two types of ecosystems. This comparison illustrates the opportunities and limitations of the ecosystem metaphor in the organizational context.

COMPARISON

Our comparison of the properties of biological and organizational ecosystems has two goals. First, we aim to illustrate

Table 1 Similarities Between Biological and Organizational Ecosystems.

Biological ecosystems	Organizational ecosystems
Fundamental organizational features	
Biological ecosystems are emergent.	Organizational ecosystems are in most cases emergent. • The exception is the growing trend of organizations trying to do more system-wide design and planning at various scales.
The existence of a biological ecosystem does not mean it is healthy, functional and persistent. • A biological ecosystem can be healthy, functional and persistent under one set of environmental conditions and not others. • Many or even most species do not perform optimally even when there is a resilient biological ecosystem.	The existence of an organizational ecosystem does not mean it is healthy, functional and persistent. • An organizational ecosystem can be healthy, functional and persistent under one set of economic, social and/or environmental conditions and not others. • Many or even most actors do not perform optimally even when there is a resilient organizational ecosystem.
Ecosystem properties	
The stability of a biological ecosystem is dependent on keystone species. • Eventual system collapse is likely to occur if keystone species are removed.	The stability of an organizational ecosystem is dependent on keystone actors.
Interaction of species is linked by flows of resources and information.	Interaction of actors and organizations are linked by flows of resources and information.
Biological ecosystems are made up of interactions that range widely in outcome. • Mutualism benefits both species. • Commensalism benefits one species and not the other. • Predation benefits one species but harms another.	Organizational ecosystems are made up of interactions that range widely in outcome. • Mutualism benefits both actors. • Commensalism benefits one actor or organization and not the other. • Predation benefits one actor organization but harms another.
Species can be specialized or generalized. • Specialists tend to interact with generalists rather than other specialists.	Actors can be specialized or generalized. • Actors tend to interact with generalists rather than other specialists.
Nestedness arises within networks of species interaction. • Nestedness confers more resiliency. • Collapse from the removal of species in a nested network takes longer.	Nestedness arises within networks of actor interaction. • Nestedness most often confers more resiliency. • Collapse from the removal of actors in a nested network takes longer.

Table 2 Differences Between Biological and Organizational Ecosystems.

Biological ecosystems	Organizational ecosystems
Fundamental organizational features	
Species do not forecast future conditions, nor do they implement strategies and structures with the goal of decreasing risk and increasing certainty.	Human actors lead organizations and try to forecast future conditions and create strategies and structures (e.g., institutions) designed to decrease risk and increase certainty.
Biological ecosystems do not include contingency plans to enact should a key actor or species fail.	Organizational ecosystems often include contingency plans to enact should a key actor or organization fail.
Biological ecosystems are structured by interactions at lower hierarchical levels (i.e., grassroots in nature).	Organizational ecosystems can be structured by interactions at lower or higher hierarchical levels, and thus can be grassroots or top-down in nature.
Biological ecosystems do not evolve for the greater good.	Organizational ecosystems that do not over time evolve for the greater good of society will be in jeopardy of being eliminated or becoming obsolete.
Ecosystem properties	
Competition is harmful to both species.	Competition can be beneficial or harmful to involved actors and organizations. • Humans have norms, values, and institutions (e.g., laws) that regulate competition in the interest of the greater good.
Biological ecosystems emerge, function, and collapse organically and without the aid or intervention of purposefully designed strategies and structures.	Organizations can design and master-plan systems and networks.
Ecosystem engineers create and modify habitats that other species rely upon.	Human engineers (actors) may create conditions that have the potential for impact beyond the local setting. • Humans have the ability to adapt and replicate innovations, which expands the impact of human engineering across multiple settings.

overlaps in biological and organizational concepts and conditions that we contend should underpin the organizational ecosystems metaphor (see Table 1). Second, we aim to identify misguided assumptions about how biological systems are organized that have compromised the usefulness of the ecosystems metaphor for understanding organizational practice and innovation (see Table 2).

SIMILARITIES

It is widely recognized that organizational ecosystems are like biological ecosystems in that they are *emergent* phenomena: that is, they most often *emerge* and become established through the development of ties that link components (species or organizations). Indeed, this is likely the feature of ecosystems that first led the metaphor to penetrate into the human sphere. Species and organizations are similar, in that both groups are made up of actors and are linked to other groups within a common ecosystem. Linkages are created by flows of resources and information. Within both kinds of ecosystems, the ways in which resources and information flow vary according to the outcome of the interaction (mutually or unilaterally beneficial or antagonistic).

When leaders of organizations within the ecosystem consider their behavior, it becomes important for them to understand the nature and management of interactions among organizations. This allows them to better enhance benefits gained through mutually beneficial interactions, and to lower the harm created through interactions. Of course, some organizations holding the advantage may actively choose strategies that increase gains through exploitative and predatory practices. An essential question is what are the potential long-term effects on the ecosystem of overexploiting or "killing off" organizations that are at a disadvantage. For instance, is the sustainability of an organizational ecosystem jeopardized when a keystone organization is overexploited, as it is in biological ecosystems?

