Abstract

The present study is the first to deal with distributional patterns, reproductive traits and transplantation practices of the gorgonian ocotocoral *Clathraria rubrinodis*, of which its population is uncommon on the Eilat reefs (Red Sea). It deals with basic research and potential practical conservation aspects of this species. Gorgonian octocorals were considered as an order among the sub-class Octocorallia. However, recent studies have led to the conclusion that Gorgonacea is not a valid order and at present its members are assigned to the order Alcyonacea. Gorgonian octocorals are dominant on coral reefs worldwide, especially in the Caribbean. Most previous studies on gorgonians were conducted there and in the Mediterranean, and prior to the current study only a single Indo-Pacific species has been examined. The intriguing relatively low abundance of *C. rubrinodis* on the Eilat reefs led us to conduct an ecological study of this species. Specifically, our objectives were to investigate its distributional patterns, population size structure and reproductive traits, including sexuality, gonadal development, sex ratio and mode of reproduction. The distributional pattern of *C. rubrinodis* was studied using a series of belt transects at five sites in Eilat. Colonies of *C. rubrinodis* were quite rare at most of the sites and depths, with the highest abundance at the Underwater Observatory reef-site at 15 and 20 m and within the Japanese Garden reef-site at 20 m. The local population demonstrated an aggregated distribution, comprised of relatively few large colonies (>20,001 cm^2, 5.8%) and dominated by small ones (<5,000 cm^2, 81.5%). This finding may suggest that colonies of *C. rubrinodis* undergo clonal propagation by fragmentation, a phenomenon that requires confirmation in future studies. We suggest

two alternative hypotheses to explain the low abundance of *C. rubrinodis* in Eilat: the deterioration of Eilat reefs has reduced its population size, and might also have affected its size distribution; or, alternatively, its low abundance might be due to life history traits of this species on the reef there. The reproductive features of *C. rubrinodis* were studied by means of histological sections. The study showed that *C. rubrinodis* is a gonochoric species and reproduces during the summer season (August-November). The maximal diameter of oocytes and sperm sacs are 180 and 200 µm, respectively, and are the lowest reported for alcyonaceans. These findings might be related to the thin coenenchyme and the short gastrovascular cavities of the polyps, which leave only limited space for the gonads. The high abundance of primordial gonads (<50 µm) found in all months implies their slow development until achieving the intermediate stages, followed by rapid maturation in the summer months. This may imply the presence of overlapping oogenic cycles in the colonies or, alternatively, a single oogenic cycle per annum associated with the absorption of immature oocytes. Histological examination of female colonies of *C. rubrinodis* did not reveal brooded planulae. Most gorgonian species studied so far appear to be either internal brooders or external surface brooders. Consequently, it is speculated that *C. rubrinodis* is a planula-brooder. Further studies should be conducted in order to verify its mode of reproduction.

The sex ratio of the population was found to be male-biased (2.7:1), a possible outcome of clonal propagation. The ecological significance and implications of such a sex ratio on the fertilization successes are yet to be studied. Long-term monitoring of the population features is required in order to evaluate the impact of the environmental changes in Eilat

on the population of *C. rubrinodis*, and this will also contribute to reaching an optimal conservation strategy.

The present study examined the practical aspects of transplantation of *C. rubrinodis* by means of artificially-generated transplants and its applicability in Eilat reefs. Additionally, it provided data on their survivorship, growth and branching rates. This was achieved by conducting two sets of experiments. The first was a combined transplantation experiment which involved rearing transplants of three size-classes (2-3, 4-5 and 6-7 cm) over a period of 12 months. The transplants were initially reared for 3 months in running seawater tanks prior to their relocation to natural reef conditions. The second experiment featured a comparative transplantation between running seawater tanks and field conditions, which involved rearing large transplants (6-7 cm) in the tanks and in field conditions for a period of 3 months. The transplants of the combined transplantation experiment demonstrated a significant increase in survivorship, linear growth increment and growth rates in relation to their size. The surprisingly high survivorship rate of all the transplants when reared in tanks (>89 %) indicated resistance to any negative impact the transplantation procedure. However, their later relocation onto the reef resulted in a decline in their survivorship, which was not size-dependent but appears to have resulted from a variety of environmental conditions yet to be identified. Differences in survivorship among the transplants were also related to their source, namely their parent colony. Annual growth rates range from 0.88 cm/y^{-1} for the intermediate-sized transplants to 3.67 cm/y^{-1} for the large-sized ones. Although most transplants of *C. rubrinodis* did not develop new side branches, branching rate was size-

specific**.** The transplants of the comparative transplantation experiment demonstrated a significantly higher survivorship in the running seawater tanks (89%) compared to those directly transplanted at the Oil Jetty and Interuniversity Institute for Marine Sciences (IUI) reef sites (<55%). The transplants placed on the latter reef demonstrated the highest linear growth increment compared to those in running seawater tanks and the Oil Jetty reef. These results can be attributed to differences in environmental conditions among the transplantation sites, such as current regime. Growth rate of the transplants of *C. rubrinodis* was highly correlated to the number of branches per transplant. This further demonstrates that survival of the transplants and their growth rate increase with size of the transplant. The transplantation experiments indicated that branched transplants of *C. rubrinodis* > 6 cm in length, obtained from different parent colonies, offer the optimal means for transplantation practices. The transplants should initially be reared in running seawater tanks, in order to ensure attachment to the substrate, and to obtain higher survivorship and growth rates when transferred to the natural reef.

The studied population of *C. rubrinodis* in Eilat is comprised of 103 colonies and might be on the verge of disappearance there and, therefore, its monitoring and conservation are important. Therefore, it is anticipated that once new colonies of *C. rubrinodis* are formed by transplantation, they will reproduce and consequently sustain the local population in Eilat.