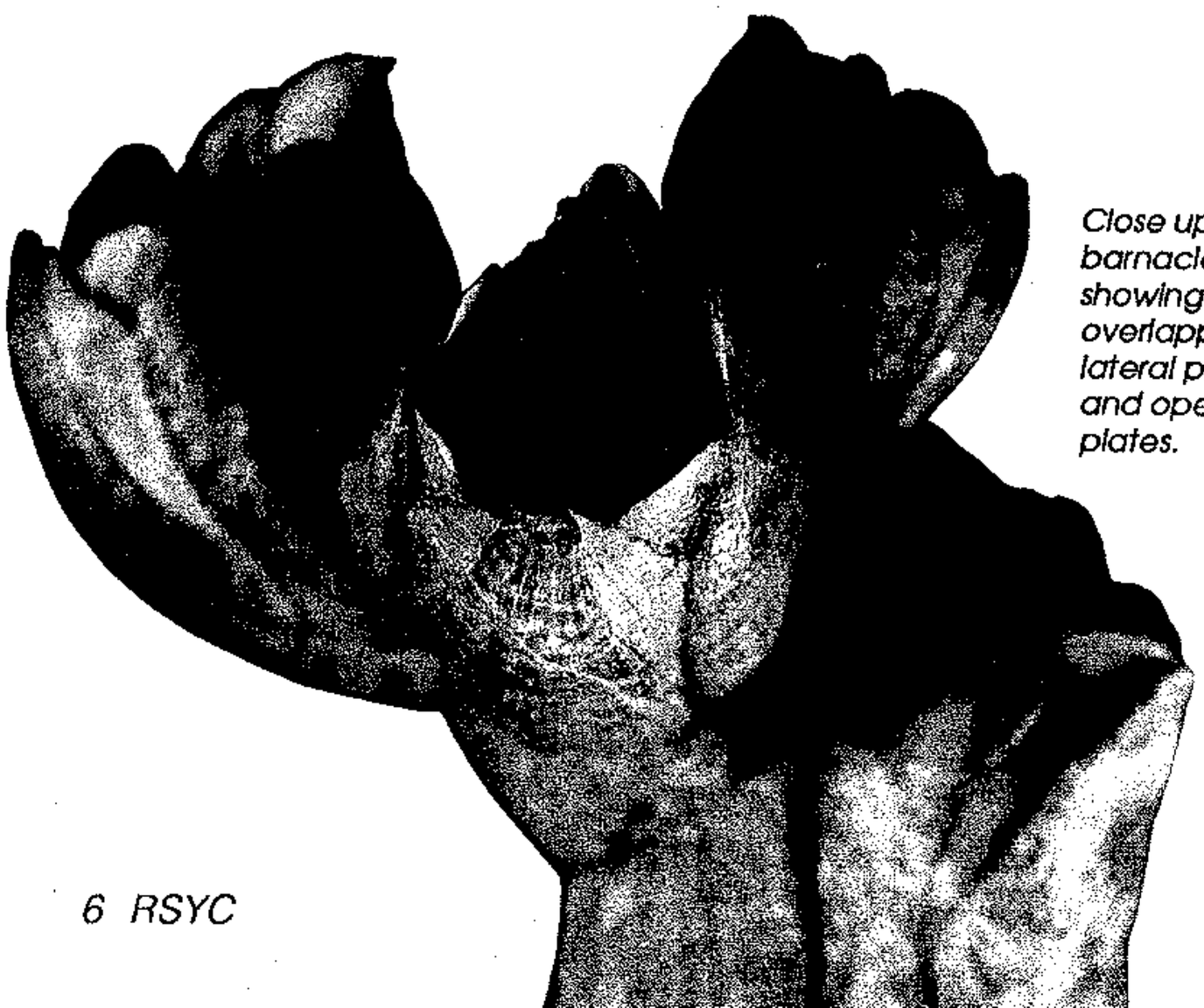
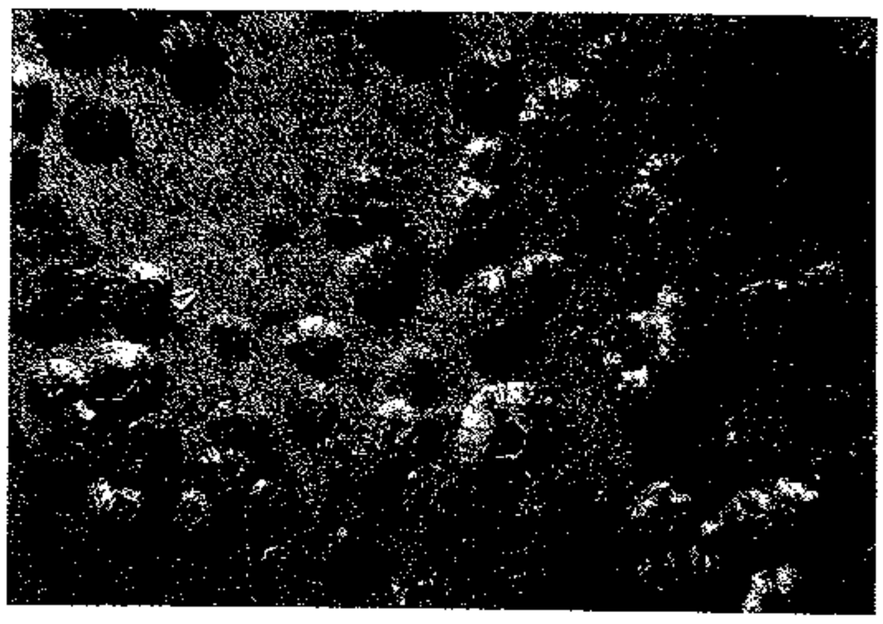
Invasion of the Foulers

