Date Mussel (*Lithophaga lithophaga*) harvesting : evaluation of damage along the Sorrentine-Amalfitane Peninsula (Bay of Naples)

Giovanni Fulvio RUSSO° & Fabio CICOGNA °°

° Stazione Zoologica "A.Dohrn", Laboratorio di Ecologia del Benthos, ISCHIA PORTO (NA) **(Italy)**
°° Centro Lubrense Esplorazioni Marine (CLEM), MASSALUBRENSE (NA) **(Italy)**

The bivalve *Lithophaga lithophaga* colonizes calcareous rocks from the surface of the sea down to a depth of 20 m, with maximum density in the first five meters. The mussel bores cavities in calcareous rocks by means of acid or calcium-binding secretions, and lives in the cavities, extending them up to 20 cm into the hard substrate. Fishermen smash the rocks with axes or hammers to excavate the bivalve and thus destroy the substrate and the organisms living on it.

Lithophaga lithophaga grows very slowly, and takes about 20 years to reach minimum commercial size (5 cm). Therefore, after date mussel have been harvested it is several decades before the same sites can be fished again. Consequently, fishermen constantly seek and destroy new harvesting sites. In this light, the "exploitation by excavation" of date mussel "banks" can be considered "extractive" activity, like mining.

This is precisely what happens, in a manner always more devastating in these last years. With the recent increase in scuba diving, the situation has deteriorated dramatically, as shown by studies on the coasts of Dalmatia (HRS-BRENKO, 1991), Apulia (BOERO *et al.*, 1990), and of the Bay of Naples (RUSSO & CICOGNA, 1991, 1992).

The calcareous cliffs of the Sorrentine-Amalfitane Peninsula (about 70 km, from Vico Equense to Positano, Bay of Naples) have been proposed as a marine reserve (Law Nr. 979/1982). To evaluate damage to date mussel harvesting, the area was surveyed in the summer 1991 by 50 transects, extending from the surface of the sea down to a depth of 15 m, perpendicular to the coastline, 1 nautical mile apart.

Following BOERO *et al.* (1990), rock damage was evaluated by measuring the size and frequency of the "bare" patches due to the excavation activity, and classified as follows:

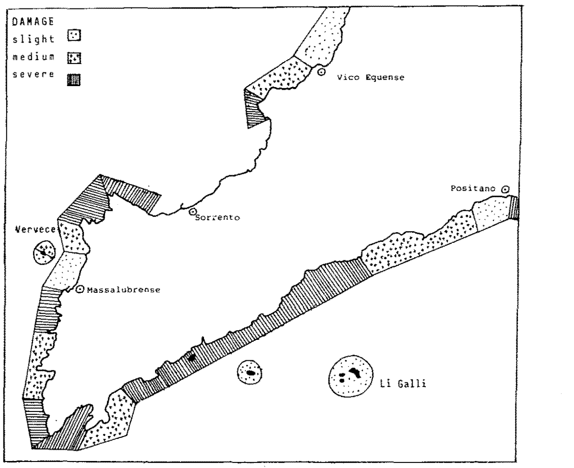
- rank 1: absence of damage;
- rank 2: slight damage (isolated patches, max. size 1/4 m2);
- rank 3: medium damage (scattered patches, max. size 1 m2);
- rank 4: severe damage (adjoining patches, size > 1 m2)

The results are shown in Fig.1. No sites without damage (rank 1) was recorded along the coast. Of the total investigated area, about 15% showed slight damage, about 35% medium damage, and about 50% severe damage.

The rank 2-type impact of harvesting was found around the rocks that extended far from the coast. Severe damages was observed on the steep cliffs near the main villages and along an extended area facing the Gulf of Salerno.

These results are alarming. Despite a law forbidding date mussel harvesting (D.M. 20/8/1988, and D.M. 2/8/1990), 50% of the total area showed "fresh" patches, indicating that excavation activity had been conducted during the year of the observations.

Stricter enforcement of the law and the sensibilization of the public opinion as to the problem are urgently required.



REFERENCES

BOERO F., CECERE E., FANELLI G., GERACI S., GIANGRANDE A., GRAVILI C., GRILLI G., PICCINNI R., PIRAINO S. & TUCCI F., 1990.- Impact of *Lithophaga lithophaga* (Mollusca) fisheries on hard bottom substrata along the Apulian coast (Ionian sea). *25th European Marine Biology Symposium*, Abstracts.

HRS-BRENKO M., ZAVODNIK D. & ZAHTILA E., 1991.- The date shell *Lithophaga lithophaga* Linnaeus, and its habitat calls for protection in the Adriatic sea. In: "*Marine Species in Need of Protection in the Mediterranean*". GIS Posidonie publ., Fr.: 151-158.

