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Fouling assemblages on offshore oil platforms: diverse vertical reefs in the Arabian Gulf

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Coral reefs are one of the most biologically diverse and complex marine ecosystems that are being degraded at rapid rates. This consistent steadily trend is especially critical in coastal areas that have experienced an impressive coastal development, as has been occurring in the Arabian Gulf. This Gulf harbours the coral reefs subjected to one of the most extreme environmental conditions worldwide, i.e. high salinities (often >45 psu) and high sea temperatures ($>36^{\circ}$ during summer season), together with extensive coastal development that have altered significantly the coastal regions of Bahrain, Qatar and UAE. In these countries most of coastal coral reefs have disappeared throughout the last decades because of habitat loss and alteration; however, offshore coral reefs have been away from these extensive disturbances and they may be considered as regional hotspots of corals. Even, the massive presence of submerged structures from offshore oil and gas platforms needs to be taken into account, since preliminary exploratory field surveys have shown a rich fouling community, dominated by a high variety of sessile groups. Thus, the conservation of coral reefs and associated macroinvertebrates and fish could be enhanced by studying the unexplored artificial reefs that grow attached to submerged structures of offshore oil platforms. This objective is currently being pursued in the framework of the project "Connectivity, diversity and genetic flow between offshore natural coral reefs and oil platforms - NPRP No.: 7-1129-1-201". We herein analyzed video footages from oil platforms located at the Al Shaheen Oil Field, ca. 90 km offshore NE Qatar. The visual assessment was done by Maersk Oil Qatar in 2014, via a

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remotely operated vehicle (ROV). The video recordings were done during routine inspections conducted in 20 oil platforms, located at 8 locations. A total of 2000 video files were analyzed to study the relative abundance of Al Shaheen Oil Field's macroinvertebrates, using the CATAMI (Collaborative and Annotation Tools for Analysis of Marine Imagery and Video) classification scheme. This guide has been designed to promote consistency and standards for classifying marine biota and substrata captured in underwater imagery from a broad range of depths (shallow-abyssal) and habitats (temperate reefs, corals, etc.). A total of 17 morphology-based functional groups were identified (Encrusting; Porifera, Octocorallia, Hydrozoa and Bryozoa; Turf: Hydrozoa and Bryozoa; Fleshy arborescent: Antipatharia, and Octocorallia; Hard Coral: Scleractinia; Foliaceous: Hydrozoa and Bryozoa; Barnacle: Cirripedia; Bivalve: Mollusca; Massive simple: Porifera; None Flesh Bushy: Antipatharia, and Octocorallia; Fan Simple: Antipatharia, and Octocorallia; Fan Complex: Antipatharia, and Octocorallia; Whip: Antipatharia, and Octocorallia; Bryozoa: Bryozoa; Anemone: Actiniaria; Unstalked crinoid: Crinoidea; Regular urchins: Echinoidea). The MNCR's (Marine Nature Conservation Review) SACFOR (Superabundant, Abundant, Common, Frequent, Occasional and Rare) semi-quantitative abundance scale was used to study the relative macroinvertebrate abundance. The submerged structures of the oil platforms were studied from 0-60 m depth, divided into 8 depth layers (0-10, 10-20, 20-30, 30-40, 40-45, 45-50, 50-55 and 55-60 m), with time intervals of 30 seconds per layer. PERMANOVA (Permutational Multivariate Analysis of Variance) was used to calculate the similarities among samples using the resemblance of Bray-Curtis similarity. Age and depth were the main factors structuring the sessile macroinvertebrate community in the studied platforms. In contrast, no differences in community structure were found among the platform locations, probably due to the high level of connectivity within the Al Shaheen Oil Field. A total of 8 functional groups contributed >10% to the average dissimilarity of the community (hard coral, fleshy arborescent, foliaceous, encrusting, turf, barnacles, bivalve and massive simple). A clear vertical gradient is apparent for the coverage of epibenthic macroinvertebrates, with diversity and biomass increasing with depth. Encrusting sponges and bryozoans are dominant at shallow depths. Other types of macroinvertebrates become dominant as depth increases, such as foliaceous bryozoans and hydrozoans, massive sponges, bivalves, anemones, crinoids and octocorals. Fleshy arborescent octocorals (*Dendronephthya* sp.) and azooxanthellate scleractinian corals were frequently found on the Al Shaheen oil platforms, at depths greater than 30m. The abundance of both groups tends to increase with depth and the hard corals also tend to be more abundant on older platforms. This study clearly showed that azooxanthellate scleractinian, reef building corals are recruiting and growing on the platforms the Al Shaheen Oil Field, in some cases at high densities. Given that no specimens could be obtained, precise taxonomic identification was not possible, but their morphology suggests they belong to the Caryophylliidae family. This finding is highly significant, given that this type of corals has not previously been reported in Qatari waters. Furthermore, it clearly illustrates the potential of this type of offshore infrastructure to support the establishment of functional reef ecosystems in areas where they are degraded or were previously absent, thus contributing to offset the current net loss of this important type of natural marine habitat.