

Biology of the European lobster, *Homarus gammarus*

TAXONOMY, DISTRIBUTION AND ANATOMY - All lobsters belongs to the invertebrate Subphylum called the Crustacea, which also includes marine animals like crabs, krill and barnacles, as well as terrestrial families like woodlice. The Order Decapoda (meaning '10-limbed') contains most of the commercially important species including the European lobster, *Homarus gammarus*. *H. gammarus* populations inhabit sub-tidal eastern North Atlantic waters from the Lofoten Islands in arctic Norway to the Azores and Morocco, including the Mediterranean and western Black Sea, but not in the Baltic. *H. gammarus* is rarely found deeper than 50m, but can occur anywhere from the low tide mark to 150m, usually on hard substrates made of rock or compressed mud. The two foremost limbs of Homarid lobsters are specialised into two large claws; one is large and blunt and designed for crushing whilst the other is sharper and slightly less bulky and used for slicing. The internal soft tissues of the body are protected by a rigid exoskeleton, the foremost part of which is the solid carapace and the hind portion is the articulating abdomen and tail, which can be contracted quickly to allow thrusting reverse swimming.

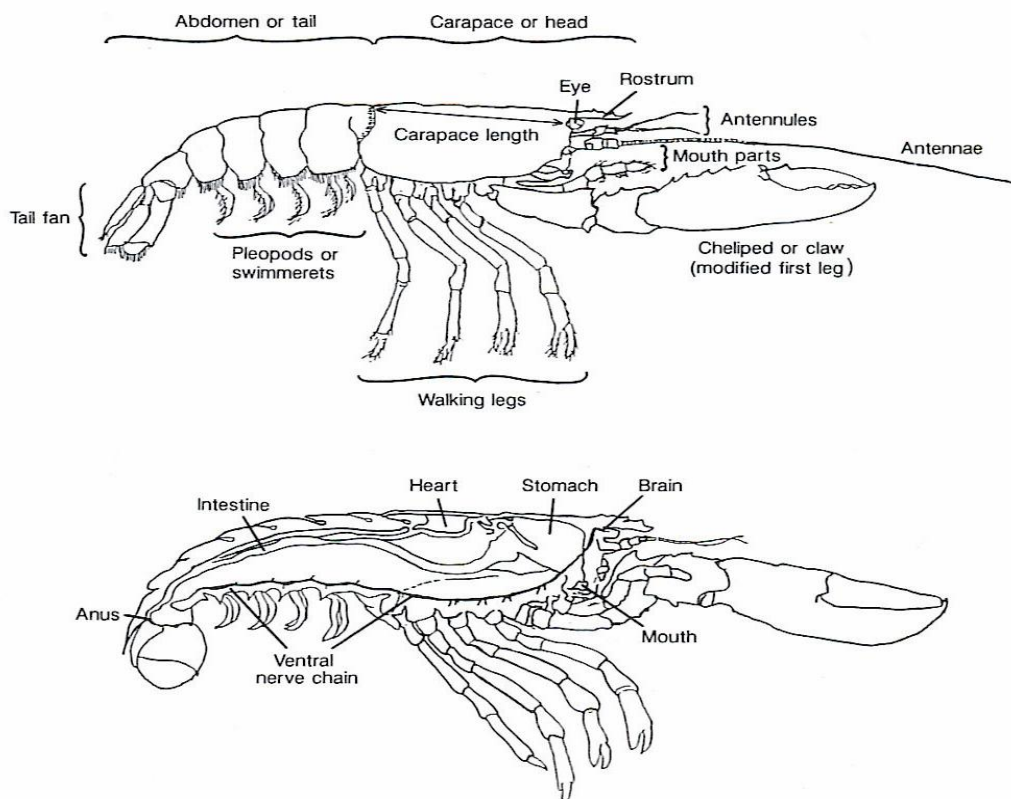


Figure 1) The external (top) and internal anatomy of a mature *H. gammarus*

GROWTH - Lobsters grow in length by shedding their hard exoskeleton, a process known as moulting. As they moult, water is absorbed by the body tissues and this causes the lobster to swell and rupture the outer exoskeleton. After it has freed itself, further swelling occurs and a new exoskeleton begins to harden. Newly moulted individuals are vulnerable to predation and tend to remain hidden until the new exoskeleton has hardened; a process that is completed within a period of a few hours to several weeks, depending on the size of the animal and the availability of calcium and the rapidity with which it is deposited. In the period between moults, new body tissue is generated to

replace the water absorbed at moulting. During each moult, the carapace length typically increases by 10-15% and the total weight by up to 50%. Once the lobster has moulted it consumes its old exoskeleton, providing the lobster with much of the calcium needed to solidify its fresh shell. Young lobsters moult up to 25 times in their first five years, and about once a week in their first month. Adults moult less frequently; with old, large adults, this may be as little as once every two years, but they keep growing throughout their lives. The largest specimen on record measured 1.26m and weighed 9.3kg (20lb 8oz). Caught in 1931 in Fowey, England, the exoskeletal shell of its crushing claw alone weighed 1.2kg. Appendages and limbs lost through injury can be regenerated, but this usually has a negative affect on both the intermoult period and the growth increment.

