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Orbicella faveolata

(Mountainous star coral, Ellis & Solander 1768)

Chamberland VF, Mendoza Quiroz S, Bennett M-J, Banaszak AT, Marhaver KL, Miller MW, Doblado Speck T, Geertsma RC, Fogarty ND

Reproductive biology [1-8]

Reproductive mode:	**broadcast spawning**
Sexual system:	**hermaphroditic**
Reproductive events per year	
at the population level:	**up to 4**
at the individual level:	**1 to 2**
Gamete bundle size:	**~2000 µm (Ø)**
Egg size:	**346 ± 36 µm (579) (Ø, Curaçao)**
	431 ± 19 µm (48) (Ø, Mexico)
	318 ± 16 µm (180) (Ø, Florida Keys)
Eggs per bundle:	**59 ± 39 (27) (Curaçao)**
	113 ± 18 (6) (Florida Keys)
Eggs per mL of intact bundles:	**not yet available**
Eggs per mL of broken-up bundles:	**25000–27000**
Sperm per bundle:	**2–21 × 10^6 (6)**
Sperm to egg ratio per bundle:	**2–17 × 10^4 : 1 (6)**
Sperm length:	**5 µm (head)**
	56.1 ± 3.3 µm (50) (flagellum)

Values = average ± SD (n)

1. Adult colony

Distribution: 0.5–55 m depth in the Caribbean, Bahamas, tropical western Atlantic coast, Bermuda, Gulf of Mexico and the Atlantic coast of Central America

Reproductive timing and gamete collection [1-6,9-10]

Months (Northern Caribbean)	July	August	September	October
Months (Southern Caribbean)	July	August	September	October
Days after full moon	5	6-7	8	
Minutes after sunset	100	185-250	275	
Duration of setting (min)	0	5	10	

possible
likely
very likely

2. Gamete setting close-up

3. Gamete release

4. Colony spawning

5. Gamete collection

Considerations for spawning observations and gamete collection: *O. faveolata* spawns predictably within a two to three night window and the release of bundles from an individual colony is quite rapid (a few minutes). Gamete bundles are smaller than those of brain coral species, but much larger than *Acropora* spp., and are pink in color. They are easily noticeable in the polyp mouths during setting, which can be short in duration (10–20 min). Gamete bundles can be collected using conical nets fitted with funnels and removable collection tubes at the top where positively buoyant bundles will gather. Because a large volume of bundles is released quickly from an *O. faveolata* colony, care should be taken to prevent overfill of the collection tubes. *O. annularis* spawns on the same nights during the same time period after sunset. Accurate species identification is therefore important to ensure monospecific gamete collections.

Fertilization [7]

Time to bundle break-up:	**10–45 min PS**
Gamete longevity:	**>4.5 hrs PS**
Suggested duration of co-incubation:	**60–90 min**
Optimal sperm concentration during co-incubation:	**10^5–10^7 cell mL^{-1}**

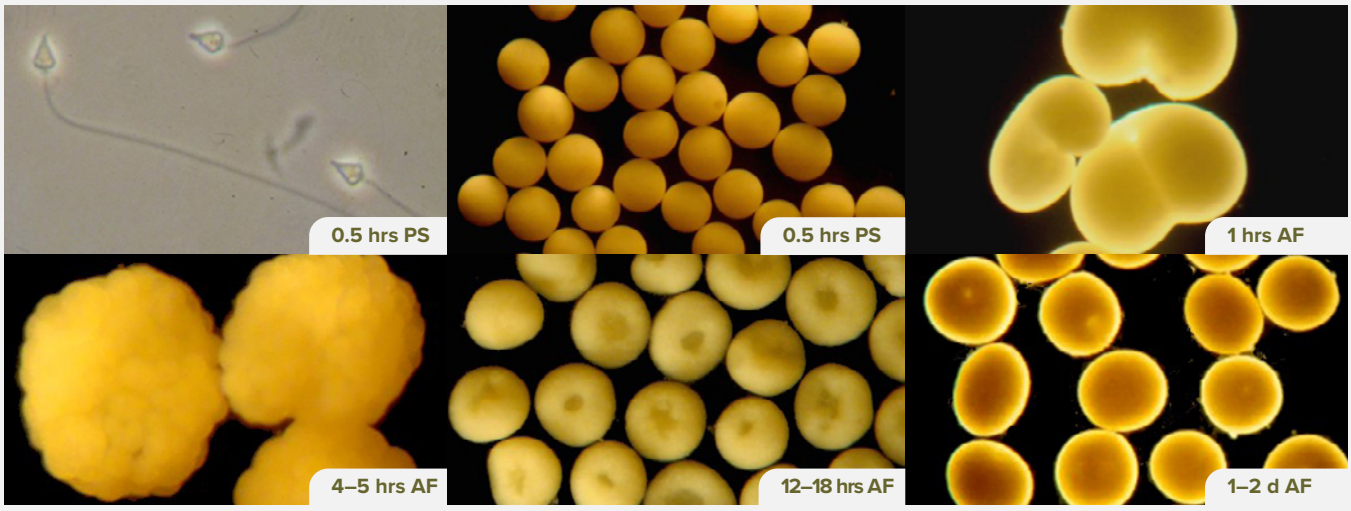
PS = post-spawning

Considerations for fertilization:
Gamete bundles break up quite quickly after release (10–45 min). Best results are achieved with sperm concentrations between 10^5 and 10^7 cell mL^{-1}. Fertilization success decreases once gametes are older than 4.5 hours but is still possible 6.5 hours after spawning. Co-incubating male and female gametes for (no less than) 1 hour is sufficient to yield high fertilization success.

