

## Chapter 42

### 2<sup>nd</sup> SECORE workshop: towards the conservation of the threatened Elkhorn coral *Acropora palmata*

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#### ABSTRACT

The SECORE (SExual COral REproduction) Project is a network of public aquaria and research institutions aimed at applying sexual reproduction techniques in order to enhance sustainability among *in-situ* and *ex-situ* coral populations (www1). In order to disseminate breeding techniques among public aquaria, the 2<sup>nd</sup> SECORE Workshop was held in Puerto Rico (USA) from the 10<sup>th</sup> to 17<sup>th</sup> of August, 2006. Coral specialists from 13 public aquaria and researchers from the U.S. and Europe participated in this training and research workshop. This was the greatest effort ever undertaken to establish an *ex-situ* population of the threatened Elkhorn coral, *Acropora palmata*. During the 2<sup>nd</sup> SECORE Workshop, *ex-situ* rearing methods were applied to the broadcast spawning Elkhorn coral, *Acropora palmata*. Larvae were successfully reared and then taken by the participants back to their institution for further research. The majority of the larvae settled within the first two days. Settlement varied between institutions with rates of 10-30 %. Preliminary results on the post-settlement survival after 3 months showed rates between 5-30 % depending on the institution.

This workshop was unquestionably a very successful initial attempt at providing sexual propagules of a threatened species to public aquaria. The workshop was a major step forward in enhancing the involvement of public aquaria in coral reef conservation and encouraging people of different institutions to work more closely and cooperatively together.

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#### STATUS OF THE CARIBBEAN ACROPORIDS

*Acropora palmata* (Elkhorn coral) and *Acropora cervicornis* (Staghorn coral) are two major reef building species in the Caribbean that once formed dense thickets and stands. Together, they were foundation species in their contribution to reef growth, island formation, coastal protection, fisheries habitat and biodiversity (Gladfelter *et al.*, 1978; Lirman, 1999; Bruckner, 2002). Historically, *A. palmata* dominated the reef crest and the shallow

fore reef (Goreau, 1959; Bruckner, 2002), but populations declined precipitously in the 1980s and continue to decline or remained at a highly reduced level (Bruckner, 2002). *Acropora cervicornis* thickets dominated shallow and intermediate depths throughout their range have also declined greatly in abundance since the 1980s. Their decline has resulted in a loss of spatial heterogeneity and the resultant reef habitat they have formed,

has negatively impacted the structure and function of the reef. These two species have declined in abundance at alarming rates from their historical levels (80-99 % decline) and throughout their range, and are currently listed as threatened species under the US Endangered Species Act (ESA). They are the first reef-building corals to obtain ESA status.

Recovery of existing populations depends not only on their rapid accretion rates, but also on successful reproduction.

Asexual reproduction by breakage (fragmentation) and reattachment of branches is the most important means of local population increase for both species (Highsmith, 1982).

Sexual reproduction that potentially provides larval influx to genetically depressed populations is less common, especially for *A. cervicornis* (Highsmith, 1982). *Acropora palmata* spawns annually in a synchronous fashion with the August moon cycle (Szmant, 1986). Unfortunately, fertilization success will decline as both species are likely to exhibit density dependent reproduction. Additionally, *A. palmata* does not self-fertilize. Genetic variability of remnant colonies may also be drastically reduced as a result of population declines. *Acropora palmata* and *A. cervicornis* are both currently believed to have a high likelihood of localized extirpation and possible extinction on ecological time scales (10-100 y), and both are highly vulnerable to natural, anthropogenic and especially synergistic stressors (Bruckner, 2002).

Therefore, as disturbances and declines increase to the point where remaining coral populations are no longer able to survive or effectively propagate by asexual means, the relative importance of sexual reproduction and recruitment increases. According to the Biology and Ecology Working Group in Bruckner (2002), "while fragmentation followed by fragment stabilization and growth may have been sufficient to maintain and expand Acroporid populations in the past, recent patterns of regional decline have increased the reliance of these species on sexual recruitment as a means of establishing and sustaining populations. Accordingly, the regional recovery of Acroporid populations will depend largely on the future success of sexual recruitment."

## SECORE PROJECT AND WORKSHOPS

In 2001, the SECORE (SExual COral REproduction) Project (www1) was initiated at the Rotterdam Zoo, where basic research was conducted on captive coral reproduction at the marine laboratory of the Oceanium. Basic methods were developed and applied in a pilot study to estimate their effectiveness and potential to supply public aquariums with sexual coral recruits. For the first time, primary polyps were shipped from Rotterdam Zoo to four European aquariums: Burgers' Zoo, The Netherlands; Cologne Zoo, Germany; Hagenbeck Zoo, Germany; London Zoo (Zoological Society of London), U.K (Petersen *et al.*, 2006). Currently, SECORE has more than 30 institutional members worldwide. SECORE is aimed at

- i) studying sexual coral reproduction,
- ii) developing *ex-situ* breeding techniques,
- iii) disseminating these techniques among the aquarium and research community through workshops and publications,
- iv) developing an international network of public aquariums and research institutions to enhance co-operation, and
- v) establishing breeding programs to sustain *ex-situ* and field populations.

