SUMMARY

Lakshadweep is a group of coral islands situated in the Arabian Sea between 08°00' and 12°30'N Latitude and between 71°00' and 74°00' Longitude. The archipelago consists of 27 islands and a number of sunken banks and open reefs. Of these, 10 islands are inhabited by man. Our knowledge on the distribution and availability of living marine resources, dynamics of the important physical, chemical and biological parameters in the lagoons, growth of corals, maintenance of the system and status of the environment is meagre. The present study, hence, attempted to widen our knowledge on the above aspects and results of which are summarised below.

Results of the faunistic survey conducted at Kavaratti, Kalpeni, Agatti, Bangaram, Amini, Kadmat and Chetlat Islands for corals and reef associated echinoderms, crustaceans, molluscs, and fishes revealed the presence of a large number of species.

A total of 110 species of corals divided among 40 genera and 15 families have been recorded; out of this 22 species are new records to Lakshadweep. Genera like Herpolitha, Leptoseris, Oulophyllia, and Pachyseris have not previously been recorded from Lakshadweep. Maximum number of species were recorded from Kavaratti, and minimum from Kadmat. Though certain islands harbour good number of species, their distribution is patchy, and area of live coral cover was found to be less. Twenty two species were found to be common to all the islands surveyed.

Altogether 50 species of crustaceans, divided among 32 genera and 18 families have been recorded. Out of these, 41 species were crabs, 2 species were lobsters and 7 species were prawns. Kavaratti Island has the highest number of species (37) and lowest in Amini (20). Eight species were found to be common to all the islands surveyed. These islands were not found to possess any substantial resource of crustaceans which could
be exploited on a commercial level. Sea ranching and culture programmes could improve the stock of lobsters and edible crabs.

Fourty six species of echinoderms divided among 31 genera and 19 families were noted in the survey. Out of these the species *Mithrodia clavigera* is a new record from Lakshadweep. Holothuroidea showed domination with 16 species. Maximum number of species were recorded from Kavaratti (42) and minimum from Bangaram (18). The starfish-*Acanthaster planci* was found to occur in Kalpeni lagoon. Thirteen species were found to be common to all the islands surveyed. Of all echinoderms, the commercially important forms from Lakshadweep are holothurians used in *beche-de-mer* industry. Four species of these were found to be available in substantial quantity. Since the exploitable area is limited, these islands may not withstand large scale commercial exploitation. There is possibility for culture and farming of holothurians, which could be tried to increase the production.

There were 230 species of molluscs divided among 87 genera and 60 families in the present survey, of this 37 species come under bivalves, 5 species under cephalopods and 188 species under gastropods. Total number of species was highest in Kavaratti (190) and lowest in Amini (70). Thirty five species were found to be common to all the islands surveyed. Gastropods ranked highest in all the islands. Micromolluscs and deep water forms were not covered, and many more species are likely to occur. The survey indicated a remote possibility for large scale commercial exploitation. However, some species of gastropods, cephalopods and bivalves have potential for commercial farming.

There found to be 120 species of lagoon and reef associated fishes, belonging to 67 genera and 35 families. Out of this, two species – *Forcipiger flavissimus* and *Pygoplites diacanthus*—were recorded for the first time from Lakshadweep. The family *Labridae* with 13 species was found to be dominating. Species abundance was highest in Kalpeni (105) and lowest in Amini (57). Fourty two species were found to be common to the islands
surveyed. The survey indicated the availability of a large number of species of ornamental value.

Hydrobiological studies were carried out in Kavaratti Atoll, which is a perfect atoll, situated along Lat. 10°33'N and Long 72°38'E. The lagoon is 4,500 m long and 1,200 m wide, having a maximum depth of 1.8 m at low tide and 3.5 m at high tide.

Samples were collected from 5 stations inside the lagoon and one station outside the lagoon on fortnightly interval for the studies on the hydrographical conditions. Productivity of phytoplankton, and seagrasses was studied for one year and production from three species of corals for two years. Zooplankton samples were collected from 4 stations at day and one station at night for the entire period of study. Diurnal studies on hydrographical parameters and on the occurrence and abundance of zooplankton were carried out in one station.

Variation in water temperature between stations were insignificant. Between stations the temperature variation was within 29.32 and 29.63°C. Temperature decreased during monsoon due to the seasonal variation in atmospheric temperature. Temperature increased during day and decreased at night.

