

## **BERKO AWARD 2016**

### **Individual annual fecundity and reproductive energy investment in mushroom Scleractinian corals**

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#### **Introduction**

Sexual reproduction is a critical life-history function important in the maintenance and evolution of coral communities (Glynn et al. 1996). Scleractinian corals, the frame builders of coral reefs, are sessile organisms that exhibit an extraordinary diversity of life history traits which manifests inter alia in their wide plasticity of reproductive strategies (Richmond and Hunter 1990). These diverse reproductive strategies are undoubtedly among the most important assets determining corals evolutionary success. However, despite intensive studies and increasing knowledge over the last few decades, we are still far from understanding the selective mechanisms and adaptive benefits that have led to the wide plasticity of this group's reproductive strategies (Fadlallah 1983, Shlesinger and Loya 1985, Harrison and Wallace 1990, Richmond and Hunter 1990, Levy et al. 2007, Baird et al. 2009, van Woesik 2010, Harrison 2011). Being the most spectacular, bio-diverse and productive marine ecosystems (Hughes et al. 2003, Hoegh-Guldberg et al. 2007) coral reefs provide important sources of goods and services for more than 450 million people from over 100 countries that live close to coral reefs (Pandolfi et al. 2011). They occupy a small part of the world's oceans yet harbor a hugely disproportionate amount of its biodiversity. Unfortunately, coral reefs are also among the most heavily degraded marine ecosystems (Pandolfi et al. 2003, 2005, Knowlton 2004, Hughes et al. 2003, Bellwood et al. 2004, Loya et al. 2004, Hoegh-Guldberg et al. 2007). Over the last four decades, reef corals have experienced increasing stress, due to local anthropogenic perturbations (e.g., Loya and Rinkevich 1980, Loya 2004) and global climate change resulting in damage to coral reproduction and recruitment failure (Baird et al. 2009, McClanahan et al. 2009, Harrison 2011). Today, it is widely acknowledged that environmental factors can have diverse and often acute effects on reproduction, with ramifications for population fitness (Grazer and Martin 2012). Recent studies pointed out the great benefit anticipated to climate change research from more coordinated effort incorporating evolutionary approaches which obtain data on how population reproductive traits respond to changing environmental conditions (Grazer and Martin 2012). Because reproductive investment and growth are often used as indicators of health or stress at the organism level (e.g. Maltby 1999), knowledge of how such allocation varies intrinsically among species or morphological types is crucial for the interpretation of physiological responses to environmental factors. In colonial modular organisms, such as scleractinian corals, differences in module size and colony growth patterns have the potential to impose varying

constraints on reproductive investment (Leuzinger et al. 2003). Such constraints can play a key role in the evolution of modularity in cnidarians. Insight into the allocation of energy to reproduction and growth is central to understanding both the life-history strategies of species and the physiological tradeoffs of individual organisms since reproductive energy allocation strategy affects virtually all other life-history traits (Schaffer 1983, Calow 1987). In their wide range of module (polyp) sizes, colony growth forms, and life-history characteristics, scleractinian corals provide an important opportunity to test how energy allocation to sexual reproduction relates to morphology, associated size and environmental constraints, and life-history strategies. In an era of global warming acquiring experimental data on coral reproduction is vital, due to apparent deleterious effects of seasonal warming of SST on reproductive phenology of marine organisms and the bleak future projected to coral reefs in view of expected failure to replenish themselves following coral bleaching and coral reproductive failure (Baird et al. 2009, Harrison 2011).

In my research, I am focusing on two different scleractinian corals, bearing different reproductive strategies; two closely related fungiid corals: *Fungia fungites* and *Herpolitha limax* (Table 1).

**Table 1. Summary of baseline information on reproductive traits of the model corals studied in Okinawa\* and the Gulf of Aqaba&.**

Species	Colonial or solitary	Coral sexuality	Reproductive mode	Reference.
* <i>Fungia fungites</i>	Solitary	Gonochoric	Brooder	Loya et al. 2009
*/& <i>Herpolitha limax</i>	Colonial	Gonochoric	Broadcaster	Loya et al. 2009

**The major objective of the proposal** is to study reproductive energy investment in scleractinian corals that differ in module size and life-history characteristics and to provide quantitative annual estimates of populations' reproductive effort. Specifically to assess: annual fecundity of individual polyps and possible energy allocation in different size/age group and under varied environmental constraints. I expect to provide assessment of possible trade-offs in energy allocation between coral fecundity and growth (i.e. different size/age).

Last summer we went on a working trip to Okinawa, Japan in order for me to conduct my PhD work in the Tropical Biosphere Research Center at University of the Ryukyus in Sesoko Island. The study has been highly successful and scientifically fruitful. We monitored the reproductive activity of *Fungia fungites* and *Herpolitha limax* for three months in a row. An opportunity which yielded important results that support the hypothesis of energy investment in different size/age groups. For example: fecundity was found to be highest at middle size and decline in older ages (Figs. 1, 2); Sex ratios were more female-biased at middle life stage than in early and late life stages. Middle size group showed high settlement rates in compare to other size groups (Fig. 3).

