

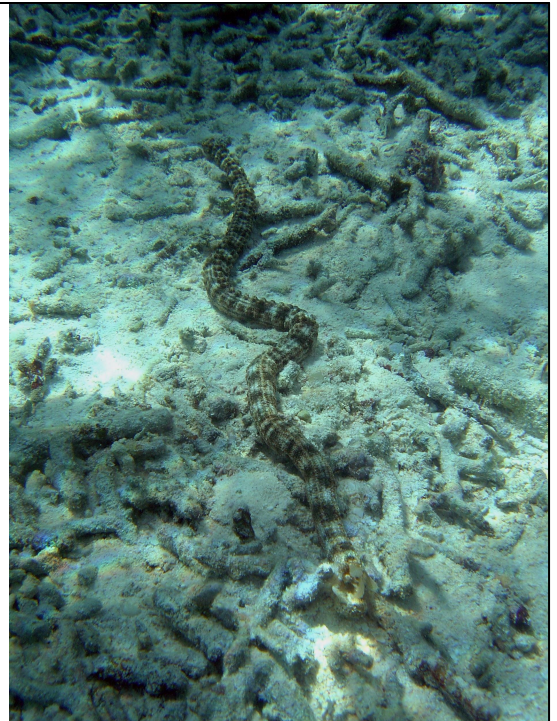
Reproduction of Holothurians

Kaylyn Flanigan

Introduction



François Michonneau, 2008

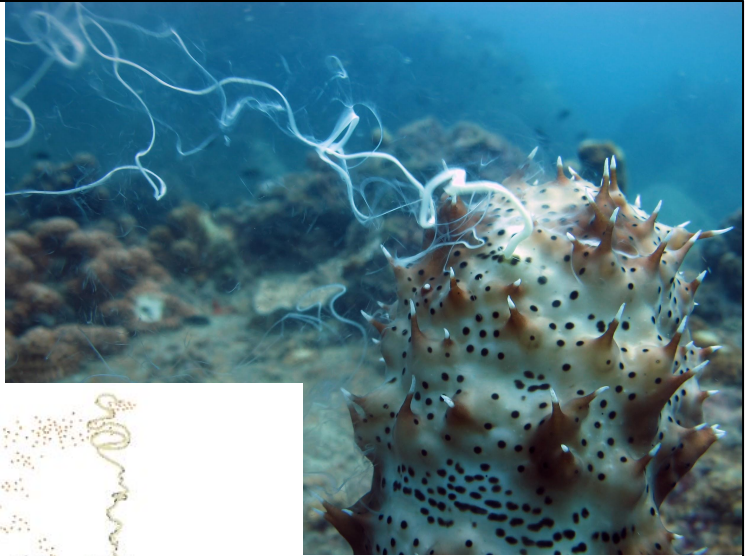


David Burdick, 2010

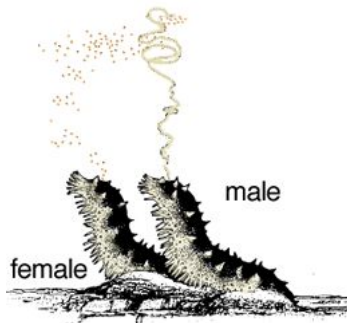
At the beginning of the week in Invertebrate Biology our professor presents us with a picture of an invertebrate ~hopefully~ unknown to us. We then try to decipher the unknown organism puzzle by placing it into the correct phylum. I initially thought it was an annelid because they look very similar (with the tentacles at one end), but I was incorrect. It wasn't until I saw the organism with tube feet that I figured out that it was a sea cucumber. Its scientifically referred to as a holothurian and belongs to the phylum echinodermata