Through the dark waters they come, like so many underwater commandos, antennae held in front of their armour-plated bodies, multiple legs sculling furiously. These are the cuprid larvae of the dreaded barnacles. The first of the swarm makes contact with the gleaming hull of a ship, its frantic swimming motion transformed into a cautious, probing investigation of the new environment. Information about the surface is relayed through the antennae, legs and other sensory appendages to its tiny nerve centre. Factors like the texture and composition of the surface, tides and water currents and clearance from the nearest competitor are integrated into a decision to settle. It flips over and butts its head against the metallic surface, cementing itself firmly to it by exudations from its adhesive glands.

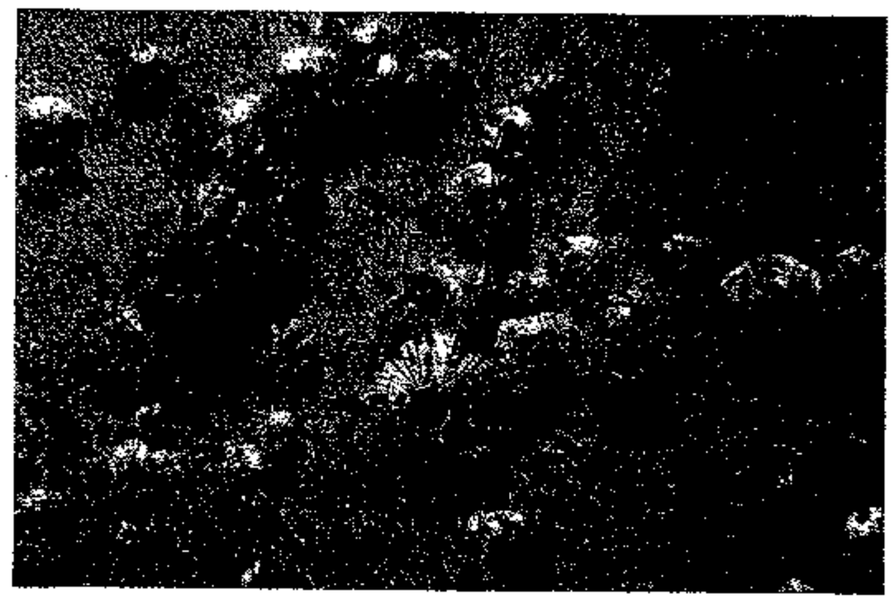
Once firmly ensconced, each larva undergoes a dramatic transformation from a mobile dispersal agent into the sedentary adult barnacle. Structures necessary for the free-swimming phase are either shed or modified to suit its new lifestyle. The eyes disappear and the legs elongate into bristle-like structures called cirri. Calcareous protective plates are secreted around the animal for security, with a slit at the top for extrusion of the cirri during feeding. With the settlement and metamorphosis of the initial wave of larvae, chemical attractants are released into the water that draw other would-be colonisers to the substrate.



