Escaping the fly room: We must adopt a broader perspective to tackle the complex problems humanity faces

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Biology is riven with philosophical dichotomies. The naturalist-reductionist rivalry is probably chief among theses. The naturalist

tradition encompasses an observational comparative approach to biology, and reflects the conventions of Alexander von Humboldt and Charles Darwin. From this tradition emerged the fields of biogeography, systematics, ecology, adaptation and, of course, evolution.

The reductionist tradition, on the other hand, seeks to ascertain mechanistic causes of functional processes, primarily through experimental probing. This enormously successful approach arguably had its birth in Thomas Hunt Morgan's 'fly room' in 1910, where experiments on Drosophila fruit flies established the existence of genes on chromosomes, and laid the foundation of modern genetics.

Morgan later applied his mechanistic experimental approach to embryology, and proceeded to advocate experimental reductionism for all biological fields. Reductionism successfully pervaded the biological sciences, scoring immense advances in our understanding of how life works.

Living in a complex world

This view of nature is, nonetheless, limited. Indeed, the most transformative advances in science have emerged from disciplinary integration. The integration of embryology with genetics in the 1960s, for example, established the fertile field of evolutionary developmental biology ('evo-devo' to its friends). This has opened whole new vistas of biological understanding that also draw on palaeontology, systematics, and biochemistry. Yet the reductionist approach remains well established in science, as reflected in the continued organisational structure of academic departments and institutes, and disciplinary chauvinism continues to pervade education, often compounded by narrow outlooks on the world we live in.

The global mayhem triggered by COVID-19 shines a light on

interconnectivity, and the need for interdisciplinary integration. The virus is possibly a consequence of the illegal wildlife trade, driven by inequalities of wealth and opportunity, cultural traditions, and ineffective law enforcement. Highly urbanized societies have facilitated rapid viral spread through transportation networks connecting global cities.

Lockdowns have consequences that transcend epidemiology, affecting employment, mental and physical health, and domestic abuse. A global economic downturn will increase poverty, while existing inequalities will be exacerbated, setting the scene for social conflicts and strife in the coming years. COVID-19 reminds us that in a complex and interconnected modern society, perturbations cascade along many pathways, driving multiple outcomes that are difficult to anticipate and plan for.

Overcoming disciplinary thinking

This is typical for so called 'wicked problems' where even agreeing on the nature of the problem is challenging, and where response actions create new unanticipated problems in other sectors. COVID 19 and our collective responses to it exemplifies a wicked problem. Climate change, species extinction, and environmental degradation are further examples.

Their diversity and complexity suggest a need for alternative understandings that transcend disciplinary boundaries. By only studying individual components, we neglect that these parts behave differently when isolated from their environmental context. Reductionist approaches that isolate components for experimental inquiry can thus provide only selective understanding.

The lesson to draw is this: If we want to adequately deal with these challenges we need to embrace a broader 'systems' approach to our work

and lives. Systems thinking will not deliver immediate answers to this conundrum, because complex systems continually change. Yet social and political structures organized around systems approaches can foster adaptive change.

Despite much current interest in systems thinking, it has yet to be mainstreamed in educational curricula, governmental organization, and societal structures. Academia should be at the forefront of innovative systems thinking, yet remains grounded in decidedly disciplinary streams. Transdisciplinary centers encompassing systems approaches are rhetorically celebrated, yet remain marginal to departmental interests, as evidenced by resource allocation and reputation. COVID-19 suggests that this needs to change.

History gives cause for hope

Joseph Woodger, an early champion of integrated thinking, started his career, like Thomas Hunt Morgan, as an experimental embryologist, but soon became interested in biology's conceptual foundations. His *Biological Principles* depicted biology as a fragmented science lacking unifying principles. Woodger argued for an integrated systems approach, where the properties of individual parts of an organism are dependent on their relationships within the whole. History now recognizes Woodger as one of the foremost theoretical biologists of the twentieth century.

It is time to escape the rigid reductionism of Morgan's Fly Room, and extend Woodger's philosophy far beyond biology, to the development and functioning of our socio-ecological systems.

More information: The author points out a historical quote that matches well with the meaning of this post:

In *The Conduct of Life* (1951), Lewis Mumford wrote, "So habitually

have our minds been committed to the specialized, the fragmentary, the particular, and so uncommon is the habit of viewing life as a dynamic inter-related system, that we cannot on our own premises recognize when civilization as a whole is in danger."

Garland Allens Biographie von Thomas Hunt Morgan: Allen, Garland E. 1978. Thomas Hunt Morgan. The Man and His Science. Princeton: Princeton University Press.

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