Sexual Reproduction

- Dioecious¹
 - Sexes are separate



Conserve Marine, 2014

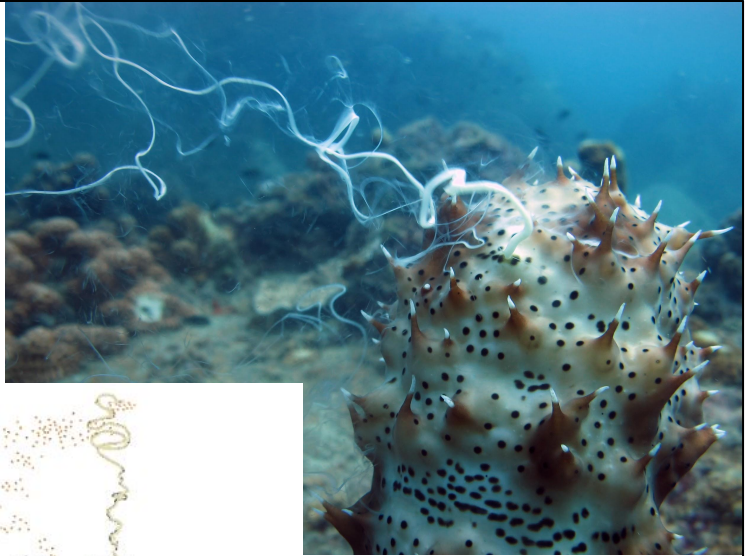


Tom Carefoot

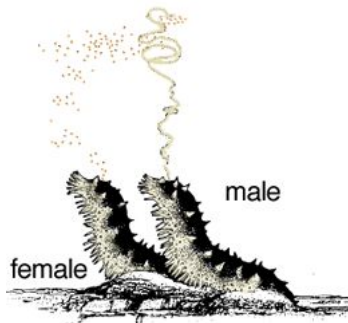
Similar to other echinoderms, holothurians are broadcast spawners^{1,2}. This means that they release their gametes into the water where ~hopefully~ sperm and egg will find each other, form a planktonic larvae, and eventually become a sea cucumber².

Sexual Reproduction

- Dioecious¹
 - Sexes are separate
- Externally indistinguishable^{1,2}
 - Internal sexual dimorphism



Conserve Marine, 2014

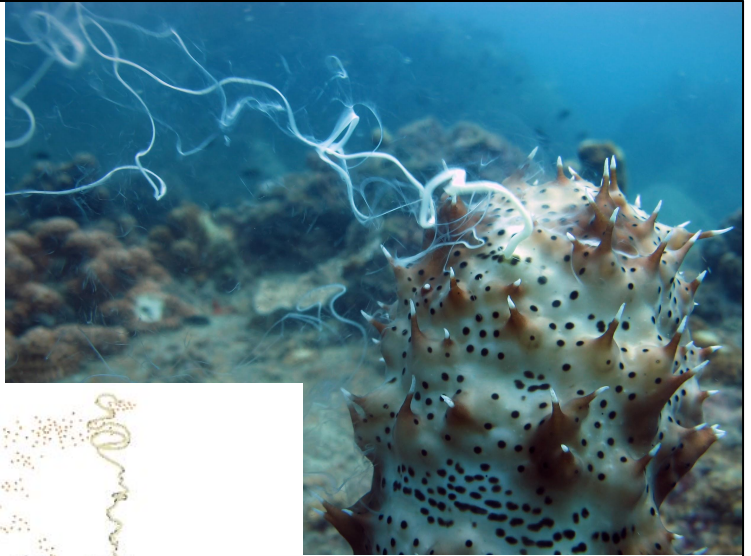


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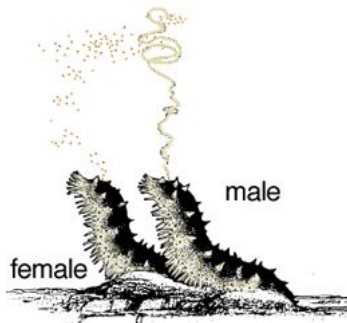
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Sexual Reproduction

- Dioecious¹
 - Sexes are separate
- Externally indistinguishable^{1,2}
 - Internal sexual dimorphism
- Broadcast spawners²
 - External fertilization