6. Fertilization

Embryogenesis [7,11]

7. Embryogenesis



Time to first cleavage: **1-2 hrs AF**
Cleavage mode: **holoblastic**
Rearing conditions: **28°C, still water containers, filtered seawater (0.45 µm, 0.5 µm, or GF/F)**

AF = after fertilization
PS = post-spawning

Considerations during embryogenesis:
Exceptionally delicate handling of embryos is recommended until gastrulation is complete. Note that embryos can be oddly shaped during the blastula stage until the end of gastrula.

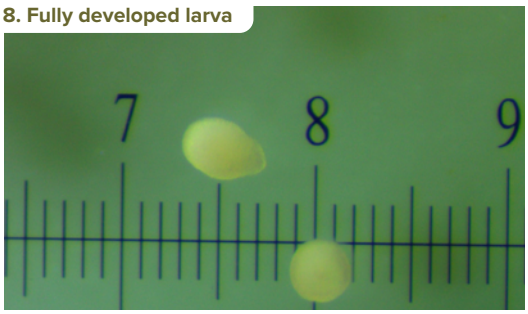
Eggs and embryos are very small and can agglomerate easily. It is therefore key to rear them in low density and to do regular water changes in rearing containers.

Larval behavior, settlement, and metamorphosis [11-15]

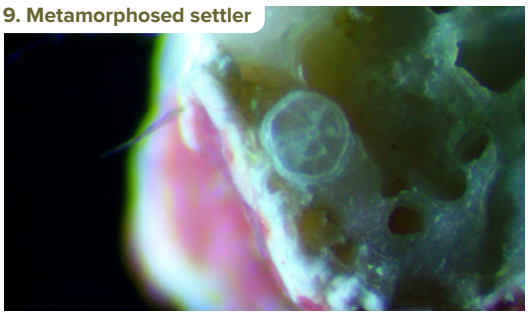
Larval size:	**500–700 µm (longest axis)**
Symbiont transfer mode:	**horizontal**
Larval feeding mode:	**lecithotrophic**
Time to motility:	**1.5–2.5 days AF**
Time to directed swimming:	**1.5–2.5 days AF**
Time to negative buoyancy:	**2.5–4 days AF**
Onset of competency:	**3–5 days AF***
Onset of metamorphosis:	**≥6 days AF***
Peak settlement:	**4–7 days AF***
Substrate preference:	**ceramic and plastic, minimal conditioning (2 to 4-week-old biofilm)**
Habitat preference:	**cryptic undersides of settlement surfaces**

AF = after fertilization
* In the presence of settlement cues (crustose coralline algae, *Hydrolithon boergesenii*)