Close up of barnacles showing the overlapping lateral plates and opercular plates.



Barnacle fouling on concrete.



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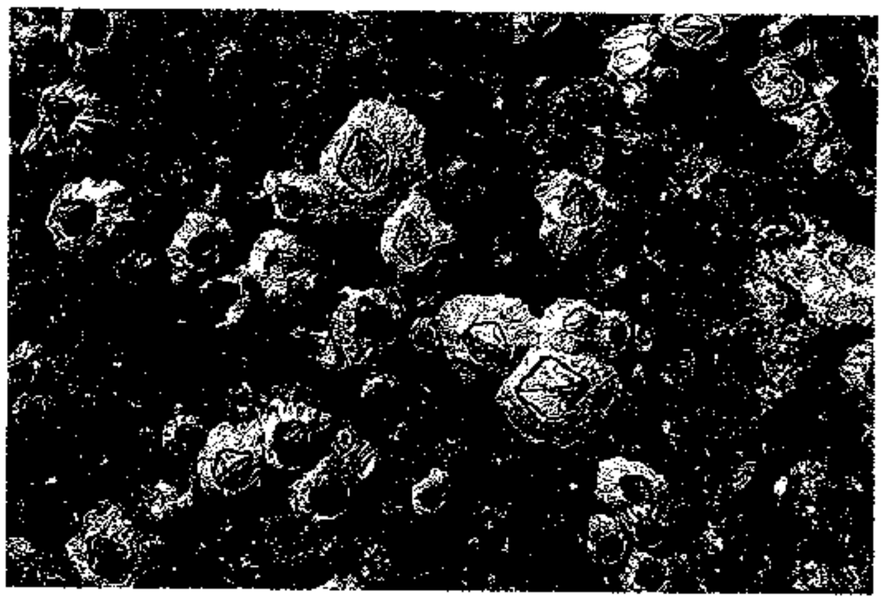

Barnacles encrusted on a jetty piling.

Invasions like this are mounted everyday on any exposed surface in the sea available for colonisation. Rocks on the seashore, floating timber, jetty pilings, buoys and ships are all vulnerable to this onslaught. Even animals do not escape this scourge of the sea. Barnacles have been found on sea urchins, sponges, hydrozoans, hard corals, crabs, sea-snakes, turtles, porpoises and whales.

Barnacles are an aberrant group of crustaceans that lead an immobile, filter-feeding way of life, as compared to their crab and shrimp relatives and have often been mistaken for molluscs by virtue of their calcareous shells. They are exclusively marine and make their living by filtering plankton from the water. About two thirds of the 900 described species are free-living,

attaching to non-living surfaces; the rest are associated with animals while a large number are parasitic. The free-living barnacles are divided into two types, the stalked and stalkless types, of which the latter form the majority.