In June 2016 I presented part of this work results in the International Coral Reef Symposium (ICRS) which was held in Hawai'i, USA.

## Results

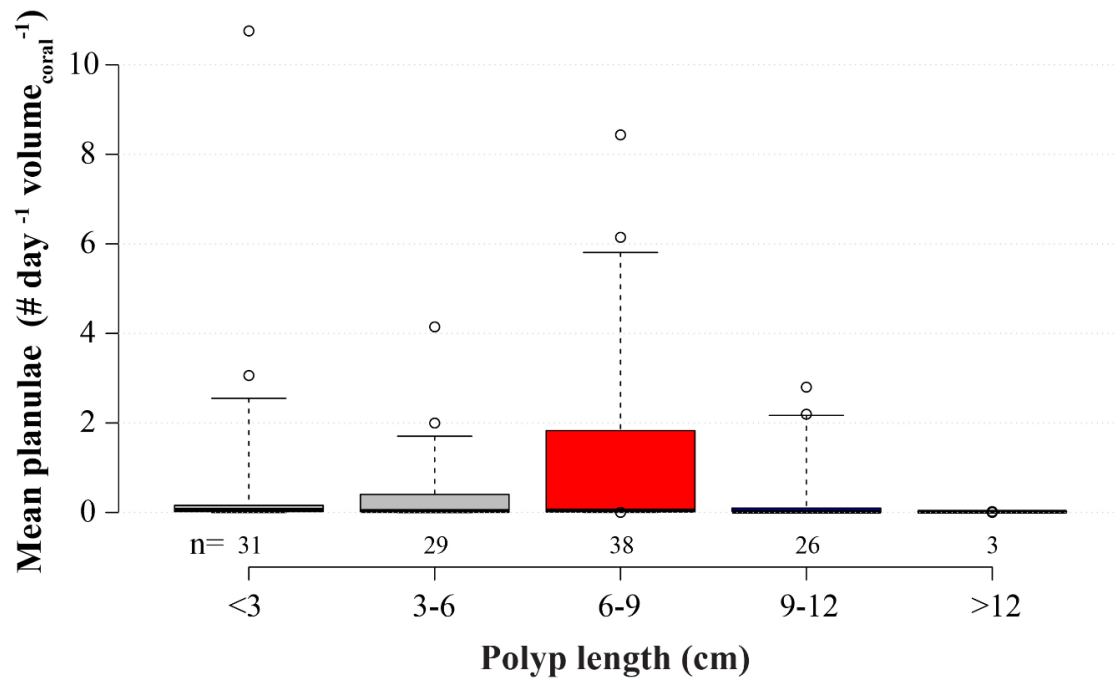


Figure 1: *Fungia fungites* female fecundity in different size/age groups. Colored boxes represent: daily average female fecundity values (number of planulae per coral volume); box limits indicate the 25th and 75th percentiles; whiskers extend 1.5 times the interquartile range from the 75th percentiles, outliers are represented by dots. n = 3-38 individuals as indicated under the boxes.