8. Fully developed larva

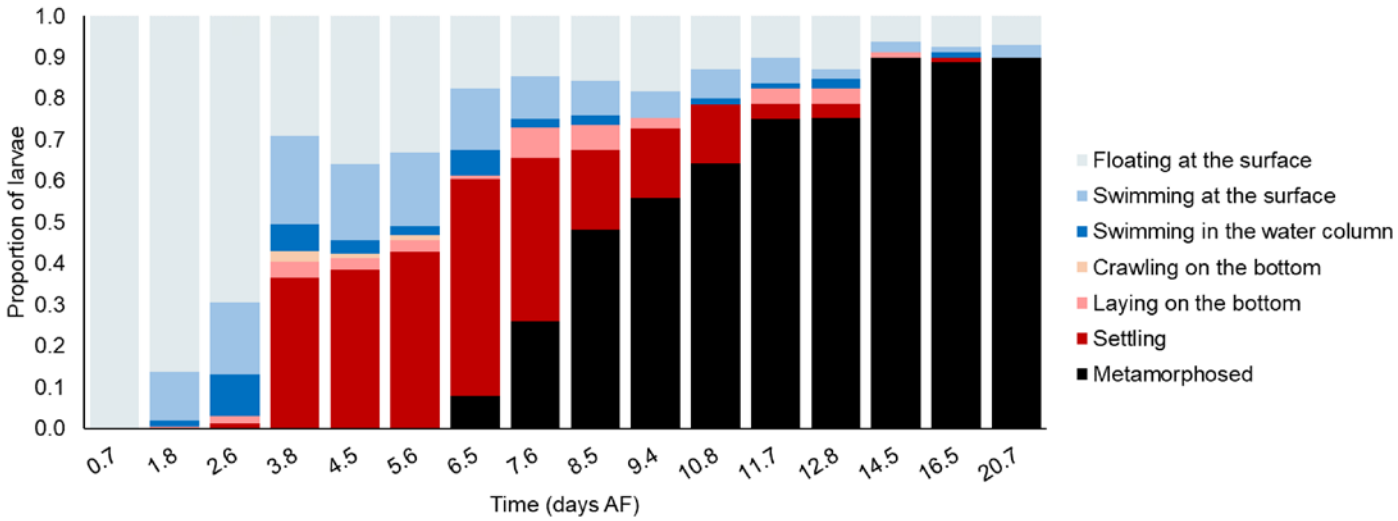


9. Metamorphosed settler



Considerations for larval rearing: Larvae become motile on the second day after fertilization and start settling on the fourth day in the presence of settlement cues. Settlement peaks when larvae are between 4 and 6 days old but can occur over a longer period of time (2–3 weeks). Crustose coralline algal species *Hydrolithon boergesinii, Titanoderma prototypum,* and *Lythophyllum congestum* induce settlement in this species. Full metamorphosis after settlement can take four days or longer. Early, post-settlement mortality is common in this species. Calcification in settled polyps begins three days after metamorphosis. Settlers are small and show a strong preference for dark, cryptic, locations. This behavior exacerbates the difficulty of scoring settlement in this species because of their small size and often transparent tissue. Using a dissecting microscope may greatly aid the accuracy of settlement counts. Gentle water movement or aeration further enhance settlement rates.

Larval behavior, settlement, and metamorphosis through time



Post-metamorphosis development and ecology [7,11,16]

Initial primary polyp size:	**487 ± 92 µm (18)**
Onset of calcification:	**3 days PM**
Skeleton morphology:	**broad columella, spaced septae, tall jagged septal teeth, concave corallites**
Time to first polyp buddin:	**4–6 weeks PM or longer**
Budding mode:	**extratentacular**
Age to sexual maturity:	**not yet available**
Minimum size at sexual maturity:	**>100 cm²**

Values = average ± SD (n)
PM = post-metamorphosis

Considerations for early post-metamorphosis rearing:
Settlers are very small, grow slowly, and tend to suffer high post-settlement mortality. Providing them with extra sources of nutrients as well as controlling the proliferation of benthic competitors and other pests are key to improve early growth rates.

It is recommended to inoculate settlers with Symbiodiniaceae shortly after metamorphosis, by placing them in proximity to fragments of several adult conspecifics within a closed culture system, although symbionts can also be acquired naturally from settlement substrates if these were conditioned in situ.

After metamorphosis and inoculation with symbionts, primary polyps can be grown in aquaria under temperatures ranging from 27–28°C (though they can withstand temperatures up to 30°C) and a salinity ranging from 35–37 ppt.

10. Post-metamorphosis development

Long-term ex situ rearing [7,17]

Known threats: This species is susceptible to overgrowth by algal mats, competition with *Aiptasia*, predation by coral-eating flatworms and crabs, as well as infections by ciliates.

Optimal light availability: This species can grow under a wide range of light intensities (100–900 µmol photons m^{-2} s^{-1}), but thrives at 300–700 µmol photons m^{-2} s^{-1}.

Optimal water flow: Gentle water movement is required for general rearing and a water flow rate of 15 cm s^{-1} is recommended while feeding settlers with *Artemia* spp. nauplii to increase capture rates.

Onset of heterotrophy: This species is able to capture and ingest *Artemia* spp. nauplii starting 6 to 10 days following metamorphosis.

Optimal diet: Live feeds (*Artemia* spp. nauplii and rotifers) can be complemented with commercial coral supplements such as Kent Marine and Brightwell Aquatics products.

Sources

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Unpublished data

Reproductive biology: Mendoza Quiroz S[1,4], Marhaver KL[2], Chamberland VF[1,2,3], Bennett M-J[1], Geertsma R[C1,5]

Reproductive timing and gamete collection: Marhaver KL[2], Mendoza Quiroz S[1,4], Banaszak AT[4], Miller MW[1]

Fertilization: Chamberland VF[1,2,3,] Bennett M-J[1], Doblado-Speck T[1], Mendoza Quiroz S[1,4], Banaszak AT[4], Marhaver KL[2]

Larval behavior, settlement and metamorphosis: Chamberland VF[1,2,3], Bennett M-J[1], Doblado-Speck T[1], Mendoza Quiroz S[1,4], Banaszak AT[4], Geertsma RC[1,5], Miller MW[1]

Post-metamorphosis development and ecology: Mendoza Quiroz S[1,4], Marhaver KL[1], Banaszak AT[4], Bennett M-J[1], Doblado-Speck[1] T, Fogarty ND[6]

Long-term ex situ rearing: Mendoza Quiroz S[1,4], Marhaver KL[1], Banaszak AT[4]

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Photo credits

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Sources *(continued)*

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