11

Mollusca: The Smaller Groups Polyplacophora, Scaphopoda, and Cephalopoda

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Class Polyplacophora

The chitons are one of the more primitive molluscan groups. They are characterized by a shell composed of eight plates. Worldwide, there are around 800 living species. Locally, chitons are represented by one order (Neoloricata), three suborders (Lepidopleurina, Chitonia, and Acanthochitonina), and around 42 species (Table 1). Chitons are a common component of rocky intertidal and subtidal communities.

Chitons are dioecious. Nearly all of the local species are broadcast spawners. Brooding species tend to be found in the high latitudes in Arctic and Antarctic waters (Pearse, 1979). Locally, most species spawn in the late winter and spring (Strathmann, 1987). Some chiton species spawn repeatedly, with spawning events associated with the spring/neap tidal cycle. Experiments suggest that the local species, *Katharina tunicata,* is induced to spawn by substances in the waters associated with the spring phytoplankton bloom (reviewed in

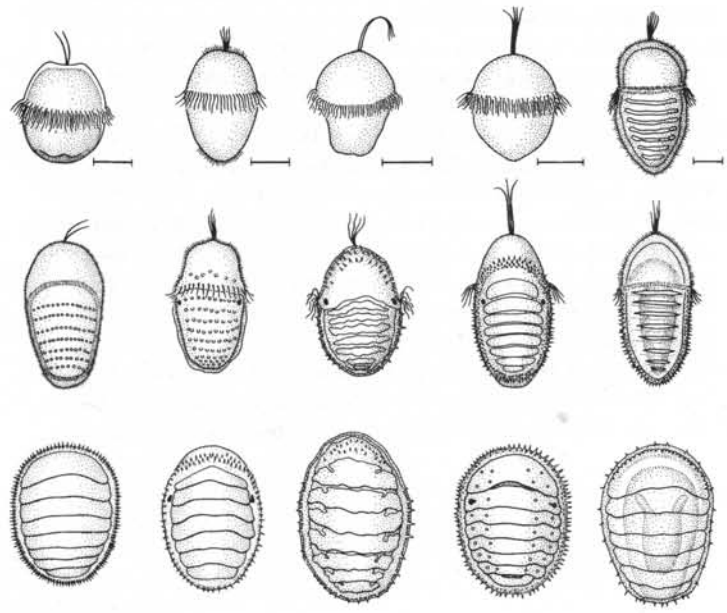

Fig. 1. Dorsal side of larvae and juveniles of several chiton species, left to right: *Lepidopleurus asellus, Mopalia lignosa, Lepidochitona cinereus, Chaetopleura apiculata, Cryptochiton stelleri.* Upper row: Newly hatched larvae. Middle row: Larvae competent to settle. Bottom row: Juveniles shortly after settlement. Scales = 100 µm. Note that *Mopalia lignosa* and *Cryptochiton stelleri* are local species and *Lepidochitona* is a local genus. (From Pearse, 1979, Fig. 16)

Table 1. Species in the class Polyplacophora from the Pacific Northwest (from Kozloff, 1996)

Suborder Lepidopleurina
Family Leptochitonidae
Leptochiton nexus
Leptochiton rugatus

Family Hanleyidae
Henleya oldroydi

Suborder Chitonina
Family Ischnochitonidae
Ischnochiton abyssicola
Ischnochiton interstinctus
Ischnochiton trifidus
Stenoplax fallaz
Stenoplax heathiana
Lepidozona cooperid
Lepidozona mertensii
Lepidozona retiporosa
Lepidozona scabricostata
Lepidozona willetti

Family Callistochitonidae
Callistochiton crassicostatus

Family Chaetopleuridae
Chaetopleura gemma

Family Lepidochitonidae
Dendrochiton flectens
Dendrochiton semiliratus
Lepidochitona dentiens
*Lepidochitona fernaldi**
Lepidochitona hartwegii
Nuttallina californica
Tonicella insignis
Tonicella lineata
Schizoplax brandtii

Family Mopaliidae
Mopalia ciliata
Mopalia cirrata
Mopalia cithara
Mopalia egretta
Mopalia hindsii
Mopalia imporcata
Mopalia laevior
Mopalia lignosa
Mopalia muscosa
Mopalia phorminx
Mopalia porifera
Mopalia sinuata
Mopalia spectabilis
Mopalia swanii
Katharina tunicata
Placiphorella rufa
Placiphorella verlata

Suborder Acanthochitonina
Family Acanthochitonidae
Cryptochiton steller

*Brooding species (Strathmann, 1987).

Pearse, 1979). Several researches have reported spawning to occur during periods of calm water.