In order to train public aquaria in coral breeding techniques, the Rotterdam Zoo organized the 1<sup>st</sup> SECORE Workshop at its marine laboratory in June 2005. A limited number of U.S. and European institutions were invited to be trained hands-on in handling larvae of:

- i) the brooding species, *Favia fragum*, of which larvae were collected from aquarium colonies;
- ii) the broadcast spawning species, *Acropora tenuis*, of which larvae were shipped by Masayuki Hatta from Akajima (Okinawa, Japan) to Rotterdam for the workshop. Two thirds of the participants successfully applied the methods learned at the workshop to obtain breeding success at their institutions. In the longer term, the Omaha's Henry Doorly Zoo (USA) and the Oceanopolis (France) built special aquarium systems dedicated to SECORE activities.

## 2<sup>nd</sup> SECORE WORKSHOP

In 2006, 25 SECORE members representing 14 international institutions held the second workshop in La Parguera, Puerto Rico, with goals to successfully rear *Acropora palmata* from spawn produced during the species' annual

mass spawning at Rincón and Bajo Gallardo sites (Petersen *et al.*, in press). During this workshop, SECORE collected and fertilized close to 1 million larvae, raised hundreds of thousands larvae in a field laboratory, brought 400,000 larvae into captivity and settled approximately 40,000 juvenile corals. In addition, we donated millions of larvae that we did not have the space to rear to other researchers at La Parguera, including Alina Szmant (University of North Carolina, USA). Gametes were collected from colonies in the field during two consecutive spawning nights, and fertilization was initiated immediately at shore with sperm concentrations of  $10^6$  ml<sup>-1</sup> or higher following the protocol of Iwao *et al.* (2002). Using this concentration, fertilization rates between 60 and 90 % were achieved. The propagules were transported from the collection site to the laboratory where embryos were maintained in 10-20 L of 1 µm-filtered seawater with frequent water changes every 3-4 h, using a protocol developed during the workshop. Embryos of *A. palmata* have an unusually slow development; with an embryonic period of three days compared to the 1-day development of other broadcast spawning species. Fully developed larvae were taken back by the U.S. participants to their institutions where settlement was carried out. Larvae were transported at concentrations of 4 larvae ml<sup>-1</sup> following the protocol of Petersen *et al.* (2005). Due to a delay in the CITES application process, European participants were not able to take any larvae to Europe. Larvae were settled on specially designed settlement tiles (Petersen *et al.*, 2005a). Post-settlement survival rapidly decreased within 3 months and varied highly between institutions. However, contrary to most institutions where survival was 10 % or lower, approximately 30 % of the 3,000 recruits at the Omaha's Henry Doorly Zoo survived the initial 3 months attaining a maximum size of 1 cm. At the beginning of 2007, CITES permits were available; about 500 recruits were transported from Omaha's Henry Doorly Zoo to the European workshop participants in March 2007.

Besides rearing *A. palmata*, larvae of the brooders *Agaricia humilis* and *Favia fragum* were collected by the workshop participants from colonies kept in flow-through aquaria. Plankton mesh was placed around the colonies using the protocol of Petersen *et al.* (2005b) to collect larvae every morning following

their release during the night. To work with both broadcast spawners and brooders is an important task for the participants in aiding future breeding attempts.

Innovative cryopreservation techniques that had been successfully applied in cryopreserving spawn of *Fungia scutaria* (Hagedorn *et al.*, 2006, 2006a) were tested for the first time with *A. palmata*. Once it is possible to cryopreserve spawn of *A. palmata*, gene banks can be established for the species. These banks have important functions. First, genetic material can remain frozen but alive for hundreds of years in liquid nitrogen, allowing the time necessary to mitigate and restore habitats. Second, large populations of a gene pool can be maintained, preventing genetic bottlenecks and prevent functional or actual population extinctions. Third, the banks can be used actively to increase genetic diversity within an ecosystem through the use of thawed samples to 'seed' shrinking populations. No genetic bank for corals currently exists, but it is crucial that conservation efforts focus on this type of conservation before a wild population's diversity is severely diminished. Unfortunately, in some areas of Florida this has already happened where *A. palmata* populations form clonal, non-reproductive stands (Szmant, pers. com.). In such areas, frozen sperm from nearby populations could have an immediate impact on the diversity and health of these clonal populations.

## FUTURE PERSPECTIVES

Currently, the authors plan the third workshop in order to intensify the work on *Acropora palmata* and to include *A. cervicornis*. Besides training public aquaria in coral breeding, one of the main goals of the SECORE workshops is to establish the Caribbean Acroporids in a maximum of public aquaria worldwide. This captive live stock may serve as a basis to establish a coordinated breeding program for these threatened species. Additionally, gene banks of both species will ultimately support the preservation of both species from extinction.

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## PERSONAL COMMUNICATIONS

Szmant, A., 2007. University of North Carolina, USA

## INTERNET RESOURCES

www1. [www.secore.org](http://www.secore.org)