There was no variation in pH and salinity with location of stations. Average variation in pH was between 8.12 and 8.18 and that of salinity between 34.26 and 34.5%. Both these parameters exhibited seasonal variation by a decrease during monsoon. Temperature, pH and salinity were positively correlated, which explains the diurnal variation in pH, and salinity.

Dissolved oxygen concentration was high in lagoon stations than the open sea station. The variation between stations was from 4.58 to 5.37 ml/l. The high photosynthetic activity in the lagoon by the benthic and symbiotic plant community accounts for this. High photosynthetic activity during day increases oxygen concentration, and intense respiration at night decreases the dissolved oxygen concentration.
Concentration of silicate, phosphate, nitrite and nitrate was very low. Except nitrate, all other parameters showed highest concentration in open sea, indicating their uptake in the lagoon. Nitrate was slightly higher in the lagoon due to the high rate of fixation in the form of nitrate by nitrogen fixing agents in the lagoon. Average variation in silicate between stations was from 3.50 to 4.54 \(\mu\text{g at/l}\), phosphate 0.26 to 0.35 \(\mu\text{g at/l}\), nitrite 0.54 to 0.71 \(\mu\text{g at/l}\) and that of nitrate from 0.11 to 0.13 \(\mu\text{g at/l}\). Except silicate, all other parameters showed definite diurnal variation with an increase at night and decrease during day indicating the relation between light and photosynthesis related utilization of these nutrients in the lagoon. This suggests the role of seagrasses and algal communities in the recycling of nutrients within the lagoon community. Except nitrate all these parameters decreased during monsoon, which may be due to the relation between light, photosynthesis, assimilation and fixation.

The lower concentration of calcium in all the lagoon stations than the open sea station indicated the high rate of precipitation by calcifying organisms. The average range of variation between stations was within 422.56 to 433.97 mg/l. Since calcification is strongly light dependent, the lower light intensity during monsoon reduced precipitation of calcium which increased the concentration of calcium during monsoon. The day time decrease and increase at night of calcium also suggests the role of light in precipitation.

Temperature, pH, salinity and dissolved oxygen increased with decreasing tide and phosphate, nitrite, nitrate and calcium showed a reverse trend, whereas silicate did not show any relation with tide.

Gross primary productivity of phytoplankton varied between 0.62±0.01 to 6.09±2.48 mgC/m\(^3\)/hr and net production between 0.20±0.13 to 1.46±0.85 mgC/m\(^3\)/hr. Highest production was during post-monsoon which amounted to 4.75±0.93 mgC/m\(^3\)/hr (gross) and 0.593±0.49 mgC/m\(^3\)/hr (net). The lowest was during monsoon, the values being 1.03±0.33 mgC/m\(^3\)/hr (gross) and 0.405±0.21 mgC/m\(^3\)/hr (net).
Productivity of the seagrass *Thalassia hemprichii* ranged between 0.281±0.10 and 1.370±0.29 mgC/g/hr (gross), and 0.154±0.10 and 0.769 ±0.26 mgC/g/hr (net). Production was maximum during pre-monsoon 0.902±0.44 mgC/g/hr (gross) and 0.556±0.26 mgC/g/hr (net) and minimum during monsoon 0.405±0.11 mgC/g/hr (gross) and 0.225±0.06 mgC/g/hr (net).

Minimum and maximum gross and net production of *Syringodium isoetifolium* was 0.255 ±0.10 and 0.812 ±0.10 mgC/g/hr (gross) and 0.175±0.13 and 0.494±0.10 mgC/g/hr (net). Highest production was during pre-monsoon (0.575±0.16 mgC/g/hr (gross) and 0.321±0.11 mgC/g/hr (net)) and lowest during monsoon (0.368±0.10 mgC/g/hr (gross) and 0.246±0.07 mgC/g/hr (net)).

Production from corals was found to be maximum during post-monsoon, the values being 0.045±0.01 mgC/g/hr (gross) and 0.020±0.003 mgC/g/hr (net) from *Porites cylindrica*, 0.052±0.01 mgC/g/hr (gross) and 0.025±0.01 mgC/g/hr (net) from *Acropora formosa* and 0.081±0.02 mgC/g/hr (gross) and 0.048±0.01 mgC/g/hr (net) from *Pocillopora damicornis*. Lowest production observed was during monsoon and highest during post-monsoon season.