Conserve Marine, 2014



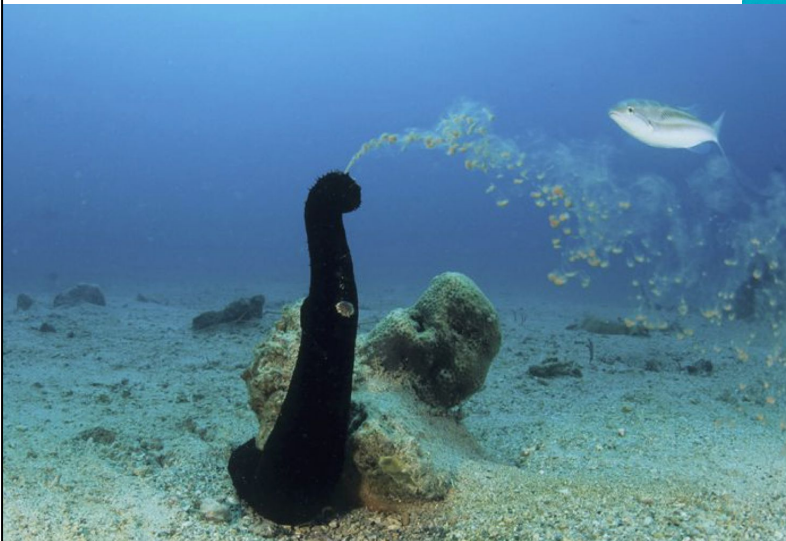
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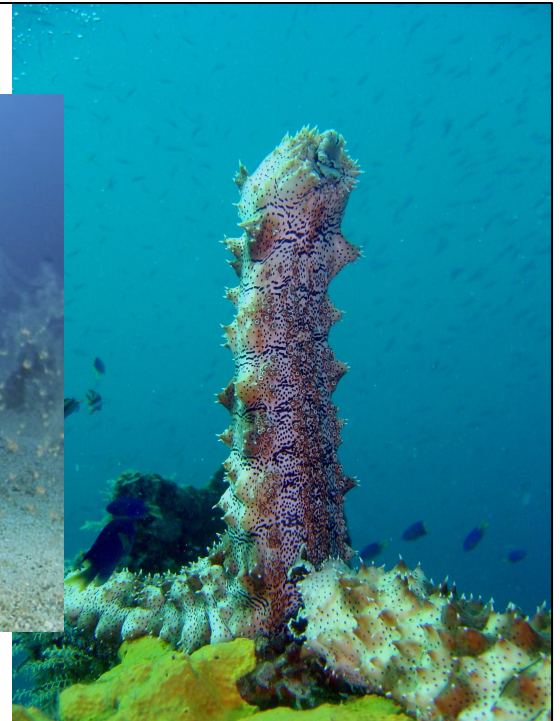
To increase the likelihood that sperm meets egg, it has been hypothesized that sea cucumbers form aggregates and all spawn in a domino effect. *H. grisea* defies this stereotype and aggregates during gametogenesis (the formation of gametes) while exchanging chemical cues between one another; however, once they are ready to spawn they aren't terribly far away from one another and fertilization can still occur².

H. scabra in the Solomon Islands, however, forms aggregates immediately before spawning².

Sexual Reproduction



Franco Banfi



David Burdick

During the release of gametes, holothurians will stand erect, with their tube feet as their holdfast, in order to stand tall above the substrate³. This behavior increases the likelihood that gametes will float through the water column instead being delivered right to the substrate.