RUSSO G.F. & CICOGNA F., 1991.- The date mussel (*Lithophaga lithophaga*), a "case" in the Gulf of Naples. In: "*Marine Species in Need of Protection in the Mediterranean*". GIS Posidonie publ., Fr.: 141-150.

RUSSO G.F. & CICOGNA F., 1992.- Exploitation of the date mussel, *Lithophaga lithophaga*: problems and prospects. *Boll. Mus. Ist. biol. Univ. Genova*, 56-57: 5-32.

Biological control of marine biofouling

Uriel N. SAFRIEL[1], Yosef COHEN[2], Neta EREZ[1], Daniel GATENO[1], Tamar KEASAR[1] and Yael DOLEV[1]

[1]Department of Evolution, Systematics & Ecology, The Hebrew University of JERUSALEM **(Israel)**
[2]Department of Fisheries and Wildlife, University of Minnesota, ST. PAUL **(U.S.A.)**

Marine biofouling is a mat made of bacteria, sea-weeds, and sessile invertebrates, which develops on man-made objects submerged in the sea. The mat makes the surface of ships' hulls uneven and rough. Due to the rough surfaces friction during movement increases, and speed is reduced. On stationary installations, biofouling intensifies corrosion, increases the mass of the installation and distorts its configuration. To combat biofouling, prior to submergence the object's surface is painted with "antifouling paints", which contain toxichemicals. The toxins initially prevent, later slow down the development of the mat, but eventually fade away. The vessel has to be drydocked, scraped and repainted. Stationary objects are scraped periodically by scuba-divers. These solutions are costly and never foolproof. Striving to improve effectivity the chemical industry produces chemicals of ever-increasing toxicity. The invention of Tributyltin has crossed the threshold between environmentally-safe and environmentally detrimental toxichemical. This chemical poisons the marine biota and damages mariculture.

We explore an alternative solution, biological control by limpets, applied to surfaces that should be protected. Limpets *Patella coerulea* can easily be detached from the shore and transplanted onto metal panels simulating a ship docked in the port of Ashdod, Israel (SAFIREL & EREZ, 1987). The transplanted limpets eat the unicellular algae and sporelings of the larger algae. While foraging for them the limpets crush and dislodge recruits of the fouling invertebrates. We found that the limpets accelerated the detachment and mortality of young recruiting barnacles *Balanus amphitrite*, presumably by repeated running over by the foot, thus undermining the barnacles' hold. Only when barnacles are > ca 1.5 mm in rostro-carinal diameter, they become safe from both physical detaching forces, and limpets.

We found that during winter, when fouling recruitment was slow, 15 limpets reduced the ca 90% biofouling cover of 20 x 20 cm experimental panels down to 1-3%, and barnacles density from 2.6-3.8 to 0.7-0.8 individuals/cm^2. With the commencement of the spring surge of fouling recruitment, the limpets controlling effect steadily deteriorated, but they continued to check the development of the high-mass bryozoan cover by the end of the 8 months-long experiment. The decline in limpets' controlling effect was due to a feed-back loop : heavy settlement of barnacles brought about an initial reduction in control that increased barnacles sizes and density. This induced accelerated mortality among limpets, bringing about a further increase in barnacles' density.

To achieve effective control, it is necessary to measure "Return time", tr, the time it takes a foraging limpet to return to a previously foraged location on the surface, and "Critical time" tc, the time it takes a fouling individual to get established on the surface such that limpets cannot remove it. The preferred density and size distribution of limpets is the one that achieves tr≥tc for the whole surface. The critical time for *Balanus amphitrite* ranges between 3-6 days. The recruitment rate with which the limpets have to deal with can be as high as 0.44 *Hydroides elegans*/cm^2/day and 0.06 *Balanus amphitrite*/cm^2/day.

Return time of *Patella coerulea* depends on its movement pattern. As of transplantation, limpets gradually increase their home range and mould territories. Their rate of movement increases with the density of recruiting algae, on which they forage. But the presence of other limpets also elicits movement, presumably for marking the surface with mucus, as a non-aggressive territorial defense measure. Even when algal density is low, a limpet moves more when there are many than when there are few other limpets on the surface to be protected. To find the optimal control, we develop a mathematical simulation model which is driven by these and other data on the life history of the fouling organisms, and the behavioral ecology of the limpets, obtained in field and laboratory experiments.

REFERENCES

SAFRIEL U.N. and EREZ N., 1987.- Effects of limpets on the fouling of ships in the Mediterranean. *Marine Biology*, 95 : 531-537.