REPRODUCTION IN SOME OF THE MARINE INVERTEBRATES

Compiled by

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REPRODUCTION IN INVERTEBRATES

1. Introduction
   - Without reproduction – no life
   - Because all organisms die, ongoing life is impossible without reproduction

2. Types of reproduction (refer to TERMINOLOGY)
   - Sexual - need to have male and female
     - Unfavourable conditions
   - Asexual – slow process
     - Many species take advantage of favourable and rapidly changing environmental conditions
     - Great increase in numbers can be achieved more quickly by asexual than sexual means

3. Regeneration vs. asexual reproduction
   - Regeneration
     - Starfish regenerates arms => No new individuals formed => just a repair job
   - Asexual reproduction
     - Starfish divides into two with disk bit present => new individual formed

4. Planktonic larval forms
   - Many different larval forms. Differ in different animals
   - Number of larval stages differ in different animals
   - A study on its own

SEXUAL REPRODUCTION
REPRODUCTION IN SOME OF THE MARINE INVERTEBRATES

1. SPONGES

Asexual

- Frequently reproduce by simply breaking into fragments
- If a sponge breaks up, the resulting fragments usually are able to reconstitute whole new individuals
- Budding is not common
- Cells are able to re-aggregate – form new sponge. Boerewors => cow

Sexual

- Hermaphrodite or dioecious
- Eggs and sperms released at different times
- Egg cells engulf adjacent nurse cells to increase food reserves
- When ripe – sperm plumes out from the exhalent siphon (water current). Sometimes in large milky clouds up to 2 to 3 metres high
- This may cause other adjacent sponges to “ejaculate”, causing a synchronized release of sperm into the water.
- Sperm sucked into sponge of same species. (water current).
- Transferred to egg cell
- Fertilization occurs in situ
- Larvae may undergo their initial stages of development within the parent (viviparous)
- They have numerous external flagellated cells on the outside and are free swimming.
- After a short planktonic stage, they settle down on a suitable substrate, where they begin their transformation into adults.
2. CNIDARIA
Two body forms

- Polyp * Sessile (asexual and sexual)
- Medusa * Free-floating (sexual)

2.1 Anemones, Corals and seafans (polyps)
Asexual reproduction

- Pedal laceration
  - As the anemone creeps over the substratum on its pedal disc, portions of the disc are occasionally torn off and left behind where they grow into small anemones.

- Binary Fission (longitudinal fission)
  - The pedal disc moves in two directions at once, stretching the sea anemone and ultimately pulling it in half
  - Each half becomes a new anemone, which can grow and split again

- Budding
  - Coral and anemones can bud off a new individual which will grow and bud off into another individual, etc.
  - They are never aggressive to members of their own clone
Sexual Reproduction

Anemones

- Most are hermaphroditic, produce only one type of gamete during one reproductive period (usually once a year)
- Gonads located in the gastrodermis on all or certain of the mesenteries
- Form band like cushions
- Eggs may be fertilized in the gastrovascular cavity or in the water
- Some anemones retain their zygotes in their gut cavity where they are brooded for some time. Viviparous
- The embryos eventually emerge from the anemone’s mouth, crawl to the base of the column and attach.
- Here the juveniles grow to about 4cm in basal diameter, before crawling away to establish their own independent adult life.
- OR “larva” a ciliated ball, unattached and free swimming
- Further development – settles, attaches and forms new tentacles
**Corals**

- Sexual reproduction similar to the sea anemone
- Can be dioecious or hermaphrodite
- In both types of coral egg development begins first. Longer
- Release their gametes only on certain nights of the year. Full moon.
- Both hard and soft corals synchronise the release of their eggs and sperm in this way, turning the clear reef waters milky white. Peaks on the 5\textsuperscript{th} night after first release.
- Over-abundance of gametes ensure fertilization
- Some corals brood. Larvae develop partly inside.
- Settle on new substrate and a new coral colony begins by budding.
**Hydroids** (examples: Obelia – resembles a small bushy algae to the naked eye)

**Asexual and sexual reproduction**

**LIFE CYCLE OF A HYDROID**

**ASEXUAL**

- Use both asexual and sexual reproduction
- Gonophore: sac-like and specialize to bud of **medusae** at certain times of the year. They resemble jellyfish. Hydromedusae. Asexually
- Hydromedusae normally dioecious.
- Eggs and sperm produced from different individuals

**SEXUAL**

- Medusa
  - Radial canal
  - Circular canal
  - Statocyst
  - Tentacle
  - Egg
  - Ciliated planula larva
- Fertilization: externally on the surface of the tube-like mouth OR internally where eggs start their development in the gonads
- Free-swimming, minute flatworm-like larvae (planula) is produced
- Planula attaches itself to the substratum after several hours, up to a day or more
- Develops into a new hydroid colony by budding
- In other floating hydrozoan like by-the-wind-sailor, the planula remains free-swimming, developing into a floating pelagic hydroid colony suspended from a chitinous float.