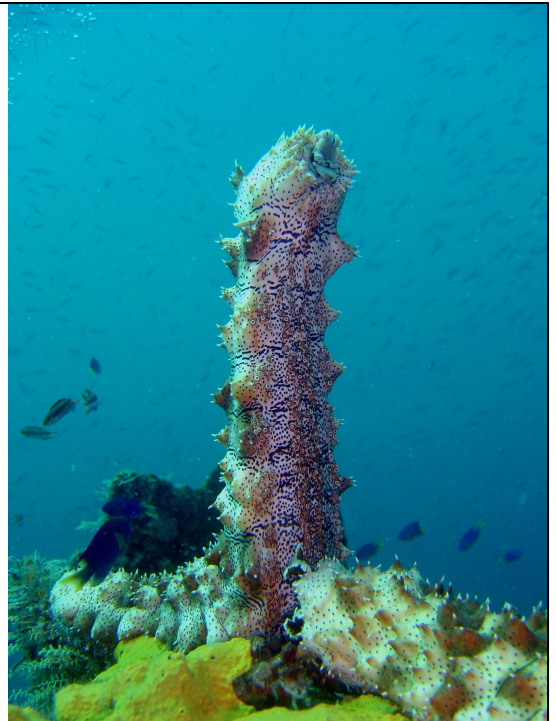
These spawning events are typically cyclical; temperate species spawn during the warmer months and have a shorter spawning period compared to the more equatorial species who have a longer, more continuous spawning period^{2,4,5}.

Sea cucumbers take cues from the environment and from one another during spawning events².

These environmental cues include water temperature, chlorophyll a levels (plankton activity), and the lunar cycle². Typically it is observed that in cooler temperatures, sea cucumbers are less likely to spawn. Some species tend to spawn when there are high levels of primary production (hypothesized to be for the survival of their offspring)².

Sexual Reproduction

1. *Holothuria scabra*
 - a. Biannual or continuous⁶



David Burdick

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Sea cucumbers take cues from the environment and from one another during spawning events².

In *Holothuria scabra* in the Solomon Islands exhibits continuous breeding with heightened breeding from September - December; however, this species in the oceans surrounding India, New Caledonia, and Indonesia are biannual breeders⁶.

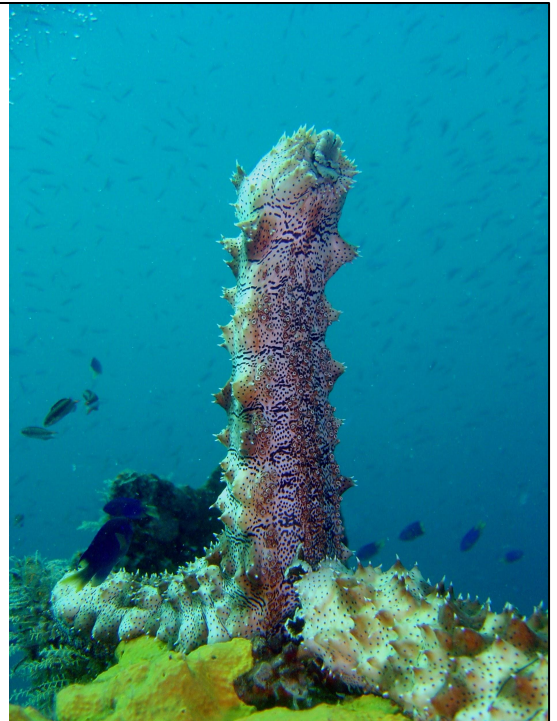
In the cases of *H. whitmaei* and *H. fuscogilvia* which live in the same geographic location, *H. whitmaei* spawns during the winter while *H. fuscogilvia* spawns in the summer⁷. This is hypothesized to happen to avoid cross-fertilization⁷.

In the case of *H. grisea*, a tropical intertidal sea cucumber, their breeding period is relatively short to that of other tropical (equatorial) species². This is thought to be because their habitat is extremely variable and these changes trigger seasonality providing a restricted number of months during which water level and temperature is

optimal for larval survival².

Sexual Reproduction

1. *Holothuria scabra*
 - a. Biannual or continuous⁶
2. *H. whitmaei* and *H. fuscogilvia*
 - a. Live sympatrically (in the same geographic area)⁷
 - b. *H. whitmaei* spawns in the winter; *H. fuscogilvia* spawns in the summer⁷