Interestingly, and much less recognized, is the fact that many features conferring resiliency on ecosystems are similar in both the biological and organizational realms. Within both kinds of ecosystems, some actors are specialists and others are generalists. In both cases, specialists most often interact with generalists rather than other specialists, forming a nested structure that improves the overall resiliency of the ecosystem. In a nested system, the removal of certain species or organizations does not inevitably fully compromise the ability of the ecosystem as a whole to persist. In other words, the collapse of an ecosystem, whether biological or organizational, due to the removal of an actor from a nested network, will be prevented or prolonged.

In addition, the resiliency of a given organizational ecosystem is likely to be positively influenced by the degree of diversity of the actors and organizations within. Recall that the relationship between resiliency and diversity is currently under debate in the ecology literature. Thus, this relationship is not considered to be a property shared by organizational and biological ecosystems. However, the resiliency of both biological and organizational ecosystems is disproportionately affected by the wellbeing and presence of keystone actors. If keystone actors are harmed or removed from ecosystems, failure becomes highly likely, if not inevitable. A critical task for leaders is to determine when, why, and how their organizations should act as either a generalist or specialist, as well to determine their positions relative to and dependencies on the keystone actors within their networks.

Finally and very importantly, existence per se is not a trustworthy measure of the general health, functionality, or persistence of either biological or organizational ecosystems. An ecosystem may degrade at a rate below the level of detection, at least until it begins to dissolve. Furthermore, an ecosystem can be robust under a particular set of conditions, but suffer and collapse if conditions change in a subtle or dramatic way. Similarly, not all actors within existing ecosystems function or perform at optimal levels. In fact, it may be the case that most species or organizations perform at below-optimal levels, and thus make limited contributions to the overall health and resiliency of a given ecosystem. In the organizational context, leaders should consistently evaluate the overall performance of the ecosystem within which their organization is nested, treating it much as a conservationist interested in maintaining a healthy biological system would. The insights gained through such ongoing evaluation will help equip leaders with the information needed to make strategic judgments regarding the impacts of broader ecosystem conditions on the health and resiliency of their own organizations.

DIFFERENCES

It is critical that the differences between biological and organizational ecosystems be identified and understood. Otherwise, mistaken beliefs threaten to degrade the trustworthiness, development and application of the organizational ecosystem metaphor. In this sub-section, we highlight six false parallels that exist based on key differences between biological and organizational ecosystems that have been overlooked or misunderstood. These are summarized in Table 2.

The first false parallel is the assumption that competition within both biological and organizational ecosystems can either benefit or harm species or actors, depending on conditions and circumstances. In fact, the consequences of competition differ. In biological ecosystems, competition is always harmful to all involved species. In organizational ecosystems, competition can be either beneficial or harmful depending on the circumstances. In cases where competition results in beneficial outcomes, interactions between organizations are influenced by norms and values, and at least somewhat structured by institutions that govern practices through established rules. Accordingly, competition is regulated in ways such that it takes place in the interest of the greater good. These interactions have no parallel in non-human systems. Unregulated competition may also take place between organizations with varied outcomes.

A common assumption is that natural structures exist that were intentionally designed to govern the functioning of biological ecosystems. This assumption is fundamentally wrong, and this leads to the second false parallel: the planning and foresight that often goes into the development of organizational ecosystems is not observed within biological ecosystems. It is well known that industries, governments, and other sectors often try to design systems and networks. However, biological ecosystems emerge, function, and collapse organically without the intervention of purposefully designed strategies and structures. Consequently, if the potential benefits of the ecosystem metaphor are to be realized, attention should be given to nurturing the conditions under which organizational ecosystems can emerge and thrive. This is more useful than efforts devoted to trying to construct (or force) the development of ecosystems.

A third false parallel is based on the assumption that biological ecosystems exhibit strategies for decreasing future risks and uncertainties. In fact, such strategies are not observed in biological ecosystems, simply because very few species apart from ourselves possess the intellectual capabilities such foresight would require. Organizational ecosystems, in contrast, do involve strategizing and planning with the intent to forecast future conditions and create structures designed to mitigate risk and increase certainty. Planning and strategizing across organizational ecosystems varies in scale and occurs according to repeating fractal patterns that promote the development and enhance the diffusion of innovation. Institutions (e.g., legal systems, educational systems) are primary examples of structures designed and enacted by human actors with the goal of coordinating interactions, decreasing risk, and increasing certainty within and across organizational ecosystems. Furthermore, organizational ecosystems can include contingency plans to be called upon should a key actor or organization fail. Biological ecosystems do not. Thus, the capacity to "manage" (or at least influence) ecosystems is a characteristic that distinguishes organizational ecosystems from biological ecosystems.