REPRODUCTION - The female lobster reaches sexual maturity in 5 to 7 years of age, at a carapace length of 75-80mm, and the male at a slightly smaller size. Mating usually occurs between a hard-shelled male and a soft, newly-moulted female. The sperm is transferred from the male via ducts situated at the base of the last pair of walking legs, to the sperm receptacle on the female. The female can retain the sperm whilst the eggs are being laid. Spawning usually occurs in the summer when the female is said to be 'berried', the eggs are fertilized as they are extruded through the small ducts and are carried underneath the abdomen for 9-12 months. The eggs change colour as they develop, at first they are dark green, then black and finally they begin to turn red as the embryo develops and consumes the yolk to reveal itself though the transparent outer layer. Hatching occurs over several nights in batches of a couple of thousand at a time, when the stage 1 larvae are released into the water column by a shake of the female's tail and pleopods, to begin their planktonic stage.

PLANKTONIC DEVELOPMENT - The larvae float at the mercy of the ocean currents in the surface layers of the water column where they are omnivorous, opportunistic feeders, eating phytoplankton and other zooplankton such as copepods. Larval life lasts approximately 5-10 weeks during which natural mortality, mostly from predation, is highest. *H. gammarus* larvae are also very susceptible to anthropogenic toxins during this phase, such as surface accumulations of hydrocarbons. Like other planktonic creatures, the larvae are often pushed together in dense clusters by converging water masses and it is at this stage when they are most vulnerable to predation by schooling fish like herring and cod and filter feeders like basking sharks. After the third moult there is a distinct change in body-structure, with the claws and tail moving from their lowly, dangled positions to jut out straight from the thorax and abdomen respectively. This alteration towards the post-larval form of an adult allows the lobster to swim forwards using the pleopods and seek a suitable substrate for benthic existence, like gravel or coarse sand. This larval to post-larval phase is a critical period in the development of *H. gammarus*; it has been estimated that only 0.005% of the hatchling lobsters survive the planktonic phase to reach the benthic phase.