Chiton larvae are non-feeding and have relatively short pelagic durations; most are in the plankton for one to two weeks (0.5 to 19 days, Pearse, 1979; Strathmann, 1987). If an appropriate settlement surface is not available, however, larvae can delay metamorphosis for up to a month (Pearse, 1979). The larvae of most free-spawning chiton species hatch as trochophores (Fig. 1). Chiton trochophores appear to be typical trochophores with no unique characteristics that would allow one to differentiate them easily from trochophores of other mollusks. Later in larval development, however, chiton larvae do develop unique characteristics that allow easy recognition (Fig. 2). Prior to settlement they first develop indentations on their dorsal side that separate the future shell valves. Seven calcified shell valves subsequently develop (the eighth valve

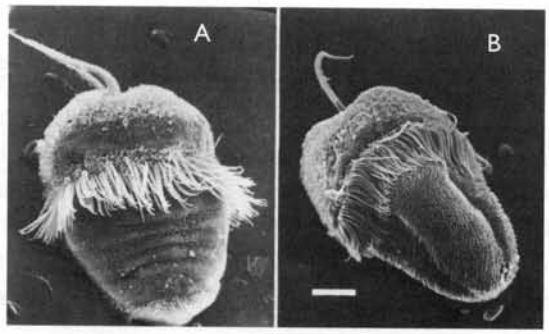

Fig. 2. Scanning electron micrographs of *Katharine tunicata*, a local species. (A) Dorsal side view of a three-day-old larva, showing the indentations separating the future shell valves. (B) Ventral side view of an eight-day-old larva, showing the developing foot. Scale = 50 μm, for both SEMs. (From Pearse, 1979, Fig. 17)

forms after settlement and metamorphosis). On the side of the larvae opposite the developing shell valves (the ventral surface), a well-developed foot forms. The distinctive shell valves of these larvae should allow one to identify a larva as that of a chiton. Few local chiton larvae have been described, however, so it is not possible at this time to develop a key to their identification.

Class Scaphopoda

Scaphopoda (tusk snails) are benthic, subtidal burrowing mollusks with tusk-shaped shells. Locally, we have seven species grouped into three families and two orders (Table 2). This group has received little attention, and most of that occurred in the nineteen century. Anatomical and reproductive studies have concentrated on species in the genus *Dentalium*, in which there are three local species. The following description is from the review by McFadien-Carter (1979).

Table 2. Species in the class Scaphopoda from the Pacific Northwest (from Kozloff, 1996)

Order Dentaliida
Family Dentaliidae
Dentalium agassizi
Dentalium pretiosum
Dentalium rectius

Order Gadilida
Family Gadilidae
Cadulus aberrans
Cadulus californicus
Cadulus tolmiei

Family Pulsellidae
Pulsellum salishorum

Tusk snails are broadcast spawners. A trochophore develops between 3 and 36 hours after the beginning of cleavage. The early trochophore in *Dentalium* is characterized by four bands of cilia encircling the middle of the larvae, an apical tuff, and the rudiments of the mantle (Fig. 3A). A disk-shaped ciliated velum at the center of which is an apical tuff characterizes the veliger stage. By this stage in development a shell has developed that envelops the larvae like a blanket (Fig. 3B). The shell has anterior and posterior apertures. Later in the veliger stage, a trilobed foot develops and the posterior shell aperture shrinks (Fig. 3C). At the prodissoconch stage, the posterior shell aperture closes so that the shell takes on the shape of a cylinder or goblet (Fig. 3D). The apical tuff is reduced, the foot increases in size, and the tentacular apparatus forms. Prior to settlement most of the velar lobe is lost, but enough remains that, on settlement, the newly settled larva crawls across the bottom by means of its foot and velum. The free-swimming stage of development lasts from two to six days. The larvae of no local tusk snails appear to have been described.

Class Cephalopoda, Order Octopoda

Three species of octopus are found in the Pacific Northwest (Table 3). Sexes are separate and dimorphic, with males possessing arms modified for the transfer of spermatophores during mating. Female octopuses deposit eggs in stalked chorions and then care for the brood during the several months needed for the maturation of the larvae. Octopus species that produce relatively small eggs generally have hatchlings that

Table 3. Species in the class Cephalopoda from the Pacific Northwest (from Kozloff, 1996)

Order Octopoda
Family Octopodidae
Octopus dofleini
Octopus leioderma
Octopus rubescens