The fourth false parallel is based on perceptions of how engineering occurs within biological ecosystems compared with organizational ecosystems. In both settings, engineers create and modify habitats that other species or organizations come to rely upon. While engineers in biological ecosystems (e.g., beavers in a pond) have strictly local effects, human engineering has the potential to create conditions whose effects often extend far beyond the most immediate ecosystem. However, the effects of engineering performed within biological ecosystems are locally confined. The spread of conditions created through human engineering at the local level is in large part due to the human capacity to replicate and adapt innovations across multiple settings. The diffusion of innovation is especially powerful in the contemporary era, where communicative capabilities have been so profoundly expanded by advances in information technology.

The fifth false parallel relates to how biological and organizational ecosystems come to be structured. As stated earlier, both biological and organizational ecosystems share similar emergent properties. However, the interactions that result in the emergence of each ecosystem can be structured in notably different ways. On the one hand, biological ecosystems are exclusively grassroots phenomena that are exclusively structured by interactions at the lower hierarchical levels. On the other hand, organizational ecosystems can be structured by interactions at lower or higher hierarchical levels, and thus can be grassroots or top-down in nature.

The final and most important false parallel relates to the assumption that both kinds of ecosystems are anchored in principles of the greater good. For biological ecosystems, this is not the case. Species, both those with critical roles to play in system stability and all others as well, exhibit goals and agendas favored by natural selection that maximize their own wellbeing. Conversely, organizational ecosystems are expected to develop over time, through foresight and purposeful planning, in ways that contribute to the betterment of those organizations and of society as a whole. Those organizational ecosystems that do not evolve in a manner that promotes the greater good are put in jeopardy of being eliminated or becoming obsolete. In this case, the group, rather than the individual, is the unit of natural selection. Furthermore, organizational ecosystems and the organizations within are accountable to and motivated by institutional pressures often exhibited by exogenous forces that range from cultural expectations to governmental action to economic realities. Thus, leaders must consider a multitude of factors that extend well beyond their own immediate goals and agendas when considering the position of their organizations within given networks and systems.

CONCLUSION

The ecosystem metaphor is a useful tool for understanding and predicting the conditions that shape and influence organizational systems. However, its appeal to business leaders and scholars has in large part been based on one central *misguided assumption*: that biological ecosystems are both communal (supported by individual commitments to the greater good) and stable. We have attempted here to clear up this fundamental misunderstanding, as well as to discuss and illuminate where biological and organizational ecosystems overlap and are inherently different.

The degree of communality within biological ecosystems is heavily debated within the ecology literature. How individual species working to maximize their own chances of success contribute to the wellbeing of natural ecosystems remains unclear to ecologists. In fact, innovation in nature happens mostly by accident and typically confers an advantage to a particular unit rather than to the system as a whole. Thus, there is little reason for business leaders and organizational scientists to look to nature for examples of how innovation occurs for the greater good of a system.

There is also no firm evidence that biological ecosystems become stable over time and that innovation is a mechanism for achieving and enhancing such stability. Instead, innovation of a species (or other unit) may increase, decrease, or have no effect on the overall stability of a given biological ecosystem. Thus, the effects of innovation diffusion on the ecosystem (which occurs, for instance, when an advantage over an antagonist has been achieved and spreads throughout the population) are uncertain. For example, an organism that innovates in such a way that it can no longer be eaten by a predator disrupts the established food web and thereby causes a ripple effect across the entire ecosystem.

However, the conceptual merits of the organizational ecosystem metaphor are such that it should certainly be retained, once appropriately clarified. In particular, the potential implications for developing a robust framework for identifying, analyzing, and managing organizations in an increasingly complex and dynamic world are substantial. For instance, studies of biological ecosystems that have investigated in depth the short- and long-term effects of uncertainty, change, and perturbation may also translate to models with the predictive power for understanding the dynamics of organizational networks and systems. However, such potential depends on the development of a robust framework that is based on ecological principles and accounts for both the similarities and differences between biological and organizational environments. Important questions that have yet to be raised that are critical to the further development and implementation of such a framework include, but are not limited to: When and why should an organization act as either a generalist or specialist? How is the health of organizations dependent on the wellbeing of the organizational ecosystem within which it is nested and embedded? How resilient is an organization in the context of a broader ecosystem? How can the emergence of new organizational ecosystems be anticipated or forecast? Last, should the identity of the CEO shift from that of chief executive officer to that of chief ecosystem officer? If so, what would the shift entail and look like?

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Executive Summary

A new operating logic is being developed as actors and the organizations they create become more interconnected in an increasingly networked global economy and society. One popular framework supporting the development of the new logic is based on an ecosystem metaphor. This metaphor has been used to describe and better understand organizational conditions and change within fields such as business, education, and healthcare. The potential implications for developing a robust ecosystem framework for identifying, analyzing, and managing organizations in an increasingly complex and dynamic world are substantial. However, the concept of an organizational ecosystem remains undefined. Thus, there exists the need for a metaphorical framework that is grounded in ecological principles and accounts for both the similarities and differences between biological and organizational environments. We work to conceptualize such a framework in this paper.

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