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Coral recruitment to the reefs of Eilat, Red Sea: temporal and spatial variation, and possible effects of anthropogenic disturbances

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Abstract

The accelerating deterioration of the coral reefs of Eilat has raised debate over the exact causes and how they affect the reefs. The hypothesis of the present study was that a low recruitment rate of reef-building coral species may play an important role in the decline of the Eilat reefs. Our goal was to assess spatial and temporal recruitment patterns in Eilat, focusing on examining the possible impact of human activities. The results of coral recruitment to 10 series of ceramic tiles on metal racks, revealed very low overall recruitment relative to other geographical regions. In addition, we found that recruitment rates and recruit survival were lowest at sites closest to the major eutrophication sources in Eilat. The low recruitment rates may be chronically too low to compensate for the elevated coral mortality rates of recent years. The significant differences between the present study and a similar study carried out during the same period using a different method, emphasize the crucial need for a standardized method for recruitment assessment in coral reefs worldwide.

Keywords: Coral reefs; Recruitment; Larvae; Pollution; Red Sea; Eilat

1. Introduction

The coral reefs of Eilat have deteriorated extensively during the last decade (e.g. Fishelson, 1995; Loya, 2004; Loya et al., 2004). Studies dealing with the Eilat reefs have suggested anthropogenic disturbances (e.g. sewage and fish-cage farms) as the main cause for the reefs' regression (Mancy, 1993; Fishelson, 1995; Abelson et al., 1999; Loya, 2004; Loya et al., 2004). At present, however, the exact causes are a source of ongiong debate.

The hypothesis that led to the present study was that low recruitment rates of reef-building corals may play an important role in accelerating the deterioration of the coral reefs of Eilat. Over the last two decades there has been a growing recognition that the rate of recruitment of larvae back to adult habitats can determine patterns of community structure (e.g. Connell, 1985; Gaines and Roughgarden, 1985; Lewin, 1986). Consequently, the pattern and magnitude of recruitment have been suggested as strongly influencing choices of conservation and management (e.g. Brock and Kam, 1994; Dunstan and Johnson, 1998).

Recruitment involves a fragile life stage that can be affected by diverse environmental factors, including human-mediated factors, such as pollution (e.g. Tomascik, 1991; Hughes and Connell, 1999). Despite the

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potential adverse impact of human activities on coral recruitment, until recently there was no attempt to examine coral recruitment patterns in Eilat or the possible effects of anthropogenic disturbances (but see Glassom et al., 2004; Ben Zvi et al., 2004).

Recruitment has three components: the rate of arrival of competent larvae to the site; the probability that larvae will settle on the reef once they arrive; and the probability that new settlers will survive after settling long enough to be censused (Keough and Downes, 1982; Connell, 1985). Low values for any of these components would lead to low recruitment. The aim of the present study was to study coral recruitment to the Eilat reefs: first, by measuring the overall recruitment rates of reef corals to the Eilat coral reefs and comparing them with other reefs; second, by studying variability in recruitment over time (between years) and space (between sites and depths); and finally, by examining possible effects of human-mediated disturbances, by comparing the recruitment pattern in the most disturbed site (i.e. the North Beach; Bresler et al., 1999, 2003; Ben Zvi et al., 2004; Loya et al., 2004) with reference sites at different distances from the North Beach.

2. Materials and methods

Coral recruitment was studied by deploying moored racks of settlement plates at five sites, two depths (10 and 30 m) per site, along the 12 km coast of Eilat, from the 'North Beach' to the southernmost reef knolls across Taba (Fig. 1). The settlement substrata were ceramic tiles, which have been found to be the most suitable settlement surface in a comparative study that examined various plate types for experiments on the recruitment of stony corals (Harriott and Fisk, 1987). The plates were mounted on moored racks made of galvanized metal mesh, in a similar setup to that described by Sammarco and Andrews (1988). The racks were designed so that 12 sets of two tiles were attached to both sides of the mesh and suspended vertically, from one to three meters above bottom. The plates were collected by divers and placed in protective carrying cases to prevent movement and minimize abrasive damage to the young settlers. They were then taken to the lab and immersed in deep trays for examination under a dissecting microscope. All coral settlers at any developmental stage were counted, recorded and their condition documented. Subsequent to the microscopic examination, plates were returned carefully back to their exact spots on the racks to enable long-term monitoring of recruitment and survival rates.

Plate censuses occurred after two short-term (5 months each) and three long-term (one year each) sampling intervals. The short-term censuses were carried out in Sept. 1998 and Feb. 1999, following deployment of plates in May 1998. The long-term censuses were carried out in 1998, 1999 and 2000, following a one year sampling interval.

Recruitment to natural substrates in the field was quantified from 112 10×20 cm quadrats, which were placed haphazardly on the reef at four sites (Fig. 1). The four sites were chosen to extend the spatially extent of the sampling further down the coast of Sinai, where moored sampling was not feasible. Each of the quadrats was censused for new recruits, using 1×1 cm grids and a 2× magnifying lens. All visible spat up to 2 mm in diameter were counted.

Statistical analyses were conducted using *Statistica 6*. A non-parametric Kruskal–Wallis Rank test was used to

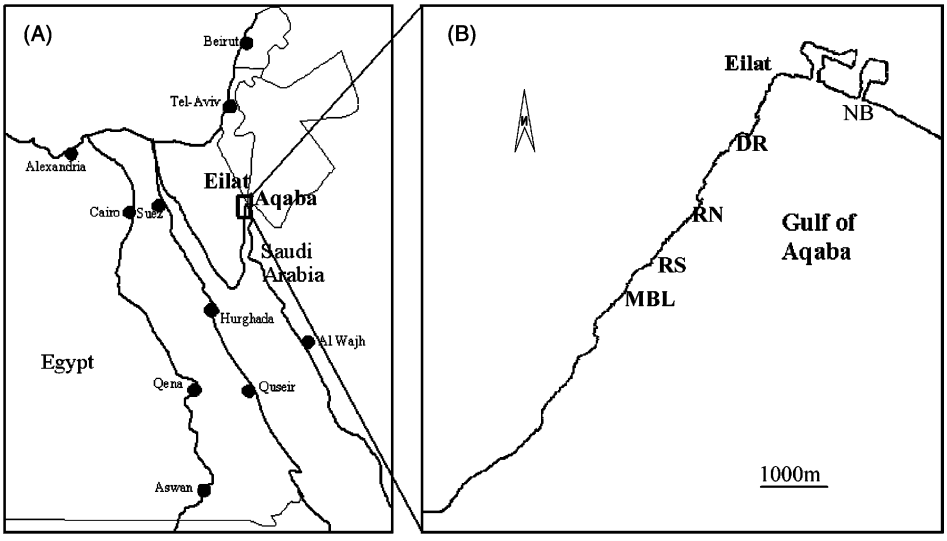

Fig. 1. (A) Regional map of the northern Red Sea and Gulf of Aqaba, and (B) a local map of the study sites along Eilat coast (Gulf of Aqaba, Red Sea). (NB) North Beach, (DR) Dolphin Reef, (RN) Nature Reserve-North, (RS) Nature Reserve-South, (MBL) Marine Biology Lab.