The structure of barnacles is eminently designed for their particular mode of living, each consisting of a calcareous refuge of overlapping plates cemented together and to the attachment surface by cement glands on the animal. These essentially consist of a base plate glued to the substrate, a series of vertical wall plates and a hatch-like cover called the operculum. These plates are continually elaborated throughout the life of the animal by the secretion of calcareous material on the interior and margins from an underlying layer of living tissue called the mantle. In this way, the diameter and thickness of its limestone fortress is continually increased as growth proceeds. Sequestered within this stronghold, the frail shrimp-like animal is safe from the predatory attentions of fish, molluscs and other opportunists. By retaining water within the walls, sealed with the operculum, it can also survive periodic exposure to air during low tides. The operculum of the animal opens to allow the extension of its cirri, which fans out into the surrounding water as a plankton scoop. The two halves of this scoop net are then swept together and downwards in a concerted action, like the opening and closing of two fists joined together at the base of the palms. Microscopic organisms ensnared in the mesh of fine, bristly setae arising from the cirri are brought to the mouth of the barnacle by this periodic furling of the feeding apparatus. It is easy to understand why Louis Agassiz described a barnacle as "nothing more than a little shrimp-like animal, standing on its head in a limestone house and kicking food into its mouth."

Barnacles are mostly hermaphrodites and, though self-fertilisation is not unknown, cross fertilisation generally take place, especially on crowded sites. Copulation is effected by the insertion of a long tubular penis into an adjacent animal. The sperm are then deposited in the ovisac within, where the eggs are held. Some hermaphrodite individuals have their male parts so reduced that they are structurally and fuctionally females. The fertilised eggs are brooded in the ovisac until they hatch into the initial larval stage, called the nauplius. A single adult may release over 13,000 larvae. After six months, during which the larvae shed their skins and grow, they turn into cypris larvae, the settling stage which completes the cycle of barnacle life.

The ubiquity and tenacity of barnacles make them important marine fouling organisms, as many a mariner who has had to clean his cruiser or yacht would attest. It is scarcely conceivable, however, that this diminutive creature is responsible for the loss of an estimated S$800 million every year. Ocean-going vessels, burdened by barnacles acquired in port, increase their fuel consumption by as much as 40%. Added to this is the cost of cleaning. Fixed structures in the sea, such as oil rigs, navigational buoys, pipelines and undersea recording instruments are also prone to fouling by barnacles. The financial penalties incurred may result from the possibility of structural overloading and the costs of maintaining the efficient operation of navigational buoys and recording instruments. Seawater intake pipes on ships and in coastal plants such as aquaculture farms and power stations are frequently clogged by the growth of these creatures. All this adds impetus to the search for measures to control the fouling of surfaces by settling barnacles. The use of toxic paints features prominently among these measures, particularly those containing copper and, lately, organic substances like tributyl tin and triphenyltin fluoride. Although these substances have proved fairly effective in the control of marine fouling organisms such as barnacles, their ecological impact on marine organisms, especially in coastal waters, has yet to be fully ascertained. The search for less envirnmentally damaging control measures in the form of proteolytic enzymes, antibiotics and other natural organic biocides, forges ahead in the ongoing war between man and barnacle.

