

***Patella caerulea* (Gastropoda, Mollusca) as a key biomonitor for chemical and thermal pollution along the rocky intertidal of the Israeli Mediterranean**

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Patella caerulea is the most common gastropod in the intertidal and splash zone of the rocky habitats of the Israeli Mediterranean, both natural and artificial. Being microalgal grazers, these organisms are constantly exposed to environmental variables, evolutionarily adapted to survive stress conditions of changing ambient parameters. This makes them suitable for studies of the occurrence of pollutants both in water as well as the atmosphere. This study was performed during 1989-1991 along various sites of the Mediterranean shore with special attention to locations occupied by electric power plants using coals, where the cooling heated-up water outflowed onto the rocky shore. Monthly samples were analyzed for heavy metals by flameless NAS for mercury, and by AAS and X-ray probe for other metals. The ecology of the population was studied on marked quadrants, and gonadial activity and GI were examined by serial histological sections.

Table 1 summarizes the results of metals in *Patella* at the sites from Rosh Hanikra on the Lebanese border to Ashdod in the south. Although raised levels of heavy metals were revealed at several sites, the detrimental synergism of pollution and higher water temperature, such as found at Hadera, (the site of the power plant), is evident, especially concerning mercury, zinc, iron and cadmium. This site also demonstrated very high levels of sulphur, chlorine and magnesium. Figure 1 shows the levels of cadmium, copper and lead in two consecutive years, 1989-1990. As evident, on most sites close to the industrial zones an increase in these metals was observed.

Table 1: Metal concentrations in *Patella caerulea* collected along the Mediterranean Sea of Israel: Maximal (µg/g/dry weight) from north to south of the country .

Site	Cd	Cu	Pb	Fe	Hg	Zn
Rosh Hanikra	3.67	7.19	5.53	1505.1	0.0	72.15
Akhziv	5.26	12.75	8.4447	1650.5	0.052	94.78
Akko	5.92	18.37	9.73	1345.8	0.013	94.72
Atlit	3.25	7.81	10.5	1388.3	0.0	75.58
Caesarea	2.10	10.18	9.22	1501.3	0.0	89.86
Hadera (EPP)	4.76	21.00	8.52	3468.0	0.225	219.40
Mikhmoret	2.80	12.82	6.02	1863.4	0.0	83.47
Sidni Ali	1.04	9.10	10.42	1468.2	0.0	53.89
Tel Aviv	2.07	25.12	13.68	2669.9	0.0	95.64
Bat Yam	2.32	11.97	8.80	1526.1	0.0	69.50
Palmsahim	4.42	7.65	5.73	1351.8	0.056	65.10
Ashdod	4.18	17.52	10.31	1852.9	0.0	66.10

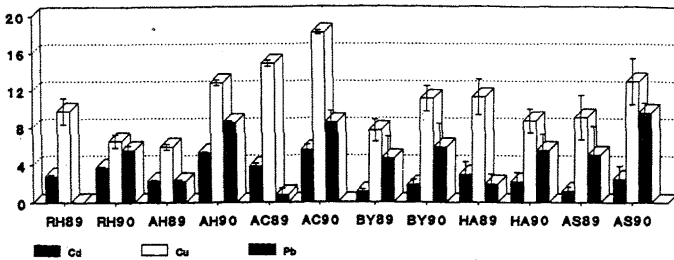
Table 2 compares the levels of three metals as reported from various sites of the Mediterranean. The Israeli material has almost the highest level of pollution.

In *P. caerulea* the levels of metal concentrations of anthropogenic origin demonstrated correlation with the proximity to power plants, both near Hadera (north of Tel Aviv) and near Ashdod (south of Tel Aviv) (Fig. 1). As these sites are in the centre of industrial areas, particularly metallurgical and chemical, we cannot isolate individual polluters, but should see the results as consequences of a possible synergism of all biological active agents.

Table 2: Metal concentration in *Patella* spp. (µg/g/dry weight) from various shores of the Mediterranean Sea (CASTAGNA *et al.*, 1985; RAMELOW, 1985)

Location	Cu	Cd	Pb
Turkey (1985)	3.5-13.7	2.1-40.3	0.3-3.2
Sicily (1985)	6.12-29.3	1.52-6.72	2.34-45.3
Spain (1978)	5.0-10.0	1.1-7.1	2.0-16.0
Lebanon (1978)	11.3-38.0	0.4-4.7	6.8-95.6
Israel (1990)	6.5-46.7	0.5-11.3	0.42-25.9

Figure 1: Selected metals in *P. Caerulea* (µg/g/dry weight) from along the Israeli Mediterranean, in 1989-1990; RH - Rosh Hanikra; AH - Akhziv; AC - Akko; HA Hadera; BY - Bat Yam; AS - Ashdod.



The ecological observations revealed that during summer, at the site of the electric power plant, water temperature in the proximity rises 10-11°C above the normal, reaching 41°C. This eliminates the local population of *Patella* and re-settling occurs during the autumn as water temperature drops back to 22-23°C. Histological observations showed that at such hot points the gonads undergo degenerative processes, leading towards reabsorption of ripening eggs, multiplication of primary ogoni, and hermaphroditism, especially masculinization. Enzyme analysis revealed that at these sites the Cytochrome P-450 showed very low levels. It can be predicted that if such hotwater outflows multiply along the shoreline, the entire population of *Patella* and other intertidal organisms will undergo a process of dramatic change.

REFERENCES

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