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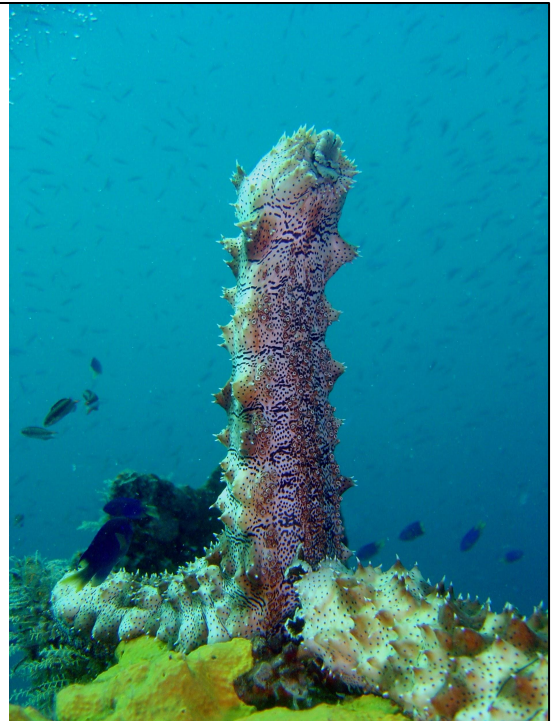
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 - b. *H. whitmaei* spawns in the winter; *H. fuscogilvia* spawns in the summer⁷
3. *H. grisea*
 - a. Tropical intertidal species
 - b. Relatively short spawn period



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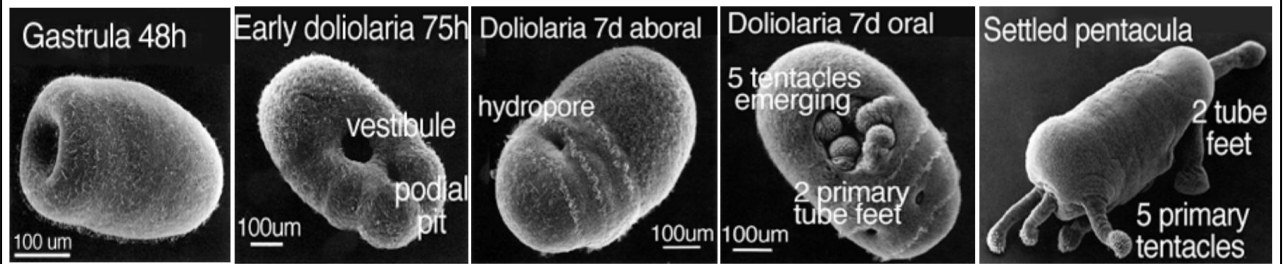
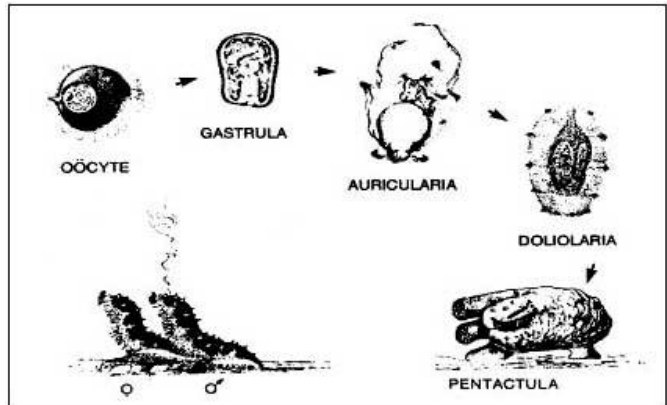
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Holothurian larvae

- Oocyte: egg
- Gastrula: ~ 24 hours after fertilization⁹
- Auricularia: ciliated intermediate
- Doliolaria: swimming larvae³
- Pentactula: five tentacled, 2 tube footed "walking" larvae³



Within one month of their pentactula stage, they will develop into juveniles⁹

Holothurian larvae actually walk about the sediment on two tube feet and 5 tentacles.