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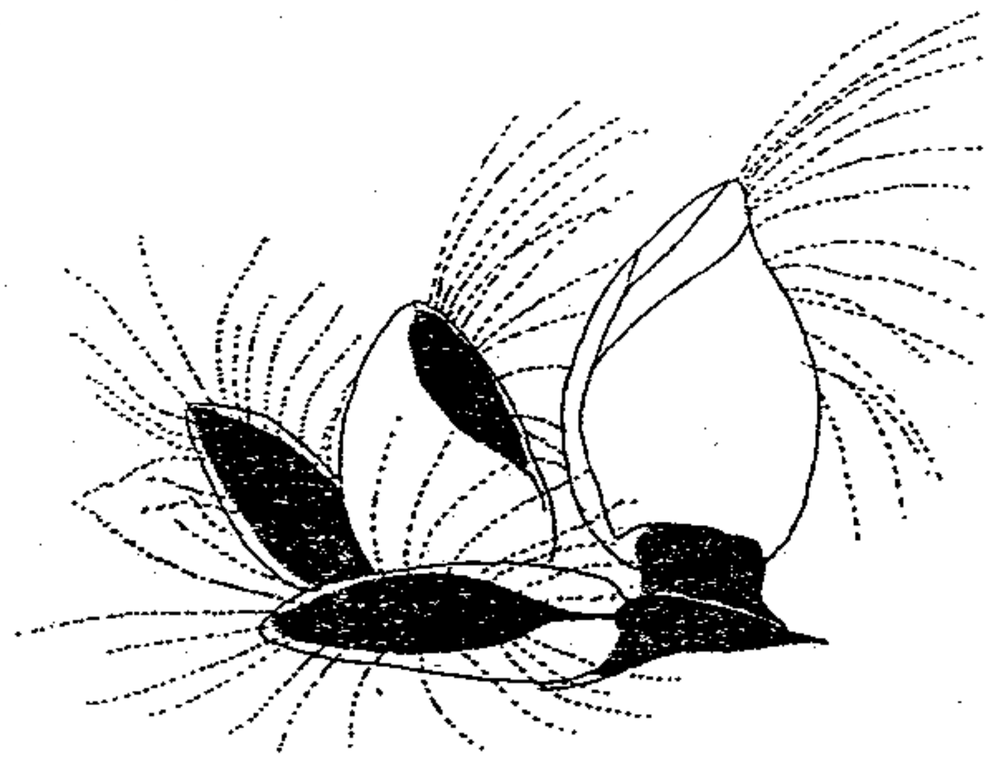
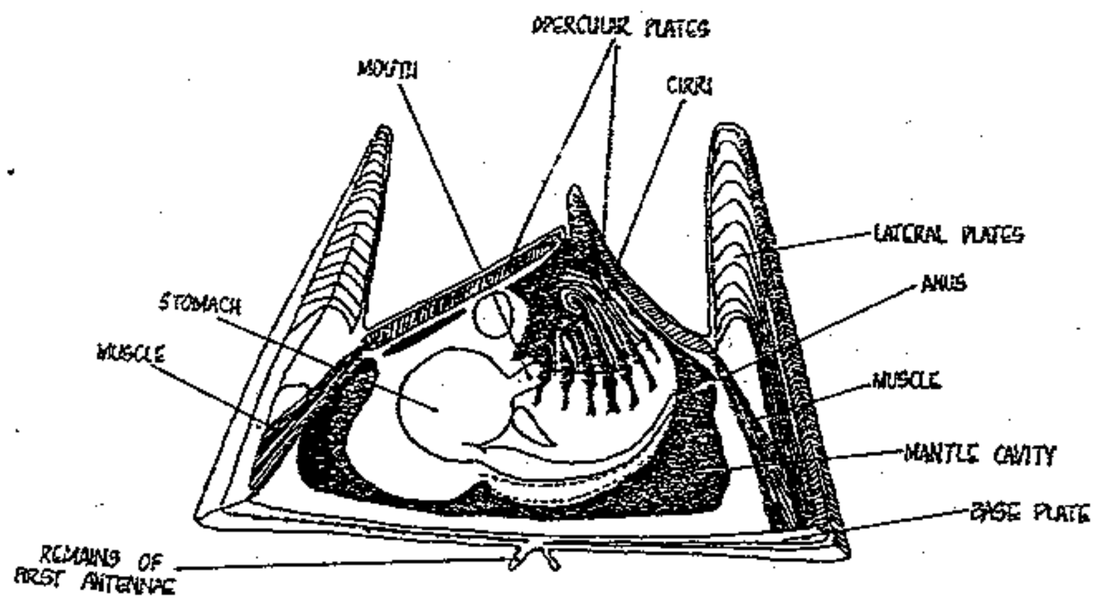


Goose Barnacles (Lepas SP) With Cirri Extended For Feeding.



Cross-Section Through A Barnacle (Balanus SP)