



Conservation education program for threatened Asian horseshoe crabs: A step towards reducing community apathy to environmental conservation



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ABSTRACT

Long-term and locally-based public education programs are essential in supporting conservation initiatives for horseshoe crab protection, particularly in Asia, where their populations have been largely exploited for food and biomedical applications. However, the implementation of such conservation initiatives can be difficult due to a community's ingrained apathy towards the environment. In addition, the effectiveness of similar education programs to engage the community in conservation work has rarely been assessed. We described the implementation strategies of a conservation education program in Hong Kong, with the objective to improve the community's awareness, engagement and environmental attitudes towards the conservation of Asian horseshoe crabs. This study evaluated the program's outreach, outcomes and impacts between 2009 and 2016. By raising laboratory-cultured juvenile horseshoe crabs at local secondary schools, this long-term conservation education program succeeded in enhancing students' knowledge on the biology and ecology of horseshoe crabs, as well as promoting positive attitudes and behaviors towards relevant conservation issues. Lessons and recommendations derived from this program can serve as guidance for similar campaigns in other places.

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1. Introduction

Tackling environmental conservation problems have recently become complicated and challenging. Once primarily scientific in nature, these issues are now almost beyond the scope of any one discipline, incorporating social, cultural and economic domains (Kessler, Csányi, & Field, 1998). The implementation of conservation initiatives involving local communities, especially young people, can be more difficult due to an ingrained apathy towards the environment (Harness & Drossman, 2011; Lo, Chow, & Cheung, 2012). Connell et al. (1999) found that Australian high school students were knowledgeable about the environment and aware of the local and global environmental problems, but pessimistic and believed that they could only do “small things” for the environment, such as material recycling. The root causes of their apathy towards environmental issues were possibly related to the inade-

quate environmental education in the curriculum, the low priority of environmental conservation by the government as reflected by insufficient funding and ineffective wildlife law enforcement, and the exclusion of youth from civic participation (Bell, 2005; Connell, Fien, Lee, Sykes, & Yencken, 1999; Harness & Drossman, 2011). In Hong Kong, General Studies is the only principal subject in which students acquire knowledge about wildlife conservation through the formal curriculum (Tsoi, Chan, Lee, Ip, & Cheung, 2016). Besides, marine ecological issues are generally a minor area of discussion compared to terrestrial contexts (Thornton & Scheer, 2012). The insufficient ecological knowledge of the community, coupled with an established culture of wildlife consumption, has caused the slow development of associated conservation actions in Asia-Pacific countries (Lo et al., 2012).

Belonging to an archaic group of marine chelicerates and often termed as living fossils, horseshoe crabs are an important benthic predator, prey, bioturbator and host for epibionts in coastal ecosystems (Botton & Shuster, 2003; Botton, 2009). The Chinese horseshoe crab, *Tachypleus tridentatus* (Leach, 1819) face particularly intensive pressure from habitat loss caused by coastal development, and unsustainable harvest for biomedical

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applications and food consumption (Gauvry, 2015; Hsieh & Chen, 2009; Liao, Hong, & Li, 2001). Population declines in *T. tridentatus* have occurred over most of its distribution range, with surveys indicating small and vulnerable populations in Japan (Seino, Uda, Tsuchiya, & Tsuchiya, 2003), mainland China (Lin, Chen, & Shin, 2014), Taiwan (Hsieh & Chen, 2015) and Hong Kong (Kwan, Hsieh, Cheung, & Shin, 2016). Decreasing horseshoe crab populations can have significant ecological implications. In Delaware Bay, USA, a decline in shorebird populations can be attributed to the reduced spawning activities of American horseshoe crabs on the shores, because of their reliance on horseshoe crab eggs for obtaining essential energy storage for subsequent migration to the Arctic (Gillings et al., 2007; Haramis et al., 2007; McWilliams, Guglielmo, Pierce, & Klaassen, 2004).

In the 2012 IUCN World Conservation Congress, a motion for the conservation of Asian horseshoe crabs was unanimously passed, which recognized Asian horseshoe crabs as “important biological resources essential for sustenance of broader ecosystem”, “important natural and scientific resources needing sustainable management” and “culturally symbolic species” (IUCN, 2012). One of the recommendations in this motion was to promote education, citizen science and community participation, as an integral component in the conservation of Asian horseshoe crabs and as a prerequisite for the development of knowledge and capacity to further such efforts (IUCN, 2012). However, at present, such conservation efforts are mostly in the form of routine ad-hoc exhibitions at aquariums and museums, school lectures, workshops and field excursions (Chen, Yeh, & Lin, 2004; Iwaoka & Okayama, 2009; Nishimura & Iwaoka, 2015). Longer-term education and public awareness programs to sustain conservation initiatives of Asian horseshoe crabs are very limited.