Asexual Reproduction



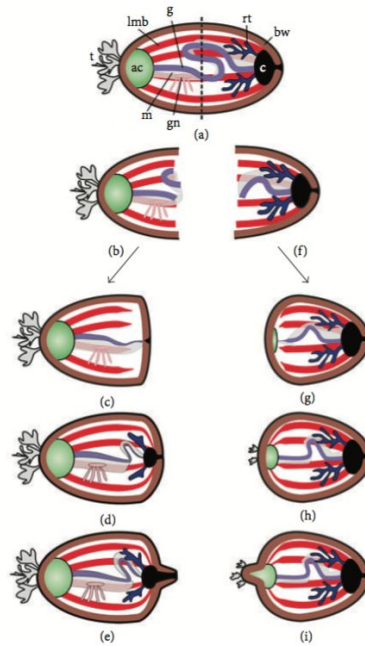
FIGURE 1: Twisting of *Cladolabes schmeltzii* during fission. a: anterior part; p: posterior part. Scale bar 2 cm.

- Fissiparous (reproduction by fission)
- Constriction site or twisting
- Process can last a few minutes or days⁸.

Igor Dolmatov, 2014.

There are 16 known species of holothurians that reproduce asexually⁸. The term for this kind of reproduction is called fissiparous (reproducing by fission).

Pros and cons of asexual reproduction



Igor Dolmatov, 2014.

Similarities between Holothurians and Echinoderms

- Capability of asexual reproduction (asteroidea and ophiuroidea)



One arm regenerating



Entire sea star regenerating from one arm

NCSU



Philippe Bourjon

- Similar to subclasses asteroidea and ophiuroidea in that they reproduce asexually by separating into two pieces and then regenerating the missing pieces¹
- Similar to most echinoderm species in that they reproduce sexually; are dioecious (sexes are separate)¹
- Similar to most echinoderm species - ophiuroids excluded - in that their sexes are indistinguishable externally¹
- Similar to sea star species *Henricia lisa* (Canada) and the brittle star *Ophiodaphne formata* (Japan) in that they form aggregates prior to spawning²
- Similar to sea star *Leptasterias polaris* in that they form aggregates during gametogenesis²

Similarities between Holothurians and Echinoderms

- Reproduce sexually and are dioecious¹



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Similarities between Holothurians and Echinoderms

- Reproduce sexually and are dioecious¹
- Sexes are externally indistinguishable¹
- Aggregations

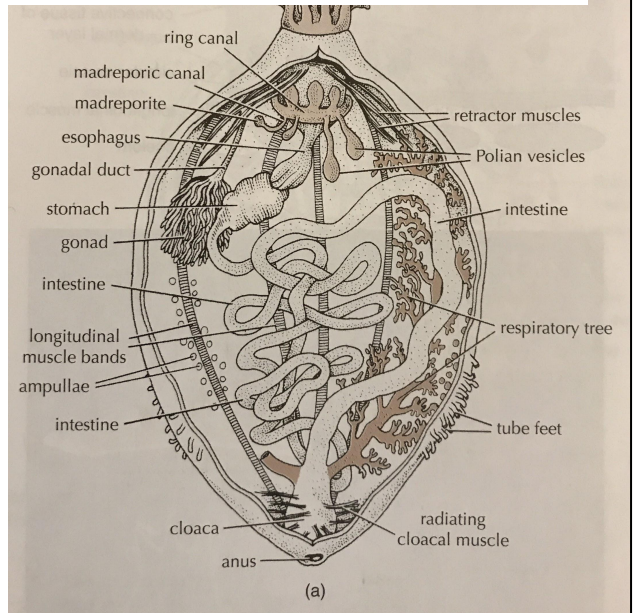


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Differences between Holothurians and Echinoderms

