the top in each genotype was used for rearing. The fresh leaves were provided daily after cleaning the tins. The total number of larvae and average weight of ten larvae were recorded at 5 days interval and pupae were kept in egg laying cages for moth emergence. Fresh groundnut plants wrapped with wet cotton were provided for egg laying. The total number of eggs in a mass was counted using a magnifying lens.

The S. littoralis larvae reared on mutants 28-2 and 45 consistently showed less leaf damage (Figure 1), high mortality, low weight and low gain in weight compared to susceptible check and parents at all the stages (Table 2). On these criteria, the mutants were comparable or even superior to resistant check. The mortality and the low gain in weight were very much pronounced especially at the early stages of the larval period indicating the effect of the existing resistant factor on neonate larvae. The resistance effect of these mutants also extended the larval period by three days and had pronounced effect on the fecundity of moths. The mortality at initial stages, low larval weight, extension of larval period and low fecundity indicate the possible role of antibiotic as a mechanism of resistance in mutants 28-2 and 45 (ref. 9). The resistant mutants along with their parents can constitute the most ideal material to establish the role of specific chemicals affecting the insect pest.

The mutants (28-2 and 45) were earlier found to be resistant to late leaf spot disease and early maturing with good pod and kernel features. Therefore they can be widely tested for their suitability in commercial cultivation. The pest and disease resistant nature of these mutants can be profitably exploited in future breeding programmes.


Received 28 February 2000; revised accepted 25 May 2000

M. N. RAJENDRAPRAKASH
M. V. C. GOWDA
G. K. NAIDU
Department of Genetics and Plant Breeding,
University of Agricultural Sciences,
Dharwad 580 005, India
*For correspondence.
e-mail: rc@zrc.kar.nic.in

On the coral reefs of the Gulf of Kachchh

The Gulf of Kachchh (22°15’ to 23°40’N and 68°20’ to 70°40’E) is a 7350 km² east-west oriented indentation lying between the Kachchh mainland and the Saurashtra Peninsula. The only reported site for coral formations in the Gulf of Kachchh is between 22°20’N and 22°40’N latitudes and 69° and 70°E longitudes along the coast of Jamnagar district.

Based on the existing classifications these reefs are grouped into fringing reefs (north of Okha, north of Beyt Shankhodar, fringing the mainland from Dhani beyt to Sikka, Jindra and Chad, Pirotan, near Valsura), platform reefs (Paga reefs, Bural Chank, Karumbhar, Mundre reef, etc.), patch reefs (Goos and Ajad) and several coral pinnacles (e.g. Chandri, etc.)

Observations on the coral reefs of the gulf using satellite imageries have so far been restricted only to the intertidal reefs because of the limitations in depth penetration of the sensors. The reefs get exposed only during low tides. As a result, available imageries and existing data from the Gulf of Kachchh are only

2. Shukla, R. M., Coral Reefs of India, New Delhi, 1986.
Table 1. GPS positions of existence of live corals in the sub-tidal zone of the Gulf of Kachchh

<table>
<thead>
<tr>
<th>Station</th>
<th>GPS position</th>
<th>Depth (m)</th>
<th>Substratum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okha (Beyt Shankhodar)*</td>
<td>22°25’19’’N 069°05’06''E</td>
<td>8</td>
<td>Coral, coralline sand, muddy</td>
</tr>
<tr>
<td>Boria*</td>
<td>22°24’42’’N 069°13’12’’E</td>
<td>5-8</td>
<td>Coral, sand</td>
</tr>
<tr>
<td>Karambhar*</td>
<td>22°26’72’’N 069°37’99’’E and 22°27’84’’N 069°37’07’’E</td>
<td>6-9</td>
<td>Coral, rocky</td>
</tr>
<tr>
<td>Pirotan*</td>
<td>22°37’06’’N 069°57’49’’E and 22°37’27’’N 069°58’27’’E</td>
<td>5-8</td>
<td>Rocky</td>
</tr>
<tr>
<td>Mungra reef**</td>
<td>22°46’39’’N to 22°46’67’’N 07°00’08’’E to 70°10’82’’E</td>
<td>15-25</td>
<td>Muddy, rocky</td>
</tr>
<tr>
<td>Munda**</td>
<td>22°42’88’’N to 22°45’14’’N 06°18’65’’E to 06°40’11’’E</td>
<td>8-20</td>
<td>Rocky</td>
</tr>
<tr>
<td>Mandvi**</td>
<td>22°47’07’’N to 22°47’61’’N 06°14’36’’E to 06°14’86’’E</td>
<td>5-15</td>
<td>Rocky</td>
</tr>
</tbody>
</table>

*Diving sampling; **Dredge and grab sampling.

