# Biology of the Atlantic Jacknife (Razor) Clam (*Ensis directus* Conrad, 1843)

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There are many clams that are identified by the common name "razor clam". They gain that moniker due to their overall shape of being long and thin, in the nature of an old-time straight razor. Many species of razor clams are favorably recognized for their taste and texture and have been commercially harvested throughout the world. More recently, interest has been rising about developing methods to farm razor clams. It is important to understand key aspects of the clam's basic biology and natural history before one can start to grow them successfully under controlled conditions.

One species that has been identified as having high potential for aquaculture is the Atlantic jack knife or American razor clam, *Ensis directus* (Figure 1, also identified as *Ensis americanus* in Europe). A native of the Atlantic seaboard of North America, the Razor clam ranges from Labrador to South Carolina.

Our knowledge of this razor clam is somewhat enigmatic given that the bulk of the information on *E. directus* in North America was published during the turn of the 20th century. The majority of recent information about the razor clam has been published as studies of *E. americanus*, following its introduction into waters of the German Bight in 1978. Since that introduction, the clam has spread through the North Sea coastline from the English Channel to Sweden and has become a dominant bivalve species in the intertidal areas within that range.

## Anatomy

The American razor clam is a filter-feeding bivalve mollusk that is easily recognized due to its unique shape, where it is 5-8 times longer (anterio-posteriorly) than it is wide and with a shape that describes a slight arc and does not taper appreciably along its length (Figure 1).



**Figure 1: The American razor clam (*Ensis directus*) (drawing from Verrill and Smith 1874.)**

The shells are covered with an elastic cuticle (periostracum) that readily sheds sediment and overlaps the valve margins to protect the mantle (Figure 2a).

Figure 3: View of razor clam with foot extended and thick mantle collar (drawing from Drew 1907.)
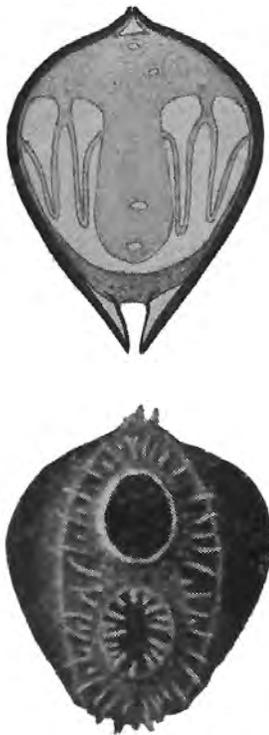
Figure 2: Razor clam views: a) cross-section through mid-point, b) posterior end view (drawings from Drew 1907.)

The short siphons are mostly round and separate with many sensory tentacles surrounding the area (Figure 2b).

The most distinctive anatomical feature to the razor clam is the large muscular foot that extends from the anterior end of the clam and is surrounded by a thick collar of mantle tissue (Figure 3).

The foot is capable of extending to approximately one-half of the total body length and the combination of foot and mantle collar is responsible for the unique capabilities of the razor clam to dig, jump and swim.

## Mobility

Using the muscular foot and thickened mantle structure, razor clams are unique in terms of their capacity to move through their environment. Under normal conditions, razor clams routinely can be found immediately at the sediment surface and, in some cases, with their posterior end projecting 25 to 50 mm above the sediment surface. However, when disturbed (they are extremely sensitive to surface vibrations), they can dig into the sediment with surprising speed and, within a very short interval, can relocate to depths of up to 1 meter below the surface. To do this, the clam slowly extends its foot with a tapered tip into the sediment. Once extended, the clam can flare the tip (Figure 3) to serve as an anchor as the foot is rapidly retracted; thereby, pulling the clam's streamlined body through the sediment. As the foot is retracting, it is forcing a pressurized stream of water between the base of the foot and the thickened ring of mantle surrounding the foot. As the water is discharged, it fluidizes the sand at the leading edge of the moving shell facilitating its progress through the sediment.

Swimming in razor clams is accomplished in a manner similar to their digging. The difference is that as the foot is rapidly retracted, while the clam is at the sediment surface or in the water column, the pressurized water escaping around the base of the foot acts to propel the clam through the water column, in a manner similar to the jet propulsion of a squid or scallop.

It is not uncommon to find razor clams lying on the surface of the intertidal zone, as they are moving from spot to spot. Often the clams are discovered as they attempt to jump across the flats. The third method that razor clams can move is jumping, which is accomplished by curling the foot under the body of the clam and rapidly retracting it (Figure 4.)



