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"Taxonomic certification versus the scientific method": a rebuttal of Rogers (2012)

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We read with great interest the correspondence article entitled "Taxonomic certification versus the scientific method" (Rogers 2012), and, as members of the Taxonomic Certification Committee of the Society for Freshwater Science (formerly, the North American Benthological Society [NABS, 1975–2011]) (SFS-TCC 2012), we agreed to respond in a constructive fashion with factual information to correct and provide perspective for a few errors, unfounded and confused assumptions, and misperceptions it presents. The nature and structure of the article and its title requires that our response be segregated into two main parts. First, we briefly describe the philosophy, purpose, and objectives of the Taxonomic Certification Program (TCP [http://www.sfstcp.com/]) as developed and administered by the SFS, including correcting inaccurate statements or false assumptions. Second, we will address the issues Rogers has with terminology used in a paper he cites (Stribling *et al*. 2003 [not 2002 as cited by Rogers]). The former issue is, by far, most important—primarily because it has the potential of adversely affecting a program that has already had a large positive impact on the quality of biological monitoring in the USA and Canada by recognizing laboratory staff with demonstrated ability to perform taxonomic identifications of benthic macroinvertebrate samples. The terminology issue is trivial, but because the comments are made in print, we correct them in print by rebutting Rogers' perception that we were in error.

Taxonomic certification

The TCP began in 2005 when NABS (now SFS) recognized and acknowledged that the ever-increasing scale and scope of biological monitoring using freshwater benthic macroinvertebrates (hereafter "macroinvertebrates") was outstripping the availability of expertise to perform accurate and precise taxonomic identifications. In part, this large increase in biological monitoring offered an opportunity for employment to those with training and experience in biology, even though that background may not have been necessarily with macroinvertebrate identification. Consequently, the availability of people offering that service also increased and, predictably, so did concern that inadequate training and inconsistent depth of experience was prevalent among them. The SFS-TCP was established not as a program to guarantee better data quality, but rather, as a process intended to help distinguish individuals who have appropriate training and experience, and subsequent to successful completion of the certification exercise, to be considered as having the *capability* of providing taxonomic data of acceptable quality. In the last 2-3 years, we have observed an increase in agency grants and contracts requiring project taxonomists to be SFS-certified, including, for example, environmental

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agencies from Idaho, Maine, New York State, Oregon, West Virginia, New Hampshire, Minnesota, the District of Columbia, Environment Canada, Parks Canada, the U. S. Environmental Protection Agency (Regions 3 and 4), the U. S. Geological Survey's Northern Appalachian Research Program, the Ohio River Valley Water Sanitation Commission, and the City of New York's Bureau of Water Supply. As an example of the language being used in these requests for proposals, the following was recently specified by the West Virginia Department of Environmental Protection (WVDEP 2011): "Must have degreed biologists on staff performing the benthic macroinvertebrate identifications. NABS certification for genus level EPT (Ephemeroptera, Plecoptera, and Trichoptera) (eastern) and genus level (Chironomidae [eastern]) is required to perform identifications. Identification of organisms by non-professional personnel or those without NABS certification is strictly forbidden."

If this trend coalesces and expands, the pool of providers will be dominated by production taxonomists who have demonstrated a capability of correctly identifying specimens; as of this writing, the success rate of those attempting certification is 68 %. It should be recognized that two of the unwritten goals of the certification process are to discourage (1) resource managers from assuming that anyone with a microscope and a few taxonomic texts (a criticism made by Rogers 2012) is qualified to perform identifications, and (2) fresh graduates with minimal academic background in appropriate disciplines from convincing a potential, unknowing employer that they are likewise qualified to do identifications. The test sets are intentionally rigorous and not easily passed without a solid familiarity with the test group. For those candidates who were unsuccessful in initial attempts at the exam (n = 256), and then retook it, a low 28 % pass rate demonstrates the success of initial tests, separating the inexperienced candidates from the more competent/ skilled taxonomists the first time around. Further, those candidates making up the 28 % made the effort to take remedial steps, re-take the exam, and ultimately acquire certification.

In Rogers' correspondence (2012), there seems to be some confusion regarding the difference between certification and accreditation. Rogers mentions the issue of certifying individuals rather than laboratories (p. 67, paragraph 2), falsely implying that the TCP is a proponent of laboratory certification. From our perspective, and in accordance with terminology from the National Institute of Standards and Technology (NIST 2012), certification is focused on the individual, whereas accreditation is focused on institutions or programs. In the context of the TCP, if an entire laboratory were to become certified, regardless of the individuals working there, it is unclear how data users could have confidence that the "true taxonomists" (as Rogers would likely define them) are the ones actually looking through the oculars and consistently recording what they see, as opposed to groups of technicians or graduate students who are producing the data, the latter of which are potentially still in training.