Productivity of phytoplankton was found to be limited by all parameters except nitrite and silicate in which the relation with salinity was significant ($r = 0.677, P \leq 0.05$). Productivity of *Thalassia* and *Syringodium* was limited by all parameters except temperature, pH and salinity. The significant correlations were with silicate and nitrite ($r = 0.677, P \leq 0.05$ for *Thalassia* and $r = 0.640, P \leq 0.05$ for *Syringodium*). Productivity of corals correlated positively with nitrite, silicate, dissolved oxygen, temperature and salinity, indicating the possible influence of these parameters on production. Significant relations were that of *Acropora* with salinity ($r = 0.486, P \leq 0.05$) and *Porites, Acropora* and *Pocillopora* with silicate ($r = 0.453, P \leq 0.05$; $r = 0.581, P \leq 0.01$ and $r = 0.512, P \leq 0.453, P \leq 0.05$, respectively). However, the relation with silicate is expected to be more of incidental because silicate is mainly metabolised by diatoms.
Major zooplankton groups observed in daytime samples were copepods, the eggs, zoea, decapod larvae, ostracods, bivalve larvae, gastroped larvae and foraminiferans. Night samples, in addition to the above groups, contained doliolum, salps, euphausiids, tunicates and tanidaceae. Numerical abundance varied with location of stations, as well as over seasons. Nocturnal abundance was very high than that of day time abundance. Average density were 581.9/m³ for station-2, 222.8/m³ for station-3, 387.1/m³ for station-5, 317.2/m³ to station-6 and 2,622.3/m³ for night station. Nocturnal zooplankton was distinct in their occurrence and seasonal variation, suggesting the presence of resident zooplankton as a component of the lagoon fauna. The sharp increase to very high density after 1800 hrs and the independence of abundance on tide also support this view.

Growth of corals was studied by tagging and 'Alizarin' staining methods in respect of monthly skeletal extension and weight of CaCO₃ accretion in a period of 28 days.

The average colony extension of *Acropora formosa* during first year was between 5.03±1.72 and 8.06±1.88 mm/28d and during second year it was 4.90±1.27 to 8.68±2.3 mm/28d. Since light and zooxanthellar photosynthesis directly enhance calcification rates, the apical branches which receive more light grew faster (7.30 mm/28d) than the lateral (6.98 mm/28d) and basal (5.95 mm/28d) branches.

Skeletal extension of *Acropora aspera* colony was between 3.08±0.69 and 4.17±0.96 mm/28d for the first year and between 3.42±0.71 and 4.69±0.69 mm/28d for the second year. Extension rate was highest on apical branches (4.47 mm/28d) and lowest on basal branches (3.77 mm/28d).

CaCO₃ accretion of *Acropora aspera* colony during the first year was between 9.76±1.33 and 11.97±1.52 mg/28d and during the second year it was between 10.39±1.144 and 13.38±1.95 mg/28d. Average accretion rate was highest on apical branches (12.97 mg/28d) and lowest on basal branches (10.04 mg/28d).
Total average colony growth and growth on the three positions of the colony also exhibited seasonal variation with a decrease during monsoon season. The low light intensity, drop in many environmental factors, high current velocity (15.06 cm/sec), high amount of total suspended matter (9.95 to 14.65 mg/l) and very high rate of sediment resuspension (103.3 to 124 mg/m$^2$/day) create less favourable conditions for growth of coral during monsoon. Heavy monsoon wind induces extreme turbulence which agitate the settled sediment and the removal of coral boulders and rocks by people create land and beach erosion which also enhance sediment resuspension rate during monsoon.

Lakshadweep coral reefs are under the threat of deterioration due to natural and manmade causes. Healthy and apparently untouched reef fauna exist only in islands which are not inhabited by man, like Suheli and Bangaram and in some deeper areas of inhabited islands like Kalpeni, Agatti and Chetlat where man cannot easily reach.

Natural damage is not in any large scale at present. The presence of Acanthaster planci, does not cause threat at present because the population is thin.

Human interferences pose more serious threat than natural damages. This is mainly by the removal of live corals by local people and visitors, excessive human activity during low tides, destructive methods of fishing, removal of coral stones and boulders from the reef and beach for construction activities, dredging and deepening of jetty, ever increasing developmental activities, housing to accommodate the teeming population and oil pollution from mechanised vessels.

Imposing strict ban on removal of corals, supplying the people with alternate materials for construction, scientific management of reef fishery, restriction on dredging, construction of proper seawalls, establishment of marine parks, creation of artificial reefs, advanced research on the environmental problems and educating people about the fragility of these ecosystem have to be initiated immediately, which would help protecting these island ecosystems.