Figure 4: Razor clam foot position during jump behavior (drawing from Drew 1907.)

The result of this action is that the body of the clam jumps into the air and moves a short distance across the flats. Razor clams have been observed repeatedly jumping as they move across the exposed sand flats.

## Growth

Although the maximum size for the razor clams approaches 20 cm over a life span estimated at 7-8 years, the market size for a razor clam is typically between 10 cm and 15 cm. Based on growth measurements made on wild razor clams collected along the coast of the North Sea, that target size could be achieved over a grow-out period of 2-3 years (Figure 5.)
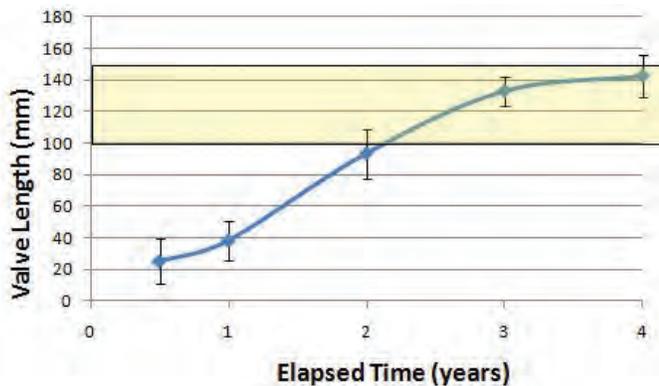


**Figure 5: Plot of average growth of razor clams from eleven sites along the North Sea (modified from Armonies & Riese 1999.) Shaded area represents estimated size for market.**

However, reports from the coast of England have suggested that the growth rate is significantly slower in that area, with time to achieve market size estimated to be 4-5 years.

## Reproduction

Razor clams have separate sexes with their gonadal tissue integrated into their visceral mass. A cold water species, *E. directus* has been observed to spawn in March-April in the North Sea, early June in Canada and somewhere in between these times in other locations. Following a large synchronized spring spawning, a continuous low level of larvae can be detected in the water column through much of the summer. As a bivalve mollusk, razor clam spawning and larval development follows normal molluscan stages with setting occurring between 10 days and 3 weeks, depending on ambient temperatures. For example, at 18°C razor clam larvae

developed from trochophore to pediveliger in 15-16 days.

A unique behavior in post-set razor clams is their capacity to migrate following setting. Juvenile razor clams, up to 10mm in length, have been observed swimming at the water surface in subtidal areas, suggesting that the small stage is highly mobile following setting. In addition, small post-set razor clams have been observed undertaking larger-scale migrations through "byssal-drifting." By deploying an attached byssal thread, small razor clams can move with the coastal water currents due to the drag on the byssal "sail". This behavior is thought to have led to the rapid expansion of the introduced American razor clam across northern Europe.

## Habitat

In the wild, the razor clam is primarily found in the low subtidal areas (below mean low water) and in subtidal areas to about 20 m water depth, although it has been reported living in depths to 100 m. With the ability of the post-set juvenile to redistribute itself, the razor clam is generally most abundant in shallow subtidal waters with densities decreasing as one progresses into the intertidal area. It is reported that in some areas spatfall occurs mainly in the intertidal and shallow subtidal but the post-set will move to deeper waters through a combination of swimming and byssal-drifting.

A primary factor governing the redistribution of the post-set razor clam is associated with selection of sediment type. Razor clams are thought to prefer clean sand to muddy sand substrate and actively seek those substrate types during the post-set migration. They also seem to orient to sites with moderate water flow. Razor clams prefer salinities of 28 to 32 psu however they can tolerate transient exposures to lower salinities. Once an appropriate site has been located, the small razor clam can establish itself into the sediment in a matter of minutes.

Post-set density of razor clams can be exceptionally high, with reported initial densities of post-set juveniles approaching 2,000 individuals per square meter. Following the first winter, through redistribution and overwintering mortality, densities usually stabilize up to a maximum of 200 ind/m². The highest sustained densities have been observed in the shallow subtidal areas. Individuals remaining in the intertidal zone are subject to environmental stresses that reduce survival.

Razor clams appear to be euryhaline in that they are found in waters ranging from open oceanic conditions (32-35 ppt) to estuarine environments where salinity

may average 25-28 ppt with short excursions to lower levels (down to 15 ppt.)