Table 2. Sub-tidal coral biodiversity along the Gulf of Kachchh

<table>
<thead>
<tr>
<th>Station</th>
<th>Stony corals</th>
<th>Soft corals</th>
<th>Associated fauna</th>
<th>Associated flora</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pirotan*</td>
<td>Favia favus, Favites melicerum, Goniopora nigra, G. planulata, Montipora sp., Platygira sinensis, P. compressa, Tubastrea aurea</td>
<td>Gorgonians</td>
<td>Perch fish, paffer fish, Sabella sp., sea anemone, Sponges, Acanthaster planci, bryozoans, gastropod, Bonellia sp., crabs, Panularia polyphagma (spiny lobster), Lysocarpsus colony</td>
<td>Caulerpa, Codium, Ulva, coralline algae, Enteromorpha, Gracilaria, Hypnea, Padina, Sargassum, Solieria</td>
</tr>
<tr>
<td>Boria Reef*</td>
<td>Montipora sp., Porites sp., Tubastrea peltata</td>
<td>Dendronephthya dendrotheca, D. brevira, gorgonians, Nephthya sp.</td>
<td>Sea lily, bryozoans, gastropods, crabs, sponges</td>
<td>Caulerpa, Codium, coralline algae, Gracilaria, Halimeda, Hypnea, Kjellmania, Sargassum, Solieria</td>
</tr>
<tr>
<td>Mungra reef</td>
<td>Young polyps – colony of Tubastrea sp., Porites sp.</td>
<td>Gorgonians</td>
<td>Bryozoans, gastropods, crabs, polychaetes, sponges, sea urchins</td>
<td>Ulva, coralline algae</td>
</tr>
<tr>
<td>Munda</td>
<td>Young polyps – colony of Tubastrea sp., dead Acropora pieces</td>
<td>Gorgonians</td>
<td>Halothuria sp., brittle star, Antedon, sea urchins, gastropods, Membranopora</td>
<td>Coralline algae</td>
</tr>
<tr>
<td>Mandvi</td>
<td>Young polyps – colony of Tubastrea sp.</td>
<td>–</td>
<td>Sponges, bryozoans, Membranopora, barnacle, gastropods, oyster spats</td>
<td>Dictyota bartleysiana</td>
</tr>
</tbody>
</table>

*All the coral forms and associated fauna were identified by Manitala I. Patel, Commissionerate of Fisheries, Government of Gujarat, Gandhinagar.

from those reefs and reef flats which are shallow, inter-tidal and get exposed during low tide.

Considering the limitations of satellite imagery and the absence of information from the deeper zones of the coral reefs of the Gulf of Kachchh, we thought it will be interesting and worthwhile to have a view of the sub-tidal regions of the coral reefs which never get exposed during low tides. This article reports the existence of live corals at the sub-tidal regions. It redefines the eastern and northern limits of coral distribution in the gulf.

While surveying the Gulf of Kachchh for the Department of Ocean Development, Govt. of India, New Delhi, under their ICMAM (Integrated Coastal and
Marine Area Management) studies in October 1998, a few live coral polyps were collected by grab sampling at Mungra, off Jodia (Figure 1). Further investigations on these sub-tidal areas were carried out in two stages: a) Investigating the sub-tidal coral reefs by SCUBA diving, around four of the islands, namely Piroton, Karumbhar, Boria and Beyt Shankhodar in February 1999; b) Grab and dredge samplings during two CRV Sagar Paschimi cruises during March 1999 and February 2000 (Figure 1). Five grids were examined during the first cruise at Okha, Karumbhar, Piroton, Mungra (on the eastern Gulf) and Mundra (northern Gulf) by grab sampling only. A few live corals with associate fauna and flora were collected in grab samples from Mungra and Mundra. As this was the first report on the occurrence of live corals from those two areas (M. I. Patel, personal discussions) the survey was repeated using a shallow water chain dredge in February 2000. One more grid at Mandvi (northern side) was added during the second cruise. Details of the diving and dredging sites are presented in Table 1.