2.3 Jellyfish

Sexual and asexual reproduction

**LIFE CYCLE OF A JELLYFISH**

- Sexually reproducing medusa is the dominant phase.
- Many reach a diameter of 4m and have tentacles 3m long. Most species ± 25cm in diameter.
• Medusa male or female.
• Female broods zygotes on her oral arms until they reach a free-swimming planula stage.
• Polyp reduced to a tiny larval stage (schyphistoma)
• The schyphistoma feeds for some time in typical polyp fashion on small zooplankton and may produce other schyphistomas asexually.
• Eventually each polyp begins to partition its body into a stack of tiny potential medusa.
• This process is called strobilation and the polyp is called a strobili.
• One at a time these asexually produced medusa are released.
• Swim away and develop into male or female medusa - The cycle begins again

2.4 Bluebottles- Colony of animals living permanently attached to each other

Sexual reproduction
• Certain individuals only for reproduction
• Reproductive gonophores are concerned solely with producing eggs and sperms
• Fertilization external
3. PLATYHELMINTHES

Flatworms

- Hermaphrodite (mainly in slow moving animals). Each animal has both male and female sex organs, including a penis
- Internal fertilization
- ‘+‘ increase their chances of successful reproduction
- Successful mating occur in all encounters with the same species
- Penises of flatworms are muscular, sometimes with hollow stylets
- Some species may have multiple penis bulbs and stylets
- (These organs are sometimes used in defence)
- Male gametes are stored for use in the bursa or seminal vesicle
- Female gametes may be temporarily stored in the uterus

COPULATION IN FLATWORMS
COPULATION IN FLATWORMS

- Copulation is usually reciprocal
- Penis inserted into the female gonopore or the common gonopore of the partner
- In some stylet rammed through the body wall of the partner to inject the sperm. Hypodermic impregnation
- After fertilization the eggs are released. Capsules. Strings.
- Usually no larva.

4. ANNELIDA

Spawning of many species of polychaete worms like many other invertebrates (e.g. corals of the Great Barrier reef) is tightly coupled to the phases of the moon. They possess a mechanism that allows them to track changes in day length and synchronise their annual reproductive cycle. As spawning time comes closer, some combination of the monthly moon- influenced change in tidal range along with changes in the amount of moonlight is thought to be the external cue that synchronises the spawning of invertebrate populations with the moon phase.
4.1 **Spiral fanworm** (*Spirorbis*) Tube dwelling – sessile

**Sexual reproduction**

- Hermaphroditic
- Anterior segments contain female sex organs
- Posterior segments contain male sex organs
- Reproductive cycle occurs at the same lunar phase each month
- Fertilized eggs are retained in the tube of the adult
- Each month free-swimming larvae are released
- Settling behaviour of a larva involves landing on a substratum to “feel” and “taste” it
- Settle. Evenly spaced. Innermost part of the blade – area of new growth. Least likely to encounter other attached organisms
4.2 Free-living polychaetes

Sexual and asexual reproduction

- Usually practice external fertilization
- Sperm and eggs shed by breeding polychaetes into the water
- Vast quantities of eggs and sperm need to be produced to allow for the inevitable wastage
- In some species the only way to release the eggs and sperm is to rupture the body wall, so that the worm subsequently dies
- Many benthic polychaetes spawn at the surface, rather than in their normal habitat

- In *Nereis* the bottom-dwelling adults undergo a radical transition in body appearance into the sexual **heteronereid** form
  - Eyes become enlarged
  - Appendages on the posterior segment changes from crawling to a swimming function
  - Paddle-shaped swimming setae take their place
  - Parapodia also develop elaborate chemosensory organs
  - Alert the worms to the presence of their heteronereids
  - Mature heteronereids – packed with ripe sex eggs
  - At precise phases of the moon- full moon and new moon (spring tide), the heteronereids swim to the surface

**SEXUALLY MATURE HETERONEREID WORM**

**SWARMING – MALE SWIMS AROUND FEMALE**
- Males release their sperm in controlled amounts, stimulating the females to rupture and release their eggs.

**REPRODUCTION IN POLYCHAETES**

**EPITOKE FORMATION**

- **Scale worms** may brood their young after fertilization.
  - The plate-like scales cover the eggs throughout the early development before the larvae is released.