The predominant factor governing survival in the intertidal has been suggested to be ambient temperature. North Sea razor clams experience high levels of mortality when exposed to air during the winter months, possibly due to the behavior of the clam to approach the sediment surface to feed. However, the biggest problem with rearing razor clams in the northeastern U.S. has been high temperatures on exposed intertidal flats in the summer, resulting in excessive mortality. Although upper lethal temperatures have not been suggested for the razor clam, Loosanoff and Davis (1964) reported that razor clams became sluggish at 30°C. Summer sediment surface temperatures on exposed intertidal flats in the northeast can exceed 35°C and high levels of mortality have been observed under these conditions. Regardless of whether the temperature is too high or too low, intertidal exposure of the razor clam is a stressor that can lead to significant mortality in a population.

## Risks

In the North Sea, exceptionally dense sets of razor clams have been observed to undergo catastrophic reductions in density over a short period of time. While no research has been undertaken to identify the cause of the mortality, there is a high probability that some sort of pathogen contributed to the large-scale die-off. The Pacific razor clam (*Siliqua patula (Dixon, 1789)*) has been impacted by infection from an unknown protistan pathogen, termed Nuclear Inclusion Unknown (NSX), that has resulted in large-scale die-offs at sites in Washington and Oregon. Although no specific diseases have been described for the American razor clam, it is highly probable that razor clam pathogens exist and need to be identified and studied.

Predation, on the other hand, is a known significant factor in survival of the razor clam. Numerous predators have been described as consumers of the razor clam, including epifaunal and infaunal denizens of the marine environment. Given the razor clams penchant for sitting at the sediment surface, they are highly susceptible to predation by shorebirds, including the American oystercatcher and most gulls. In addition, the numerous crabs and demersal fishes that are foraging at the sediment surface during times of submergence can also prey on razor clams. Siphon nipping has been described as a common source of damage to razor clams in the wild. Infaunal predators are also a factor in razor clam survival.

Whether being attacked from above by predatory gastropods, such as the moon snail (*Euspira heros (Say, 1822)*), or from below by carnivorous worms, such as the ribbon worm (*Cerebratulus lacteus (Leidy, 1851)*), they are highly susceptible to these predatory acts because of their inability to completely close their valves to protect the soft tissue and because of the fragility of their shell.

The primary mechanism that razor clams employ to avoid predation is their mobility. If attacked from above, they can rapidly dig to depths that make them inaccessible. One report describes a razor clam digging to such an extreme that its movement described a complete arc in the sediment resulting in the animal exiting the sediment in reverse at a location several meters away from the attack site. If attacked from below, the razor clam can exit the sediment and either swim away if submerged or jump across the flats if exposed to avoid the infaunal predator.

## Markets

The traditional market for razor clams in the northeast was as a supplement for soft shell clams that were shucked for frying. When soft shell clam resources were low, harvesters would target razor clams as a replacement. The preferred size was large (15 cm).

More recently, demand has been increasing for live razor clams, with a market size of 10 - 15 cm. Market price has exceeded $2.00 (USD) per pound for live razors over the past few years. The challenge with the live razor clam market is their lack of hardiness for transport and holding. Shelf life can be very short (1-2 days) without some type of intervention by the harvester/handler. The most common method for extending the holding time for live razor clams is to bundle them, holding the bundle together with rubber bands, similar to the market strategy for asparagus. This approach compresses the valves of individual clams together and relieves the adductor muscles from having to hold the valves together. Shelf life can be extended to up to a week with bundled razor clams.

## Conclusion

The American razor clam appears to be a suitable candidate for culture. Although the clam has a few unique attributes, many of the biological characteristics of the species appear to be similar to that of other

infaunal bivalves and, therefore, farming should prove to be routine for culturists knowledgeable in infaunal clam culture. However, more biological information on the species is needed to fill in knowledge gaps for improving culture.

The primary consideration in farming the razor clam is siting, as razor clams will evacuate an area rather quickly if the site is not suitable for their needs. One important factor in siting is the sediment type. Observation of farmed razor clams indicate that they will avoid digging in if the sediment type is not appropriate. Unless contained, the razor clam seed will move off the culture site in search of new and more suitable substrate.

The U.S. razor clam market is small but developed. If supply is available, wholesalers have indicated that they can increase the market size but are hesitant to do so without adequate resources.

In summary, the Atlantic razor clam (*Ensis directus*) is a viable candidate for farming. The current level of knowledge on the biology and the ecology of the species is sufficient to allow farmers to start developing optimal technology for growing them to market size. However, some adaptation of current shellfish culture practices will need to be implemented to accommodate their unique biological attributes.

## Relevant Literature:

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