

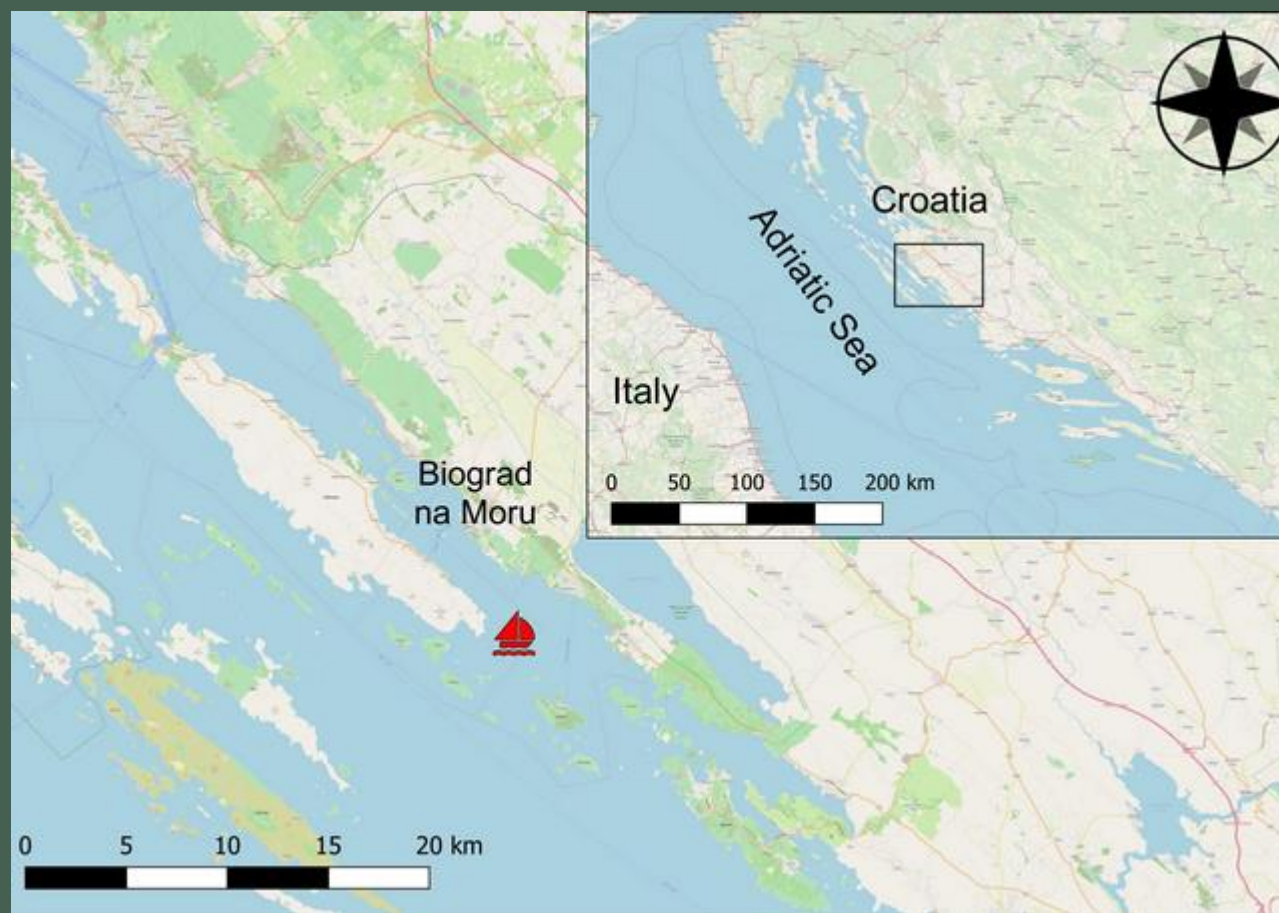


Post medieval cargo - contemporary problem source of mercury in pristine seawater environment (Gnalić, Biograd na Moru, Croatia)

Vlado Cuculić^{*1}, Neven Cukrov¹, Irena Radić Rossi² and Željko Kwokal¹

¹Ruđer Bošković Institute, Division for Marine and Environmental Research, Bijenička c. 54, Zagreb, Croatia

²University of Zadar, Department of Archaeology, Mihovila Pavlinovića 1, Zadar, Croatia



The shipwreck location

1583. - a merchant ship Gagliana Grossa - from Venice (Italy) to Istanbul (Turkey), sank at 25 meters of depth near the islet of Gnalić.

Shipwreck - discovered in 1967; the study of mercury impact on the environment began in 2013. Seawater sampling was performed eight times in six years (2013-2019).

Portion of the mercury from the ship's cargo were meant for medical and cosmetic purposes.



Mercury cargo (500 - 1000 kg) in various forms: elemental mercury, ore cinnabar (HgS), and vermillion powder (HgS , opaque red pigment). Powdered sulphur in cargo indicates the possibility of its use in the vermillion production process.



More than 500 unframed mirrors also contributed to the total Hg amount.

Mirrors - made by applying mercury and tin between two finely processed glasses.





Seawater samples were collected by scuba diving at eight positions 1 to 1.5 m above excavating area (60 x 20 m), as well as in vicinity and on the sea surface above the site. Measurements of mercury species (total, reactive and dissolved gaseous) were performed 24 hours after sampling using CVAAS method.

- We noticed a difference between the results obtained during recovering of the artefacts, cleaning of the hull at the shipwreck site and during the idle state when workspace is conserved.
- During archaeological activities all three measured mercury species, i.e. total, reactive and dissolved gaseous appeared in concentrations up to three orders of magnitude higher in comparison with the average (1.4 ng L^{-1}) found in the Middle Adriatic seawater.
- In the absence of excavation activities, concentrations of mercury species are more than one order of magnitude higher compared to surrounding pristine environment.

- As a part of the sunken ship's cargo, mercury has been a threat to the marine environment for centuries;
- Mercury has been driven even more by archaeological excavations, that have transferred it from the deeper sea floor layers from where Hg is spreading further into seawater producing elevated concentrations;
- Data indicates the need of removal of all forms of mercury, especially elemental (roughly estimated 500-1000 kg) from the seabed in order to stop damaging impact on seawater and sediment, and consequently on marine life.