Biologists merge methods, results from different disciplines to find new meaning in old data

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A growing number of scientists are merging methods and results from different disciplines to extract new meaning from old data, says a team of researchers in a recent issue of *Evolution*.

As science becomes increasingly specialized and focused on new data, however, researchers who want to analyze previous findings may have a hard time getting funding and institutional support, the authors say. In a commentary piece in the journal *Evolution*, the authors argue for removing cultural and technological barriers to this process.

"By putting together pieces of prior research, it is possible to transform how you do science and open the doors to findings that previously were unattainable," said Brian Sidlauskas, a former postdoctoral researcher at the National Evolutionary Synthesis Center and lead author on the article. "But such an approach runs counter to the way science traditionally has been conducted, so pursuing synthetic science is somewhat risky."

"We need to reduce the risk, remove the barriers, and encourage more pursuit of synthesis," said Sidlauskas, now a professor at Oregon State University. "The potential is staggering," he added.

Some of the most important research of the last quarter-century, the authors argue, has resulted from "synthetic science" —an approach which combines concepts, tools, and data from multiple disciplines to produce new insights or discoveries.

They cite the work of J. John Sepkoski Jr., who over a 20-year period compiled a database of more than 37,000 entries tracking the first and last appearance of different organisms in the fossil record. The entries, they write, "cut across taxa, time, and geography to reveal emergent patterns over more than 500 million years of life that could not be extracted from the component data in isolation."

"That database led to previously undetermined knowledge of five separate mass extinctions through time, understanding of how major geologic events can increase or reduce biodiversity, the realization that near-shore environments produce a disproportionately large share of evolutionary novelty, and other findings," Sidlauskas said. "It also spawned a new field of synthetic paleobiology."

Sepkoski's data aggregation is one of four methods of synthesis the authors say can transform science. The others, including examples, are:

- Conceptual synthesis: The emerging discipline of evolutionary medicine is one example of how linking concepts from two distinct fields can yield new ways to approach scientific problems. For example, a recent study linked an increase in asthma rates to immune responses that might originally have helped our ancestors fend off parasites.

- Integrating methods: Integrating approaches and analyses from two distinct fields - such as genetics and evolutionary biology - has led to new ways to use modern DNA sequences. For example, researchers can now look into the past to understand the origin of genomes and reconstruct how their structure has changed over millions of years.

- Re-use of results: The authors also review a pair of landmark studies that — after combining hundreds of previous results — found that climate change alters species' distribution, abundance and morphology. These synthetic studies gathered more than 2,300 citations in just five years and substantially informed the current United States government policy on climate change.

Despite the promise, there are a number of cultural barriers to pursuing this kind of science, the researchers say. For one, it is difficult for young scientists to find appropriate training. In addition, peer review and journal publication tend to emphasize the analysis of new data rather than old, they argue. Funding from state and federal agencies is more frequently directed toward more conventional approaches, not to mention the institutional challenges with job searches, promotion and tenure - all of which are geared toward more traditional science.

The technological barriers also are daunting, but offer tantalizing potential, Sidlauskas said.

"When you're looking to synthesize data from several hundred individual studies, data formatting, storage, and accessibility become huge issues," he said. "There has been a growing movement by funding agencies and journals to permanently archive all raw data and materials in some kind of standardized format so they are not lost over time and can be used by researchers of the future."

"It's kind of an open-source approach to science," he added. "Data archives may require some kind of proprietary protection for a few months or years, but after a certain amount of time, they should become public domain. Only by saving the data that underlie today's science will we allow future scientists to use those data in ways that may far exceed what the original researchers envisioned."

More information: Sidlauskas, B., G. Ganapathy, et al. (2010). "Linking big: The continuing promise of evolutionary synthesis." *Evolution*; doi:10.1111/j.1558-5646.2009.00892.x

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