Why Descriptive Science Still Matters

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DAVID A. GRIMALDI AND MICHAEL S. ENGEL

"Descriptive" in science is a pejorative, almost always preceded by "merely," and typically applied to the array of classical *-ologies* and *-omies*: anatomy, archaeology, astronomy, embryology, morphology, paleontology, taxonomy, botany, cartography, stratigraphy, and the various disciplines of zoology, to name a few. But there is chronic misunderstanding as to what descriptive science actually is, and thus there is ignorance of its significance. This in turn imperils these disciplines and even the existence of fundamental knowledge in academia, as recent history teaches us.

First, an organism, object, or substance is not described in a vacuum, but rather in comparison with other organisms, objects, and substances. The comparative method assesses variation among individual things, and organizes it into systems and classifications that are used for making predictions. A thing is relevant in the context of other things: Tiny Pluto is relevant because it behaves differently and is shaped differently than the thousands of other planetary bodies in the Kuiper Belt. Even the most prosaic description is actually a highly selective account of features that are found to be significant in comparison with related things. As a result, there is no such thing as a perfectly complete description or a perfectly complete classification or organization system; as descriptions become more refined and thorough, so do the systems of organization. The composition of our solar system, for example, would not have been so controversial in 2006 were it not for improved observations and descriptions of Charon (Pluto's moon), Ceres and other asteroids, and 2003 UB_{313} (a.k.a. Eris, the farthest object in the solar system). What makes the recent discussion of the solar system so surprising is that it was based on something that most people thought astronomers had already described a long time ago.

Second, descriptive science is not necessarily low-tech science, and high tech is not necessarily better. Genomic sequencing and planetary probes (e.g., the Mars rovers, Spirit and Opportunity) are tools for descriptive science. They gather data that will refine, corroborate, and possibly even revise current descriptions. The problem is that the high-tech descriptions are seen as more scientific, and this has repercussions in academia. Romanced by technology and large grant overheads, academic administrators supplant low-tech with higher-tech descriptive science, even though the new data may not be much of an improvement. In these times of megalabs, we need to remember that scientific giants of the past observed and described with quaint tools, but nevertheless uncovered enduring patterns. We still employ, for example, the basic systems (with numerous refinements, of course) that were established by Carolus Linnaeus in 1758 for biological classifications, by William Smith in 1815 for the geological timescale, and by Dmitri Mendeleev in 1869 for the periodic table of the elements.

More recent architects of scientific paradigms still include individuals working on the technological fringes, such as the lesser-known researchers Bruce Heezen and Marie Tharp (she died this past year). From 1952 to 1977, Heezen and Tharp methodically charted the ocean floor with ocean-depth soundings, revealing the midoceanic ridges and the rift valleys within them. Even though Alfred Wegener proposed the theory of continental drift in 1912, it was still heretical to espouse the theory in the 1950s, despite the voluminous new descriptive evidence that supported it. The chairman of Heezen and Tharp's department at Columbia University was so enraged that he fired Tharp and virtually drove Heezen from his lab. So, for the last decade of the project, Tharp was cloistered at home—much like Darwin writing his *Origin*—drafting the maps that changed our view of Earth's surface and showing that money doesn't solve everything. The work of Willi Hennig (1913–1976) transformed systematics and thus evolutionary biology. Very few people know that he wrote his seminal work, *Grundzüge einer Theorie der phylogenetischen Systematik,* when he was a prisoner of war in 1945. This and later phylogenetic treatises built upon his extensive descriptive work on the morphology, taxonomy, and biogeography of flies, which he always did alone while seated at his microscope, constantly making notes and sketches, drinking coffee, and smoking.

Biology's equivalent of stellar and oceanic cartography is taxonomy and the morphology on which it is based, including old-fashioned natural history observations on behavior, life histories, and species distributions. Yet, unlike these analogous fields, taxonomy is derided as anachronistic, which is ironic given that taxonomy is still making startling discoveries in a rapidly disappearing natural world. This is demonstrated by recent findings such as the discovery several years ago of a new insect order from Africa, the Mantophasmatodea, and in

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2006 of a 375-million-year-old vertebrate from the Arctic, *Tiktaalik roseae,* that is a transitional form between lobe-finned fishes and true tetrapods. The description of any species is a hypothesis about the identity of individual organisms, which is testable against further evidence such as DNA sequences (and is usually confirmed). Unfortunately, there is as much of a crisis for taxonomists as for what they study. Imagine what could be accomplished—at a fraction of the cost of a Mars rover—by a small army of explorers and taxonomists toiling away to discover and categorize organisms, like Tharp working to map the ocean floor.

Finally, a theory is only as good as what it explains and the evidence (i.e., descriptions) that supports it. In biology, no theory is more profoundly explanatory than evolution. Two years ago, the well-funded efforts to impose intelligent design on K–12 biology curricula were effectively laid to rest with the court ruling in *Kitzmiller v. Dover* (400 F. Supp.2d 707 [M.D. Pa. 2005]) that intelligent design is not scientific, and teaching it in public schools is therefore unconstitutional. But as biologists rejoice over this victory, we need to remember that Darwin was largely a biologist who was a prolific describer of everything from barnacles to orchid pollination and animal emotions. His *Origin of Species* succeeded so well because it assembled and explained vast descriptive evidence. Few people are as insightful as Darwin, Mendeleev, Wegener, Hennig, or William Smith, but we lesser souls can still create enduring science through work that is gloriously descriptive, if only academic institutions have the foresight to provide for it.

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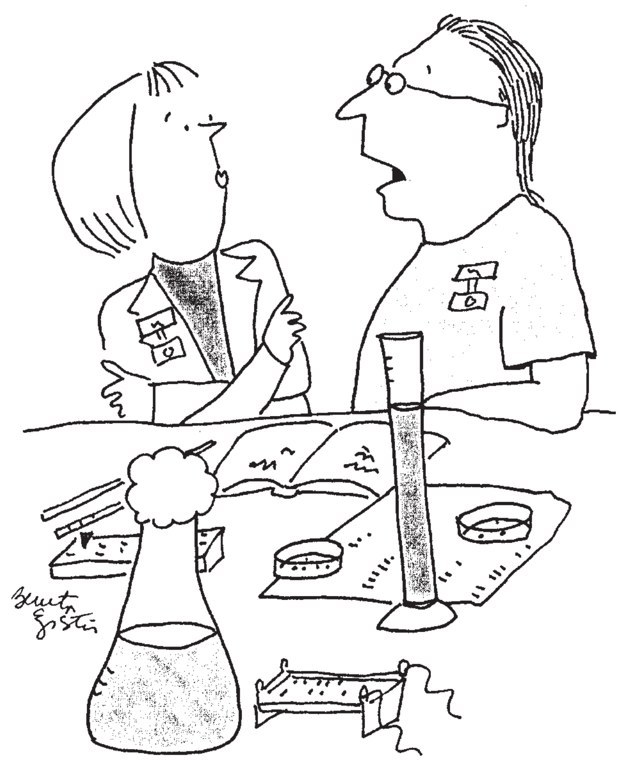

"I already wrote the paper.
That's why it's so hard to
get the right data."