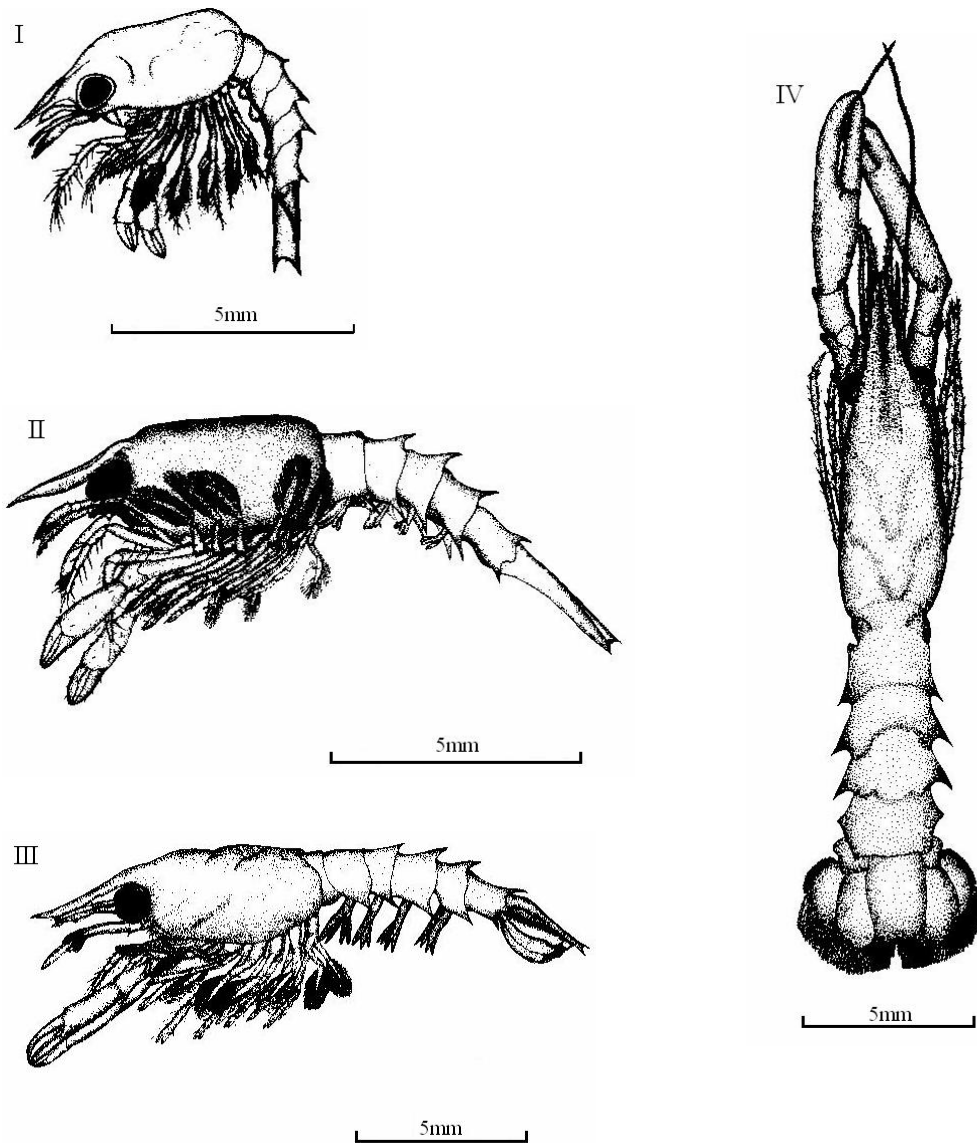


Figure 2.) The three larval stages (I, II and III, left) of the lobster *H. Gammarus*, and the first juvenile stage that occurs after the third post-hatch moult (IV, right)

BENTHIC DEVELOPMENT - Post-larval juveniles experience a much higher survival rate from Stage IV, as they are now out of reach and view of many of the abundant pelagic predators. Despite significant and widespread investigations, comprehensive information is unavailable on the early benthic phase of the post-larvae. Little is known about the habits of the lobster in the first few years that follow settlement as they are rarely observed in the wild, unlike related species such as *Homarus Americanus*, the European lobster's western Atlantic relative. What has been ascertained, in the laboratory environment at least, is that once settled, the juveniles burrow into the seabed where they spend approximately 2 years, seldom moving. Gravels ranging from coarse sand to fine shingle appear to be the preferred habitat, though juveniles have also been known to form burrows in cohesive mud. At this stage they will eat marine worms and other post-larval animals like small crabs, urchins and gastropods, as well as retaining the ability to filter-feed on plankton. At a carapace length of about 15mm they leave their burrows for crevices in rocky substrate to begin life as an adult.

MATURITY - The diet of adult European lobsters, who hunt mainly nocturnally, comprises mostly of benthic invertebrates such as crabs, molluscs, urchins, starfish and polychaete

worms, but may also include some fish, algae and zooplankton. Feeding is reduced in the winter as the metabolic rate slows because of the lower sea temperatures. Though typically sedentary animals, the lobster will roam to find food and has a typical home range of 2km, while some individuals have been known to stray 10km or more from their burrows. The typical colouration of a mature *H. gammarus* is dorsally blue/navy and ventrally lighter, with an orange or yellowy tinge. This colouration is caused by a pigment in the exoskeleton called astaxanthin, which turns bright red when significantly heated; hence the lobster's colour after cooking. The exoskeletal colour is determined by the presence of several different astaxanthins that each colour the shell blue, red, or yellow. Occasionally, one or more of these astaxanthins can be missing or suppressed, causing an unusual colouration in the host lobster. Although extremely rare, lobsters have been observed to be bright blue, red, orange, calico or entirely albino.

POPULATION GENETICS - While genetic data from wild populations suggests that a female mates with only one male, the male lobster can fertilise multiple females, producing a polygynous breeding system. Molecular markers such as microsatellite, mtDNA and allozymes have allowed extensive sampling of over 5,000 animals from 46 European locations that deduced a low level of overall genetic divergence among populations. No evidence was provided for major genetic differentiation between Atlantic and Mediterranean populations, unlike those seen in many other marine species. Overall, 4 distinct genetic populations have been identified in northern Norway, Netherlands, Atlantic Europe and Mediterranean. The Norwegian, Dutch and Mediterranean populations differ from the remaining Atlantic Europe group because all have reduced gene diversity. A large number of discrete populations of *H. gammarus* have limited gene flow between them, conducive of an island model of population structure. Though the overall level of genetic divergence remains low, the populations living at the extreme ranges of the species' distribution are likely to be genetically adapted to tolerate what are extreme environmental conditions for the species.