Status of the coral reefs after the Gulf War

Helge Vogt

Abstract: Selected sections of coral reefs in Saudi Arabia were monitored over a one year period in order to detect any changes that may have occurred as long-term effects of the Gulf War oil spill. In June 1992, 10 permanent transect lines were established; three on inshore reefs in Dawhat ad-Dafi and close to Abu Ali, and seven on offshore reefs surrounding the islands of Karan, Kurain and Jana. Six of these transects were revisited in February 1993 and eight in May/June 1993. A band along each transect, 0.5 m wide and 50 m long, was recorded with a S-VHS video camera. All video pictures were then examined by a computer image-analysis system. Maps of each transect were drawn and the live coral cover calculated. A comparison of the results obtained during the subsequent recordings showed that little change in live coral cover had occurred. During all the periods of fieldwork no abnormal numbers of dead corals were found in any part of the reefs. These findings suggest that no short-term or long-term changes can be attributed to the Gulf War events. Although some reefs in Kuwait show signs of stress and coral bleaching, which may partly be related to the effects of the Gulf War events, no such signs were observed on the Saudi Arabian reefs.

INTRODUCTION

The coral reefs in the Arabian Gulf occur in an environment with great extremes of temperature and salinity, as well as high turbidity (Sheppard & Wells 1988). Normal winter water temperatures in the Gulf are amongst the lowest at which coral reefs exist (Downing 1985). Intermittent cold periods can lower the water temperatures well below normal conditions (Shinn 1976) and in 1988/89 the lowest temperatures ever recorded in a coral reef area were measured by Coles & Fadlallah (1991). In these harsh conditions few coral genera are able to survive, the number of species is thus considerably reduced compared with the other regions surrounding the Arabian Peninsula (Sheppard & Sheppard...
Within Saudi Arabian territorial waters, most coral reefs are located offshore (Plate 1) because of temperature fluctuations, high salinities and sedimentation along the coast (BASSON et al. 1977). In some areas salinities may exceed 60 ppt, thus prohibiting the development of coral reefs (SHEPPARD & WELLS 1988). Nevertheless, poorly developed fringing reefs do occur close to the shore, e.g. north of the peninsula of Abu Ali (Plate 2). Offshore, patch or platform reefs range in size between 2 and 31 ha (MCCAIN et al. 1984) and occur abundantly (SHEPPARD & WELLS 1988, Plates 3, 4). However, the best developed and most diverse reefs in terms of species richness are located around six Saudi Arabian islands.

In early 1991, the reef habitats came under serious threat as several million barrels of oil (MCKINNON & VINE 1991) drifted towards the inshore and offshore reefs (MEPA 1991). This oil could have had an impact on the corals by covering and consequently smothering the colonies. In addition, toxic components of crude oil can have a detrimental effect on the viability of coral larvae and may lead to a reduced rate of reproduction of the corals (LOYA & RINKEVICH 1980). Temperature reductions caused by the plume of the Kuwaiti oil fires may also have posed another serious threat to the reefs in the Gulf which are known to live close to their distribution limits.

In order to monitor potential changes in the reefs that might occur as long-term effects, 10 permanent study sites were established on inshore and offshore reefs. Recordings were made at these sites up to three times during periods of fieldwork in July 1992, February/March 1993 and May/June 1993.

**MATERIALS AND METHODS**

Permanent reference stations (Table 1) in the offshore reefs were set up by placing seven transect lines perpendicular to the shoreline of the islands of Karan, Kurain and Jana. On the inshore reefs, two transects were established perpendicular to Abu Ali Island and one was placed on the reef top of “Pole” Reef, located in the Dawhat ad-Dafi. The 50 m transect lines were tied to corals at intervals of roughly 10 m. The positions of the lines were marked by buoys and their locations recorded by GPS. The same lines were used for fish counts by
Table 1: Percentages of live coral cover of the transect areas.

<table>
<thead>
<tr>
<th>Transect number</th>
<th>Location</th>
<th>Area</th>
<th>Coordinates (N/E)</th>
<th>July 1992</th>
<th>Feb./Mar. 1993</th>
<th>May-June 1993</th>
<th>SD</th>
<th>max. diff. betw. 2 recs</th>
</tr>
</thead>
<tbody>
<tr>
<td>T 1</td>
<td>Jana</td>
<td>offshore</td>
<td>27°21'39&quot; 49°54'15&quot;</td>
<td>26</td>
<td>27</td>
<td>26</td>
<td>0.27</td>
<td>1</td>
</tr>
<tr>
<td>T 2</td>
<td>Jana</td>
<td>offshore</td>
<td>27°22'02&quot; 49°54'45&quot;</td>
<td>26</td>
<td>33</td>
<td>27</td>
<td>3.55</td>
<td>7</td>
</tr>
<tr>
<td>T 3</td>
<td>Jana</td>
<td>offshore</td>
<td>27°21'13&quot; 49°53'41&quot;</td>
<td>43</td>
<td>54</td>
<td>50</td>
<td>5.33</td>
<td>11</td>
</tr>
<tr>
<td>T 4</td>
<td>Kurayn</td>
<td>offshore</td>
<td>27°38'49&quot; 49°49'09&quot;</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T 5</td>
<td>Kurayn</td>
<td>offshore</td>
<td>27°39'16&quot; 49°49'10&quot;</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T 6</td>
<td>Karan</td>
<td>offshore</td>
<td>27°43'05&quot; 49°50'12&quot;</td>
<td>38</td>
<td>44</td>
<td>4.72</td>
<td>6</td>
<td></td>
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<tr>
<td>T 7</td>
<td>Karan</td>
<td>offshore</td>
<td>27°42'25&quot; 49°49'28&quot;</td>
<td>13</td>
<td>20</td>
<td>4.85</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>T 8</td>
<td>Pole reef</td>
<td>inshore</td>
<td>27°19'14&quot; 49°25'16&quot;</td>
<td>11</td>
<td>15</td>
<td>3</td>
<td>5.82</td>
<td>12</td>
</tr>
<tr>
<td>T 9</td>
<td>Abu Ali</td>
<td>inshore</td>
<td>27°21'05&quot; 49°30'55&quot;</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>T 10</td>
<td>Abu Ali</td>
<td>inshore</td>
<td>27°21'10&quot; 49°32'21&quot;</td>
<td>14</td>
<td>12</td>
<td>16</td>
<td>2.00</td>
<td>4</td>
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<tr>
<td>Jana reefs average</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
<td>38</td>
<td>34</td>
<td>2.90</td>
<td>6</td>
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<tr>
<td>Inshore reefs average</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>20</td>
<td>17</td>
<td>1.28</td>
<td>3</td>
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</tbody>
</table>