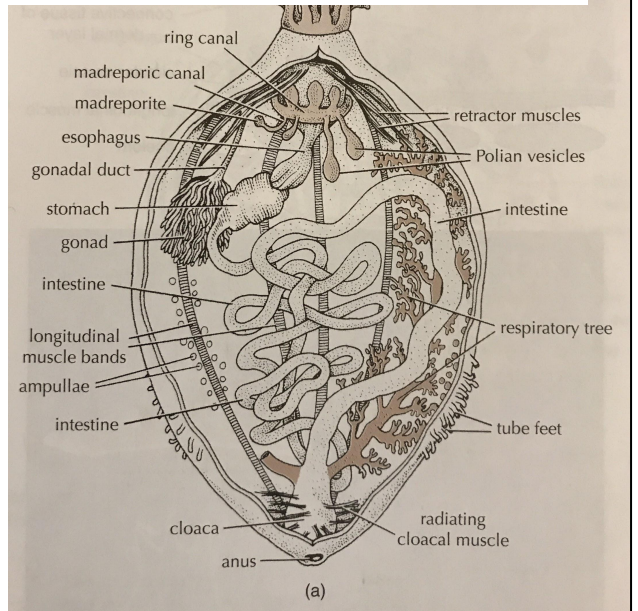
- Holothurians only possess one gonad



Pechenik, 2015

Differences between Holothurians and Echinoderms

- Holothurians only possess one gonad
- Not *all* species of echinodermata can reproduce asexually

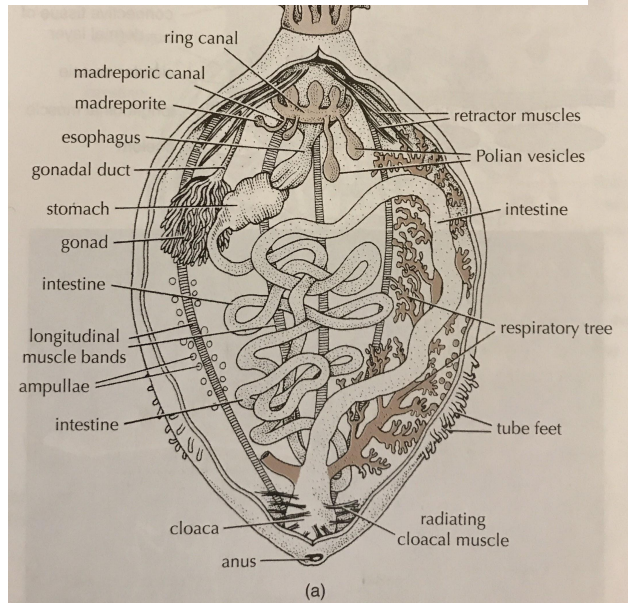


Pechenik, 2015

Differences between Holothurians and Echinoderms

- Holothurians only possess one gonad
- Not *all* species of echinodermata can reproduce asexually
- Typically external fertilization

Pechenik, 2015



Works cited

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- 2 Leite-Castro, L.V., et al. "Reproductive Biology of Sea Cucumber *Holothuria grisea* in Brazil: Importance of Social and Environmental Factors in Breeding Coordination." *Marine Biology*, 163(67): 1-13. 2016.
- 3 Carefoot, Tom. "Reproduction: Spawning and Fertilisation of Sea Cucumbers." *A Snail's Odyssey*.
- 4 Navarro, P.G., et al. "Reproductive biology of the sea cucumber *Holothuria sanctori* (Echinodermata: Holothuroidea)." *Scientia Marina*, 76(4): 741-752. 2012.
- 5 Hopper, D.R., et al. "Sexual Reproduction of the tropical sea cucumber, *Actinopyga mauritiana* (Echinodermata: Holothuroidea), in Guam." *Bulletin of Marine Science*, 63(1): 1-9. 1998.
- 6 Ramofafia, C., et al. "Reproduction of the commercial sea cucumber *Holothuria scabra* (Echinodermata: Holothuroidea) in Solomon Islands." *Marine Biology*, 142: 281-288. 2003.
- 7 Shiell, G.R., and S. Uthicke. "Reproduction of the commercial sea cucumber *Holothuria whitmaei* (Echinodermata: Holothuroidea), in the Indian and Pacific Ocean regions of Australia." *Marine Biology*, 148: 973-986. 2006.
- 8 Dolmatov, I.Y., "A Review: Asexual Reproduction in Holothurians." *The Scientific World Journal*, 2014.
- 9 Kumar, V., et al. "Scenario of Sea Cucumber with Special Reference to India." *Aquafind*, 1991.