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Andrew L. Rhyme

Roger Williams University, arhyme@rwu.edu

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The importance of open access in technology transfer for marine ornamental aquaculture: The case of hobbyist-led breeding initiatives

^{1,2}Andrew L. Rhyne

¹New England Aquarium, Edgerton Research Laboratory, Boston, Massachusetts, United States of America; ²Roger Williams University, Department of Biology and Marine Biology, Bristol, Rhode Island, United States of America

Abstract. Access to peer-reviewed literature is often restricted to a limited segment of the target audience. Barriers are in place to prevent open access of information. In the applied research science of aquaculture, these barriers have slowed progress and innovation. Here, I present a case study of how the internet and hobbyists are transforming both access and flow of information from closed circles to open dialogue within the field of marine ornamental fish rearing. This open approach is leading to innovation a rate remarkably faster and at a lower costs than could have been accomplished by traditional methods. Aquaculture societies, aquarium professionals, hobbyists, and scientists pursuing the captive production of species should embrace this movement. Whether production is for profit, conservation, or pure enjoyment, the free flow of information provides exciting new opportunities.

Keywords: open access, marine ornamentals, aquaculture.

Literal and figurative barriers to information access. As an academic and a scientist in the United States, I often take for granted our unfettered access to information. We generally have access through our institution's libraries to nearly every published form of information. Yet, much of the published work in the applied science field of Aquaculture remains hidden from much of the intended audience. Outside of academia, access to primary scientific literature is actually quite limited, with costs of up to 35 USD per PDF, or annual subscriptions to single journals often exceeding 1000 USD. In applied fields such as Aquaculture, these access issues construct a very real and practical barrier to information flow and as a result, inhibit progress and development (Brown 1999).

The most highly respected journals in Aquaculture contain useful information, ideas, and protocols that are not readily available to major segments of the Aquaculture community, both literally and figuratively. In the rare case where primary scientific literature is technically available to commercial producers, there is often a disconnect between authors and audience. It is generally agreed that laboratory scale research is important and is a primary source of cutting-edge technologies that will, down the line, be appropriated for business. These lab-scale developments, however, are not always immediately applicable to commercial scale production without necessary tweaks in the process. The understandable reluctance of scientists to give away intellectual property, coupled with the reluctance of commercial producers to adapt from of laboratory to commercial scales, creates at best very slow progress that is further hampered by the logistical barriers to information access.

The traditional model of university research, disseminated through peer reviewed literature and/or professional conferences is not sufficient for applied disciplines. Extension agents are often employed to bridge university research and commercial production. While a

valuable asset, these agents are regionally focused and are employed by local governments or state universities which can further limit breath of impact. Currently, there exists a lack of information and technology transfer between grant funded institutions and the broader community. These barriers sometimes originate from geography, but more often reflect the uneasy relationship between production facilities, the hobby breeder and university researchers. Specifically with regards to Aquaculture, it seems that the ability to rear fish, corals, and invertebrates is an intoxicating experience; those that have mastered this art are often the most reluctant to teach and transfer information. This reluctance stems both from the traditional guarding of intellectual property and from the lure of financial gain (through profits or grants). This reluctance, often interpreted as paranoia, is understandable in a climate of increased competition for decreasing funds and the academic requirement of "publish or perish". The current rewards and safeguards on intellectual property creates understandable tension between academic and commercial communities, but the reality is that both sides could benefit from a different model of information flow where non-traditional forums (such as open-access academic journals, online bulletin boards or lay-literature) are valued within applied academic disciplines.