Using the “Raising Horseshoe Crabs in the Classroom” program in Maryland, USA as a template (Kreamer & Kreamer, 2015), a “Juvenile Horseshoe Crab Rearing Program” in secondary schools has been conducted in Hong Kong since 2009. What is different from its American counterpart, is how the program was initiated and implemented. The American program was run by the Department of Natural Resources, Maryland State Government, while this rearing program was conducted under the partnership between a non-governmental organization (NGO) and a public university in Hong Kong, supported by grants from private corporations. One of the key aspects of this rearing program, unlike the US program, is to provide an opportunity to restore *T. tridentatus* populations at a local mudflat, where a startling 90% drop in juvenile populations was observed in 2004 (Shin, Li, & Cheung, 2009). In addition, the program aimed to impart knowledge on the basic biology and ecology of horseshoe crabs by providing a “learning by doing” experience, and to raise public awareness about threats to horseshoe crabs locally and internationally. The ultimate goal of the program was to reduce the ingrained apathy of the local community, especially the youth, on environmental conservation issues. As the effectiveness of developing similar education programs are virtually unknown, in this paper, we describe the program implementation strategies and assess their outcomes and impacts towards secondary school students (ages 13–17) in Hong Kong. We also provide recommendations for a similar rearing program, which may be applied to other places.

2. Materials and methods

2.1. Program implementation

Ocean Park Conservation Foundation Hong Kong (OPCFHK) and City University of Hong Kong (CityU) initiated a pilot program of rearing laboratory-cultured juvenile *T. tridentatus* at ten local

secondary schools in 2009. Students formed teams to raise the juveniles for 14 months, under the supervision of their teachers and technical advice from CityU. All the cultured juveniles were then released by the students at Ha Pak Nai, a natural horseshoe crab spawning and nursery shore for re-population purposes in 2011. After successful completion of the pilot project, the program was conducted on an annual basis with initial financial support from OPCFHK, and later from private corporations. The program has been gradually developed over the years, and is currently comprised of seven phases: (1) school recruitment, (2) program orientation, (3) set-up of aquarium and rearing of juveniles, (4) school-based activities, (5) mid-term sharing event, (6) coastal clean-up and wild release, and (7) finale event. Fig. 1 illustrates the timeline and different learning components designed for the program.

From 2012 onwards, a total of 30 secondary schools were selected to join the program each year, according to a rating system developed by OPCFHK. When applying, teachers are required to provide detailed descriptions on how the program can be implemented at their schools to benefit the intended students' learning objectives, to maintain routine horseshoe crab husbandry, and to incorporate the rearing activity, if feasible, into the syllabus of the science curriculum. Schools which participated before were allowed to re-join the program, so that they can serve as mentors in enhancing communication and experience sharing with newly-recruited schools. All participating schools were invited to attend an orientation workshop with an introductory lecture on basic biology and ecology of horseshoe crabs, their importance and the potential threats to their existence, followed by a laboratory visit at CityU (Fig. 1). During the workshop, school teachers and students received an information package, including instructions for setting up an aquarium, protocols for the rearing of juvenile horseshoe crabs and procedures for collecting data during the rearing process. Students were also required to monitor and submit a monthly data sheet comprising size measurements of juvenile horseshoe crabs and water quality of the aquarium, such as water temperature, salinity, pH and ammonia concentration, under the guidance of their teachers (Fig. 1). Since the information on rearing requirements for Asian horseshoe crabs is limited compared to their American counterparts (reviewed by Carmichael & Brush, 2012), students were encouraged to modify and improve the rearing protocol based on their observations during the rearing duration. The CityU team answered any queries related to rearing techniques via phone calls or posting on a social e-platform created under the program. During the mid-term sharing and finale event, both teachers and students shared their rearing experience, and learned from the feedback and comments from other schools.

Beginning from 2013, teachers and students also had to organize a school-based activity to disseminate the conservation importance of horseshoe crabs (Fig. 1). Students were involved in designing information displays and other promotional materials, and played the role of ambassadors in delivering conservation messages and sharing their rearing experience to their classmates and teachers, parents, family members and the public. In particular, the horseshoe crab aquarium displayed at schools could attract the interest and engagement of visitors to appreciate such unique marine living fossils on local shores and understand the threats facing them. Students also had opportunities in assisting research studies undertaken by the CityU team related to horseshoe crab biology and ecology. Prior to the end of the program, teachers and students were invited to visit a local horseshoe crab spawning and nursery site (Fig. 1), where they cleaned up the shore and released the juveniles under their care to the intertidal area. For larger-size juveniles, the animals were tagged with a small implant device so that the CityU team could visit the shore repeatedly to track and

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