- **Syllidae** – undergoes asexual budding.
  - Divides the body into a posterior individual that becomes sexually mature.
  - Original front end remains asexual. Can bud off more individuals later.

- **Palolo worm of Samoa**
  - Epitokal region – chain of egg-filled segment
  - This type of reproductive behaviour occurs at the beginning of the last lunar quarter in October/November around the shores of Samoa.
  - Mass release of white writhing epitokes.
  - Natives harvest = delicacy.
  - During swarming the females produces a pheromone that
attracts the male and stimulates the shedding of sperm. Males swims around the female while releasing sperm
- The sperm in turn stimulates the shedding of eggs. **Hysterical spawning**

5. **PYCNOGONIDA** (pycno = great or multiple; gonas = reproduction)

**Sexual reproduction**
- Dioecious
- Females poorly developed ovigerous legs or absent
- Gonad, either testes or ovary is single and located in trunk above intestine
- Branches of gonad extended far into legs
- In both sexes reproductive openings series on ventral side – different pairs of legs
- On reaching maturity – eggs migrate into the femurs of the legs containing gonopores.
  - Egg laying: male hangs beneath the female – heads in opposite directions
  - Eggs fertilized as they are emitted by the female
  - Male gathers them into his ovigerous legs
  - Cements as many as 1000 eggs into an adhesive, spherical mass
  - Eggs brooded until they hatch
  - Larvae can remain on the ovigerous legs or in shallow-water species develop on or in hydroids and corals.
    - Sequences of moults. Adult.
6. CRUSTACEA

6.1 Barnacle

- Hermaphroditic – but most species practice cross-fertilization between different individuals
- Can only accomplish this if they can reach an adjacent barnacle
- Hence the need for an extra-long penis. Can be 3 x length of the animal
- Store their fertilized eggs in the mantle cavity beneath the body. Brooded
- Early larval developments take place here
- In some cases the release of the larvae is triggered by a bloom of phytoplankton, thus ensuring an adequate food supply for the larvae
6.2 Decapods

Sexual reproduction

- Dioecious
- In many decapods the female releases a pheromone sensed by the male
- Female reproductive openings at the base of the 3rd pair of walking legs. Male openings at the base of the 5th pair of walking legs
- Adults copulate and sperm is transferred from the male to the female
- In some shrimp species the female bears a special pouch in which to store the sperm for later fertilization
- In others, the eggs are extruded and fertilized soon after sperm transfer
- Most female decapods brood their fertilized eggs by attaching them to their swimmerets
- Brooding females are referred to as “in berry”
- Crab holds eggs under their abdomen

Rock lobster

- Very complex life cycle. Takes about 10 months to complete
- Fertilized eggs hatch after 80 – 90 days
- Different larval stages. Second larval stage goes through 11 moults.
• Becomes larger and more elaborate each step
• After 7½ months of floating around in the sea, they change into another larval stage and begin to look like miniature rock lobsters although they are both soft and almost transparent.

**Hermit crab**
- Sexes attracted by pheromones
- Precopulatory courtship
- Male hermit crab holds the female with one nipper and taps and strokes her with the other or pulls her back and forth
- Two or more males will often fight over a female while she leaves them squabbling
- Males not in the least faithful. Will readily abandon the female if a larger female appears.

**Crabs**

![Image of crabs](image.png)

**MATING SEMATOPHORE SIGNALS OF THREE SPECIES OF FIDDLER CRABS**

• Amongst few crustaceans able to practice internal fertilization. Success of the group.
REPRODUCTION AND LIFE CYCLE OF CRABS
7. BRYOZOA

Sexual reproduction

- Mainly hermaphrodite. Produce eggs and sperm from the same colony
- Sperm and eggs normally released at the same time
- Most species brood their fertilized eggs. Eggs always large, yolky and few in number
- When eggs are shed into the sea water or have been brooded internally, the escape from the body cavity by way of a special opening in the region of lophophore
- Some have larval stages.

**REPRODUCTION IN BRYOZOA**

**Ovicell brooding**

**Brooding in coelom**

**a) WITHIN COELOM**

**b) CAVITY OF SHEATH**

**c) OVICELL**
8. MOLLUSCA

Sexual reproduction

- **Dioecious or hermaphrodite**
- Mostly cross fertilization

GASTROPODS – complex methods of reproduction. Most diverse group of molluscs

**Winkles and Limpets** practice external fertilization

- Shedding sperm and eggs into the water
- Wasteful product
- Up to 60% of the body mass of a limpet mat be gonad and the production of gametes consumes a great deal of the creature’s energy.
Winkle e.g. Moon shell

- Sexes separate (dioecious), but do not spawn into the water
- Male possesses a penis
- Transfers sperm to female
- Female lays eggs in a case made of mucus and sand – **sand collar**
- Embryo develops in the collar which eventually deteriorates – releasing larvae into water.