Live corals – both soft and stony are abundantly present in the sub-tidal regions of the reefs at various stages of growth. The genera observed for stony corals are: Favia, Favites, Goniopora, Montipora, Sinularia, Tubastrea, Turbinaria and broken branches of Acropora. The soft coral genera are Dendronephthya and Nephthya. Stony corals dominate the Piroton reef while soft corals dominate the other reefs. A total of 12 species of stony corals, 7 species of soft corals, 28 species of benthic marine algae and 23 species of benthic fauna could be recorded during the underwater survey (Table 2).

The abundance of live corals decreased from the inner to the outer reefs, from 75 to 80 per cent at Piroton and Karumbhar to around 50 per cent at Boria and Beyt Shankhodhar. Siltation varied from moderate to fairly high from the inner to the outer reefs. Underwater tidal currents were stronger at the inner reefs.

The Mundra reef and Piroton island mark the northernmost extent of coral patches and the easternmost limit is the Mungra reef near Jodia (Table 1, Figure 1). Solitary corals are believed to exist as far as Jakhau in the north and Dwarka on the Saurashtra coast.

The dredging survey off Mundra, about 2–3 km off Adani Port, covering an area of around 8 km² revealed a plethora of live corals, Tubastrea sp. and live polyps with plenty of gorgonians, soft coral Dendronephthya sp., bryozoans, brittle star, sea urchins, holothurians, polychaetes with the algae Ulva sp. and dead Acropora branches. This area seems to be a place of growing corals (Figure 1). Dredging off Mandvi covering 3.5 km² revealed similar assortment of live corals with their associate flora and fauna. These pioneering observations led us to conclude that a considerable area in the northwestern Gulf of Kachchh has live corals. Details are presented in Table 2. Inclusion of these sub-tidal live corals will certainly change the currently held belief that there are 20–30% corals in the Gulf of Kachchh which are alive.

The number of scleractinian coral species reported earlier from the Gulf vary from 37 belonging to 22 genera to 44 species of stony and 12 soft coral species to 40 species of 23 genera and 3 species of soft corals. This fragile and isolated ecosystem that contributes to the shore stability needs to be further investigated. It will soon be subjected to increasing stress with ever increasing oil import activities in the Gulf of Kachchh.

We opine that corals always existed off the northern coast of the Gulf, but were covered by the prograding sediments from River Indus. The rate of sedimentation is very high on the northern shores, which leaves the southern shores almost starved of sedimentation because of the existence of a dynamic barrier in between created by the high velocity tidal stream flowing through the central channel of the Gulf. During the recent years it has been concluded that the sediment outflow from River Indus has reduced to 50 x 10⁶ tonnes yr⁻¹ from the earlier 250 x 10⁶ tonnes yr⁻¹ because of the construction of several barriers across the river. It is very probable that the corals may have come back to life with the reduction in the amount of sediment. This is, perhaps, evident from the abundance of polyps and small growing corals with little or no marine algal growth.


ACKNOWLEDGEMENTS. We thank the scientist-divers from the National Institute of Oceanography, Dona Paula, Goa. We also thank Mr. M. I. Patel, Commissionerate of Fisheries, Govt. of Gujarat, for identifying the corals and the sub-tidal fauna, Mr. R. Venkatesan of National Institute of Ocean Technology, Chennai for fabricating the dredge. Mr. Jayendra Lakhmaparkar for help in mapping, Dr. B. R. Subramanian of ICMAM Project Directorate of DOD, Chennai for making the ship available and the Gujarat Ecology Commission, Vadodara for financial help.

Received 13 March 2000; revised accepted 25 May 2000

Geetanjali Deshmukhe
K. Ramamoorthy
R. Sen Gupta

Gujarat Ecological Society,
5 Golden Apartment, Subhanpura,
Vadodara 390 023, India

*For correspondence.
e-mail: gesbrdi@vnsl.com