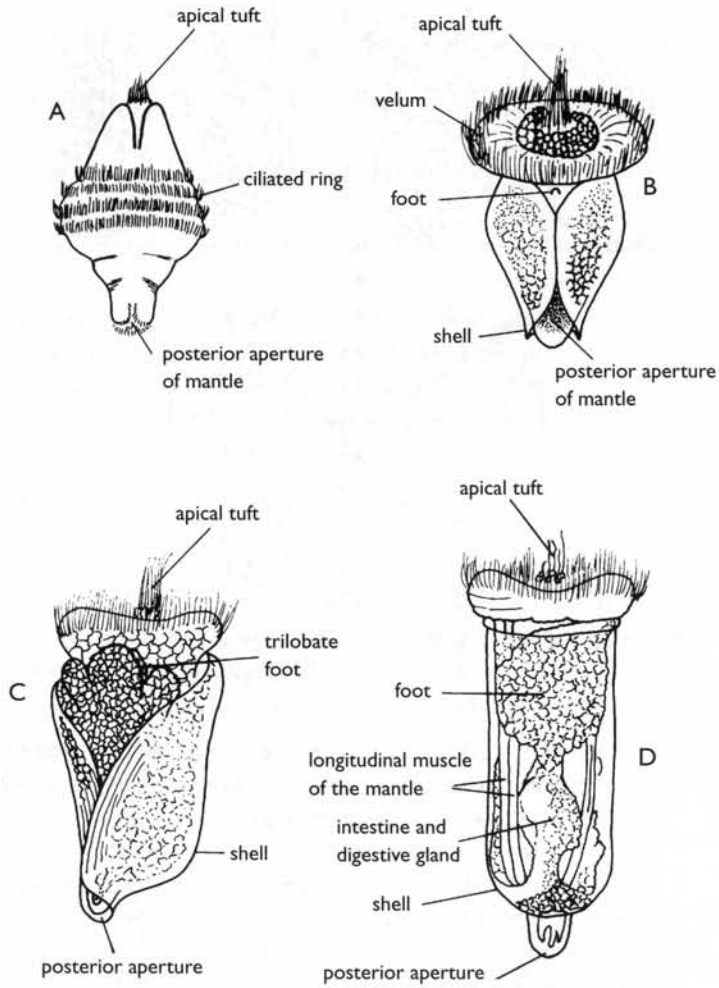

Fig. 3. Larval stages of *Dentalium*. (A) Early trochophore. (B) Veliger showing mantle development. (C) Later veliger; note the shrinking of the posterior shell aperture and the development of the trilobed foot. (D) Prodissoconch stage; note the cylindrical or goblet-shaped shell. (From McFadien-Carter, 1979)

spend time in the plankton prior to settling. Species producing large eggs tend to have hatchlings that settle to the bottom immediately (Wells and Wells, 1977). *Octopus dofleini* and *O. rubescens* produce pelagic juveniles; *O. leioderma* apparently produces benthic juveniles (Strathmann, 1987). The young of the former two species have been described, but those of *O. leioderma* have not. Figure 4 provides a general idea of the appearance of the pelagic juvenile stage of an octopus.

Key to the pelagic juvenile stage of local octopus (adapted from Green, 1973)

1a. Juvenile possess 10 arms ..... Orders Sepioidea or Teuthoidea
1b. Juvenile possess 8 arms 2

2a. Juveniles with jellylike consistency; length of longest arm less than one-third dorsal mantle length; some lateral teeth in radula with many cusps (Fig. 4C) ..... *Bolitaena diaphana*

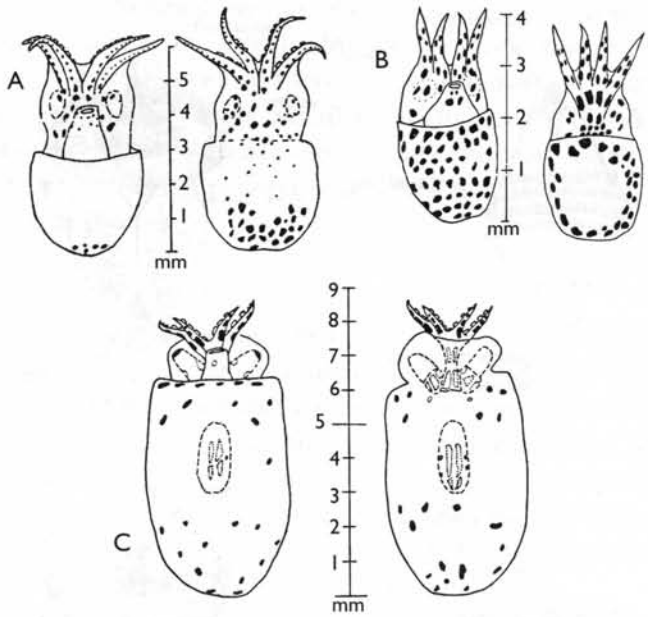

Fig. 4. Pelagic juveniles of (A) *Octopus dofleini*, (B) *Octopus rubescens*, and (C) *Bolitanea diaphana*. Ventral views to the right of the scale bar; dorsal views to the left. (From Green, 1973, Figs. 2, 8, 12).

2b. Juveniles without jellylike consistency; length of longest arm more than one-third dorsal mantle length; lateral teeth in radula not with many cusps 3

3a. 2 rows of large chromatophores on each arm; generally only 4 chromatophores on funnel, ventral mantle completely covered with even pattern of chromatophores; juvenile may be 2 mm long and have 4 suckers arranged in single row. When preserved, arms likely straight (Fig. 4B) ..... *Octopus rubescens*

3b. 1 row of large chromatophores on each arm; generally 7 or more chromatophores on funnel; anterior part of ventral mantle bare of chromatophores; larvae >2 mm and always with >4 suckers in double row. When preserved, arms likely curled (Fig. 4A) ..... *Octopus dofleini*

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