Whelks

- Dioecious. Practice internal fertilization
- Reproduction seasonal
- Can find several dozen whelks clumped together in a mating aggregation in the rocky intertidal zone
- Females lay eggs in small (5mm) yellowish vase-shaped egg capsules
- Attached to rocks shielded from direct sunlight
- Development within the capsule
- No free swimming larval stage
- Cannibalism within the capsule. Only one well fed juvenile.
- Relinquishes the potential dispersal and feeding benefits enjoyed by those animals with planktonic larvae.

**Nudibranch**
- Hermaphrodite
- Meeting of two adults for reproduction involves the simultaneous exchange of sperm with the subsequent fertilization of each animal’s eggs.
- Thus their solitary habits are somewhat countered by this double mating that results in two animals carrying fertilized eggs
- Each species lays eggs in a specific manner – spirals, strings or flat sheets
- Development in the egg cluster
Abalone

- Sexes separate – dioecious
- Sperms and eggs released into the water through the excurrent openings in their shells.
- Zygote develops in water
- Two larval stages – trochophore and veliger
- Rely on yolk stored in egg for nourishment
- Larvae mature rapidly and are competent to settle within a weeks’ time
- Settling triggered by contact with a chemical produced by coralline algae, the food for the young abalone
- Larvae now regarded as juvenile
- Become sexually mature. Cycle repeated.

Bivalves

- Most are dioecious
- Large gonads fill most of the visceral mass. Brown and yellow colour depends on sex.
- Release sex cells into water. Individuals in close proximity.
- Fertilisation is ensured.
- Planktonic larvae develop.
- Settle and metamorphose into adults.
- A few bivalves brood their young – one species in SA has a brooding chamber.

**REPRODUCTION IN BIVALVES**

- **sperm**
- **eggs**
- **male**
- **female**
- **larva**
CHITONS
- Most are dioecious
- Single median gonad.
- Copulation does not take place.
- Gametes transported to the outside by exhalent currents
- External fertilization in the sea.
- Fertilised eggs enclosed with a spiny envelope and are usually shed into the sea singly or in strings. Larvae look like larvae of polychaetes.
- Some species brood the eggs in the mantle cavity. No larval stage.

CEPHALOPODS
Reproductive behaviour quite complex
- Dioecious
- Squids and cuttlefish have an elaborate courtship before mating
- Male takes the initiative. Approach other individuals head-on, all the while displaying rippling dark stripes of colour on the dorsal surface
- Approached animal male – same colouring. Females remain pale – coloured if receptive to male’s approach, thus signalling willingness to mate.
- Sperm transfer is a complex procedure
  - Male reproductive organs package the sperm into elaborate spermatophores – gelatinous sheath or sperm package
  - They are loaded into the sperm groove by the penis
  - Waves of muscular contraction along the arms carries the packaged sperm along the groove to the tip of one of the males arms

SPERMATOPHORE OF A SQUID
- Tip modified into the spoon – shaped palm that is used to transfer sperm into the female’s mantle cavity near her reproductive opening
- Male may transfer as many as 50 sperm packages in an hour.
- Package ruptures inside the female’s reproductive tract assuring sperm reach their destination.
- Females hand fertilized eggs in strings from rocks in caves or crevices.
- Here they remain in attendance aerating and cleaning their eggs with their siphons, without eating until hatching occurs.
- Some are so weakened by constantly brooding their eggs that they subsequently die.

**Ruptured Spermatophore**

**Reproduction in Octopus**
**Paper nautilus.** Shell a delicate floating brood chamber into which she eventually lays her egg. Male mates with female and then dies. Positions herself with her posterior end just inside the egg-filled case. Drifts and swims to spawning grounds where she dies. Tiny Argonauts hatch.

9. ECHINODERMS

9.1 Starfish

**Asexual reproduction**

- If starfish is cut evenly into two (at least one fifth of the central disc), each half might regrow the missing portions.

- Considered asexual reproduction since two individuals are produced from an original one without asexual activity
**Sexual reproduction**
- Most dioecious
- Pair of gonads lie in the central region inside each arm. Open to the exterior via pores at the base of the arms.
- Eggs and sperm shed into the water.
- Fertilization external
- Usually only one breeding season per year.
- A single female may shed as many as 2,500,000 eggs
- In some species fertilized eggs are brooded in special cavities or simply under the animal
- Larvae swim by means of conspicuous bands of cilia.