other team members (KRUPP & MÜLLER 1994) in order to allow for a comparison between specific coral habitats and their fish communities. All underwater work was done by SCUBA diving.

All transects were recorded using a S-VHS-C camera in a handmade underwater housing. In order to obtain defined areas, squares of 50 x 50 cm were placed on the reef. The squares consisted of 21 aluminium bars, which were stretched between two 10 m cords running on either side. This ladder-like structure allowed 20 squares to be placed on the reef at the same time. Once the first 10 m of the transect were filmed with the video system all the squares were rolled onto a plastic tube and then placed on the next 10 m section of the transect. The aluminium bars of the squares also served as scaling bars.

Several video recordings were obtained north of the islands where the prevailing strong northerly winds prevented the time-consuming establishment of transects.

**Video image analysis:** Images were analysed by using a "Macintosh IIsi" computer with a built-in "Screen Machine" framegrabber card. The "Screen Machine"s" hardware and software allowed the display and the storing of video images on the computer system. The digitized images were then used to calculate the coverage of corals by employing the "NIH Image"-programme described by LENNARD (1990).

During the first step of the analysis process the digitized image covering an area of one square was temporarily displayed on the computer monitor. All objects within the squares were then outlined and filled with false colours, thus colour-coding all species and substrate types. All images were then shrunk and fitted into a map form with each sheet containing up to 28 images. This process was conducted for 1525 images with all images being represented in a total of 64 colour-coded maps. On each map the areas covered by species or substrate type were calculated by the use of the "NIH Image"-programme.

**RESULTS**

In general, live coral coverage (Table 1) ranged from poor to good. In July 1992, it varied from 11 to 43 % with an average of 26.7 %. The live coral cover increased with increasing water depth down to about 6 m. Below this water depth, coral cover gradually became sparse and corals mostly occurred as single colonies.

The average amount of live coral cover was stable during the year of investigation. At Jana Island where three transects were recorded three times, the average live coverage varied only between 32 and 38 %. The two transects at Karan were only recorded twice; between these two recordings, in July 1992 and June 1993, the difference in live coral coverage was 6 and 7 %. No range can be given for the two transects at Kurain because they were recorded only once. At all three inshore reefs the range of variation in the average value for live coral coverage was between 17 and 20 %.
Plate 2: Nearshore reefs are mainly composed of a single species of coral (Porites compressa). This photograph was taken at a fringing reef north of Abu Ali Island.

Plate 3: Offshore coral reef at Kurain Island. This reef is dominated by Acropora.

Plate 4: An abandoned fishing net causes damage to a coral reef at Kurain Island.
DISCUSSION AND CONCLUSIONS

The results indicate little differences between the recordings of the transects. The maximum difference in live coral coverage between any two recordings along the same transect ranged from 0 to 12 % with standard deviations for all recordings along a transect varying between 0 and 6 % (Table 1). The actual differences are even lower because the data do not always reflect real changes in live coral coverage. Most of the recorded differences are due to seaweeds temporarily overgrowing coral, thus reducing the visible coral coverage, mistakes caused by changing locations of the lines and errors of the recording and analysing system (VOGT 1994).

These figures clearly indicate that live coral cover was not in a state of decline but remained stable, on a poor to good level.

In May 1992, FADLALLAH et al. (1993) found numerous dead coral colonies, corals with tissue degradation or in a state of bleaching in Kuwait. EAKIN et al. (1993) analysed stress bands in coral skeletons in the same area and found that corals, especially from Qi’tat Urayfijan, showed definite signs of stress. Bleaching related to stress and coral mortalities have been observed in earlier years in this area by DOWNING (1985). According to FADLALLAH et al. (1993) and EAKIN et al. (1993) the damage could be partly caused by the effects of the Gulf War and may be related to oil releases, smoke clouds, sewage and pollutant releases. However, natural and anthropogenic stresses may have had synergistic effects.

In November/December 1992, a more comprehensive investigation of the most important coral reefs in Kuwait was conducted by DOWNING & ROBERTS (1993). It showed that only limited mortalities had occurred at the reefs surrounding the islands of Kubbar, Qaru and Umm al-Maradem. At Qi’tat Urayfijan evidence of impact was observed but recovery was well advanced. The authors stress that although effects of the Gulf War may have contributed to the observed mortalities, they may have had only a minor influence compared to other environmental factors.

Personal observations and the findings of ROBERTS (1993), CAVA & EARLE (1993) and Anon. (1993) show that no comparable damage to corals was observed in Saudi Arabian reefs. Occasional findings of bleached Acropora specimens are believed to be caused by natural disturbances (Anon. 1993). No visible damage that may be attributed to oil was observed at any part of the reefs. This is despite the fact that the coastlines of the inshore and offshore islands were severely affected by oil.

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REFERENCES


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