The TCP and its oversight committee (TCC) have never claimed that certification itself elevates data quality, contrary to the statement of Rogers (2012: p. 67, paragraph 1). What the committee does claim is that certification demonstrates that a person has sufficient skills to have the *capability* of providing high quality data—specifically, accuracy of genus- and/or family-level identifications. However, the TCC also recognizes that certification does not guarantee that a person *is* providing good data. That is a different issue requiring specific oversight, such as a structured, routine, and rigorous quality control (QC) evaluation (e.g., Moulton et al. 2000, Brunialti et al. 2002, Stribling et al. 2003, 2008, Haase et al. 2006, Milberg et al. 2008).

Taxonomists versus identifiers

Rogers (2012) takes exception to our use of the word "taxonomist" (Stribling et al. 2003) to refer to those who identify unknown specimens using taxonomic literature produced by "research taxonomists" on morphology, anatomy, formal nomenclatural actions within the International Commission of Zoological Nomenclature, dichotomous keys, descriptions, and other related materials. Based on exactly the same thought structure, Rogers also disagrees with characterization of the SFS-TCP as providing taxonomic certification, preferring that it be called "identification certification" (p. 67, line 5). We assume that his mention of the scientific method in the title may be anchored in his incorrect assumption that we are saying identifiers and research taxonomists are equally competent practitioners of the scientific method. Whereas we agree that it is not desirable for individuals to have an over-reliance on a single, favorite, comprehensive identification manual, we would also argue that to identify specimens competently requires some of the same skill, understanding, and attention to detail that research taxonomists possess. Neither the TCC nor Stribling et al. (2003) used the phrase "bench taxonomists" (Rogers 2012: p. 66, paragraph 6, line 5]) and we feel that we do understand and appreciate what taxonomists do. To suggest otherwise is simply inflated, misdirected umbrage. In fact, some of us distinguish and discuss "nonresearch taxonomists", "production taxonomists", and "parataxonomists" in recent publications (e.g., Stribling *et al.* 2008) and the differences with those doing research taxonomy (e.g., alpha, beta and

gamma taxonomy). We should also point out here that many authors have properly suggested that taxa are hypotheses (e.g., Wheeler & Platnick 2000, Fitzhugh 2005, de Carvahlo et al. 2007, Wheeler 2007). Wheeler & Platnick (2000) emphatically stated that phylogenetic species are the endpoints of evolution, and are "explicitly, rigorously, testable". In this context, each time a person evaluates an individual specimen through a dichotomous key, s/he is *de facto* testing the hypothesis of the research taxonomist that authored the key. If the individual specimen fails to match any ultimate key couplet result, the hypothesis is rejected, thus meeting a basic requirement for an exercise to be called science, i.e., that the parenthetical phrase is falsifiable (Popper 2002). In fact, specimens failing to follow dichotomies in the key or match descriptive language provide evidence to the author that may allow her/him to revise the hypothesis. With apologies to some statisticians, if one agrees that applying appropriate taxonomic identification effort to describe sample content is, in this sense, hypothesis-testing, then "diagnosticians" (Rogers 2012: p. 66, paragraph 6, line 14]) should be considered more than simple unskilled labor. Several of the TCC members have substantial experience in authorship and application of dichotomous keys, and thus are aware of the fact that most authors of identification keys are not thinking in terms of hypotheses; rather, they are thinking about the best way to transfer their knowledge to others. Keys are a form of expert system that assist in communicating a synthesis of morphological and other diagnostic features that best differentiate species or other taxonomic groupings.

On a positive note, we do agree with Rogers (2012) in terms of the need for quality control (QC) on macroinvertebrate identifications. We want to be clear, however, that QC is still necessary even when identifications are accomplished by a person certified by the SFS-TCP. Thus, although proper QC may render certification unnecessary, certification does not negate the need for QC, *especially* when the person is performing duties as part of a routine biological monitoring program. The key here is confirming adequacy of the QC analysis, but that is an entirely different issue beyond the scope of this rebuttal. However, the comment in Rogers' (2012) penultimate paragraph that "… re-identifications are then compared to the original identifications and discrepancies (if any) are re-examined with the goal of resolution" warrants a specific response because it suggests a misunderstanding of QC. One of us (JS) has been performing these kinds of sample data comparisons for more than 15 years involving thousands of samples. From this direct experience, the number of samples for which there has been 0 % error is very small (< approximately 10), and this is with the primary and/or QC re-identifications being performed by production taxonomists (*sensu* Stribling et al. 2003) that are among the best in the USA. These production taxonomists are considered to be among the most qualified due to combined academic and practical training, an enormous depth and breadth of experience, and their frequent *and willing* participation in the taxonomic comparison process as part of routine QC. Thus, it is obvious that a healthy skepticism should accompany *any* claim of perfection in biological sample identification.

In conclusion, all members of the SFS-TCC, as well as the community at-large of biological monitoring and assessment practitioners, would like to see increased use of biological data in water quality assessment and environmental management decision-making. We continue to refine, improve, and defend the SFS certification testing program for freshwater macroinvertebrates because we firmly believe that it will, in concert with rigorous QC programs, substantially improve the quality of both basic and applied benthic science. This, in turn, will lead to better natural resource management—with decisions being based on policy derived from scientifically sound evidence rather than conjecture or evidence of unknown quality.

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