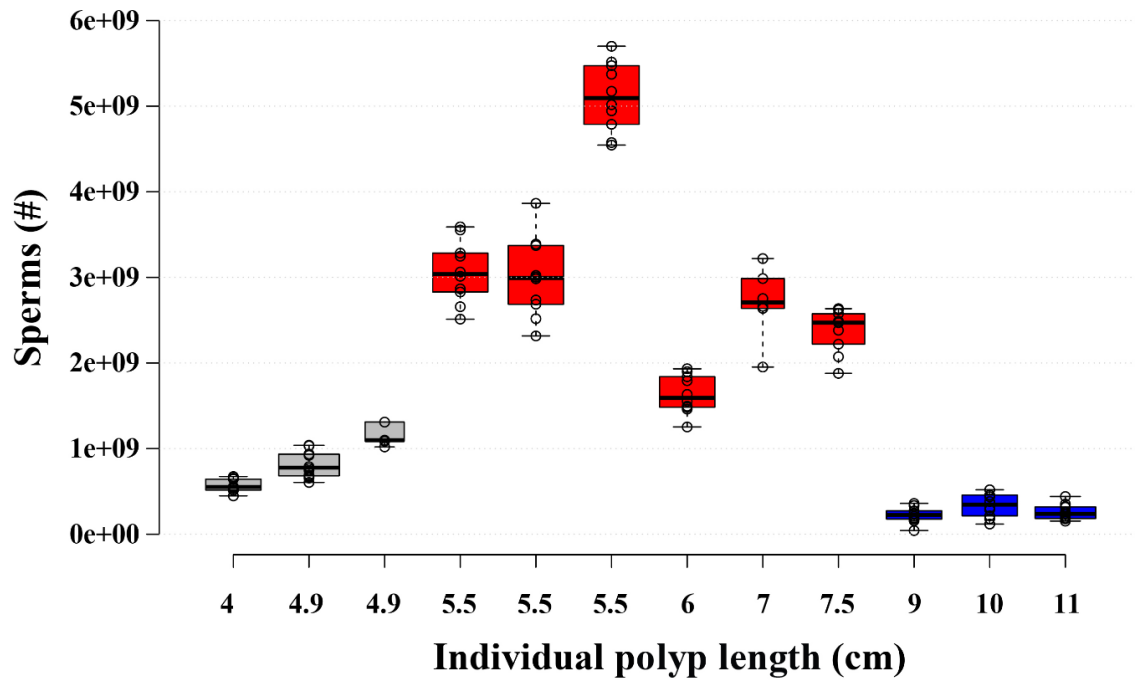


Figure 2: *Fungia fungites* male fecundity in different size/age groups. Colored boxes represent: daily male fecundity values (number of sperm released by an individual); center black lines show the medians; box limits indicate the 25th and 75th percentiles; whiskers extend to minimum and maximum values; n = 12 individuals with 10 pseudoreplications each.

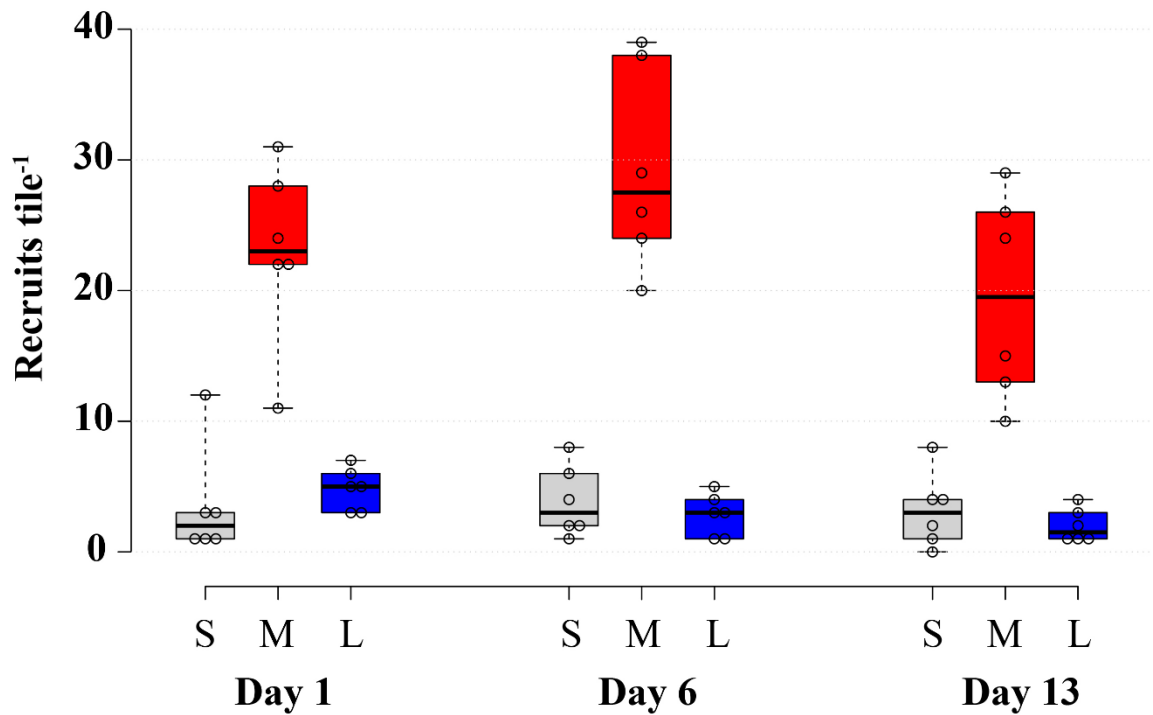


Figure 3: *Fungia fungites* settlement success and survivorship in different size/age groups. Colored boxes represent recruits per tile; gray boxes represent small group; red boxes represent middle size group; blue boxes represent large group; center black lines show the medians; box limits indicate the 25th and 75th percentiles; whiskers extend to minimum and maximum values; n = 6 tiles per group size.

On a personal note, being a mother for two little kids and a PhD student is challenging as it is. But traveling to the other side of the world with little kids for a field work is even more challenging. I was privileged to conduct my research in Sesoko marine station, a field trip I initiated after the failure of a well-planned project in Aqaba due to 'Tzuk Eitan' war, 2014. It has been indeed a unique and fruitful experience, both scientifically and personally. However, it is important for me to mention that the work there was extremely intense and demanded a lot of time and effort.

Thank you for considering my application  
Lee

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