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ASSESSING RECOVERY FROM HYDROCARBON SPILL EXPOSURE IN MEDITERRANEAN MUSSEL MYTILUS GALLOPROVINCIALIS: A MULTI-BIOMARKER APPROACH

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Oil spills are among the most dangerous and unpredictable marine pollution events, threatening the health of entire ecosystems. In this context, assessing the ability of marine organisms to return to pre-stress conditions is of particular interest and importance. This study investigated the recovery capabilities of the sentinel organism *Mytilus galloprovincialis* following a 4-day exposure to a hydrocarbon mixture (diesel-engine oil, ratio 1:1). Phagocytosis, DNA fragmentation, immune-related enzyme activity, and microbial community composition, were analyzed during recovery in clean seawater (0, 3, 7, 14, and 30 days). Phagocytic activity recovered after 14 days, while DNA damage returned to pre-exposure levels within 3 days, suggesting rapid cellular turnover. Immuno-related enzyme activities (i.e. lysozyme, glutathione peroxidase, esterase and alkaline phosphatase) measured in plasma, gills, and digestive gland exhibited a tendency toward recovery after approximately 14 days, indicating the reversibility of hydrocarbon-induced effects. The hemolymph microbial community showed an increase in the relative abundance of known hydrocarbon-degrading bacterial genera (e.g., Alcanivorax, Oleibacter) at 0 days, which progressively decreased over time, while in the digestive gland, the microbial community showed a shift in favor of polysaccharide-degrading bacteria and antioxidant-producing bacteria after 3 and 7 days of recovery, which could support recovery processes. Overall, the results suggest that *M. galloprovincialis* possesses all the resources necessary to return to pre-exposure conditions, indicating a high potential capacity for resilience after short-term exposure to a hydrocarbon spill. This could be important information to fill gaps in our understanding of the mechanisms underlying recovery processes and the timeframe required for the restoration of homeostasis.