**9.2 Brittle star**

**Asexual reproduction**
- Similar to that of starfish
- Fission can take place along any plane
- Missing half regenerated

**Sexual reproduction**
- Most dioecious
- Five gonads are simple and sac-like
- When gonads are ripe - rupture – sex cells are carried out of the body in the ventilating water current
- Fertilization external
9.3 Sea Urchin

**Sexual reproduction**

- Dioecious
- Five gonads line the inner surface of the upper half of the test.
- Release their gametes via pores arranged around the anus
- Fertilization takes place in the sea water
- Brooding occur in some cold water species
- Various larval stages
- Larval stage lasts for about 2 months.
- Planktonic life. During this period bilateral symmetrical. After 2 months radial symmetrical.

**SEXUAL REPRODUCTION IN SEA URCHIN**

Early juvenile

Late echinopluteus

Early echinopluteus
LIFECYCLE OF THE CAPE SEA URCHIN
9.4 Sea Cucumber

Sexual reproduction

- Dioecious
- Single gonad which resembles a tuft of long yellow threads that unite at their bases and open to the exterior at a dorsal pore just behind the head
- Gonads expand greatly during the reproductive season and may fill much of the body cavity.
- Sex cells released into water.
- Fertilization external.
- Remarkable coelomic incubation. Development takes place within the coelom. The young leave the body of the mother through a rupture in the anal region.
- Some 30 brooding species are known – mostly cold water species.
  - Can our red chested species at the microscope be considered a brooding species?
  - According to the illustrations and observations made by Lewis Jason at different times this can be true.
FERTILISED EGGS ON SEA CUCUMBER

As observed and sketched by Lewis Jason

Section of cucumber, enlarged to show skin opening up and eggs settling into cavities and absorption into body of the cucumber leaving slight protuberance.

Cluster of fertilized eggs surround mouth and tentacles. Tube feet and constrictions moving eggs down body.

Cucumber assumes “C” as eggs are distributed down the body by constrictions and tube feet.

DETAILS OF “SWELLING”, INITIAL GROWTH AND BIRTH OF SEA CUCUMBER

A: “Tear” in mother’s skin
B: Swellings
C: Birth starting
D: Emerging juvenile.

Approx. 7 mm
9.5 Feather stars

Sexual reproduction

- All dioecious
- Since the body is so small, there is a little room for anything apart from the gut. The gonads are therefore housed in the pinnules on the arms.
- During the reproductive season these pinnules become greatly inflated until the sperm and eggs are released into the water.
- External fertilization
- Larval stage
- Brooding in cold water species.
BIBLIOGRAPHY


TERMINOLOGY

1. **Asexual (non-sexual) reproduction**: Reproduction without sex cells (gamete) formation, occurring by fission or budding. The replica has the identical genetic material as the parent.
2. **Atoke**: Asexual, unmodified state of an individual in some polychaete groups from which grows the sexual portion(s) the epitokes.
3. **Dioecious** (Gr. Di = two + oikos = house). Having separate sexes (male and female) in unisexual individuals. Found in animals and plants.
4. **Epitoke**: Pelagic reproductive form in polychaetes.
5. **External fertilisation**: The fusion of the gametes takes place outside the body e.g. in water.
6. **Fertilisation**: The process where a male and female sex cell unite to form a new individual.
7. **Hermaphrodite** (Gr. Hermaphroditos – containing both sexes) An organism with both male and female functional parts.
   a. In living organisms there are two types of reproduction.
8. **Internal fertilisation**: The fusion of gametes takes place inside the body.
9. **Oviparous**: An animal that lays eggs and the young hatch outside the body of the female.
10. **Ovoviviparous**: An animal that produces membranous eggs that hatch in the maternal body and the young are later born alive.
11. **Reproduction**: The production of new living organisms passing on traits from one generation to the next.
12. **Sexual reproduction**: The production of offspring using sexual material from different parents (male and female) to produce individuals which are genetically non-identical to the previous generation.
13. **Spawning**: The process of releasing eggs and sperm into the water.
14. **Spermatopore**: A capsule or mass created by males of various animal species, containing spermatozoa and transferred in entirety to the female.
15. **Swarming**: Synchronous behaviour of epitokous polychaetes when they swim to the surface during the shedding of eggs and sperm.
16. **Viviparous**: Animals that gives birth to live young after a period of nourishment inside the maternal body.