Breaking through information access barriers: marine aquarium community case-study. The marine aquarium community is a perfect case-in-point example of how facilitating information access can inspire new ideas and promote progress. The marine aquarium community is comprised of millions of hobbyists from dozens of countries spending their free time and disposable income to bring the marine world into their homes. Professionals are also a part of this community; they contribute knowledge and expertise gleaned from their work in public aquariums, e.g. SECORE (Petersen 2006), small businesses, and a growing number of for-profit commercial production facilities. Perhaps surprisingly to some, university faculty and researchers are ever increasing members of this community. Research faculty and students interested in non-traditional aquaculture are a rapidly growing demographic as these once-hobbyists turn their passions into formal research careers. Partly because the scientists have their roots in the hobbyist industry, there has been on occasion remarkably free and open exchange between the two groups. Other factors contributing to the free flow of information relate to issues of scale: scientific laboratory research occurs at a similar scale as marine ornamental production, which operates at the same scale as the marine aquarium hobby. In all cases, small tanks can be maintained in a laboratory, a small storefront, a home, or a garage without needing access to warehouse-sized facilities. In part because of demographics and scale, information flow has transcended traditional pathways where scientific progress originates with scientists and eventually trickles down to hobbyists. Technology, particularly the internet, has enabled communication from hobbyist-hobbyist, hobbyist-scientist, hobbyist-small business, scientist-small business, and every combination thereof. There has been a free exchange of ideas and techniques without geographical or professional boundaries that has unquestionably accelerated the growth of the marine aquarium industry, particularly in the area of coral husbandry. Information that was once only available through the traditional publishing world has shifted format, and is now open for the entire world to read and discuss in online forums or bulletin boards. While this is not unique to this hobby, the aquarium hobby can serve as a beacon and a model for all applied industries, and large-scale commercial Aquaculture (for food or trade) may also benefit from such an open approach.

Conservation consequences of information bottlenecks. Open approaches to information and technology can help the marine aquarium community, but can also help to conserve environmental populations of focal marine organisms and ecosystems. A perfect case study is that of the mandarin dragonet (*Synchiropus* sp.). These small, highly charismatic fishes are among the most desirable species in the marine hobby. However,

these fish are heavily collected from the wild, which has caused declines in their population (Rasotto 2010). To add insult to injury, the collection process is inefficient; most of the collected fish starve to death in captivity, thereby creating a vicious cycle of continued overharvesting from the wild. This morbidly high demand created an exciting opportunity for aquaculture: captive breeding could reduce wild collections and would solve current husbandry challenges. In 2010, the first captive-bred mandarin dragonets were commercially available (ORA 2010). However, mandarin dragonets were first captively bred in the late 1980s (Sprung 1989), with methods published in the peer-reviewed literature a decade later (Sadovy 2001). Not until 30 years later did this knowledge translate to application. How many mandarin dragonets would have been spared with better communication through open access?



Figure 1. Male *Synchiropus splendidus* (Photo Credit: Luc Viatour)

Fostering faster invention: a combination of competition, necessity, and an open approach. The plight of the mandarin dragonet was championed in 2008 by MOFIB (Marine Ornamental Fish and Invertebrate Breeding Association, www.marinebreeder.org) breeding initiative with their Breeders Challenge Contest, which was developed to spur innovation and dialogue. Breeders Challenges traditionally feature species that hobbyists have identified as important to their trade. Hobbyists gathered in an open forum to discuss rearing and husbandry methods, which included discussion on how to wean from wild to prepared feeds, facilitating adult spawning, and rearing larvae. This caught the attention of a professional hobbyist, Matthew L. Wittenrich, a Ph.D. candidate at Florida Institute of Technology. Armed with years of rearing knowledge in the culture of other species (Wittenrich 2007), Matthew quickly began posting his efforts and displayed (in real time) the mass rearing of two highly desired fish (*Synchiropus splendidus* & *S. picturatus*) (Wittenrich 2008). Hobbyists from around the world paid attention, posting questions, comments, and words of encouragement. Matthew rose to the Breeders Challenge, and presented the first proof of potential commercial viability, including high larval survival. Wittenrich did not follow the traditional methods of preliminary rearing trails followed by

replicated studies, nor did he only disseminate information through the printed literature or professional meetings (Wittenrich et al 2010). The successful commercial rearing of mandarin dragonets in 2010, now available for purchase, is demonstrated proof that an open approach can work. The key to bringing this species to commercial fruition was open access exchange of information.

Opening the door to an open process. I would hope that others would join me in supporting the free flow of information by publishing their work in open access journals, and encouraging societies like the World Aquaculture Society, the American Fisheries Society, and European Aquaculture Society to go to an open access format. We should fully applaud blogging or posting on discussion forums in real time about efforts to rear new species or develop new live feeds. The dialog that occurs on MOFIB and other online forums can spark innovation that is not possible through traditional formats. I believe that open access is the key to faster breakthroughs, and to better translation between academia, hobbyists, and commercial industry. The Aquaculture field has an opportunity to become an exemplary model for all applied science fields: let's seize it.

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Author:

Andrew L. Rhyne, Department of Biology and Marine Biology, Roger Williams University, One Old Ferry Road, Bristol, RI USA 02809, arhyne@rwu.edu. Research Department, New England Aquarium, Central Wharf, Boston, MA USA 02110, arhyne@neaq.org.

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