MARINE BIODIVERSITY CONSERVATION AND MANAGEMENT

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V. CRUSTACEAN BIODIVERSITY, CONSERVATION AND MANAGEMENT

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INTRODUCTION

India is endowed with a rich fauna of edible crustaceans, several of them supporting commercial fisheries since ancient times. At present as many as 150 species of this group form part of the commercial catches either on regular basis or as occassional inclusions. The number of species entering into the above faunestic list is ever on the increase as a consequence of the extention of fishing activities to deeper waters and capture of nonconventional species. The insatiable demand for crustaceans in the international markets has resulted in tremendous increase in their exploitation along Indian coast during the past 3-4 decades. Though this has augmented the production and export of crustaceans many fold over the years, the recent changes in fishing pattern involving destructive innovations of fishing gears, excessive fishing pressure on some of the traditional stocks (Suseelan & Pillai, 1993) and the multifarious activities of man causing damages to the natural habitat of crustaceans (Suseelan, 1987; Anon., 1991) are potential threats to the biodiversity of this important group. At present the crustanceans, with an average annual production of about 3.2 lakh tonnes (1985-94), constitute above 16% of the total marine fish landing of the country.

The present paper examines the various kinds of human activities which affect the natural population of crustacean fauna and the

possible measures that could be adopted to conserve them for our sustained benefit.

SPECIES DIVERSITY, DISTRIBUTION AND STATUS OF EXPLOITATION

An inventory of the faunistic records of Indian decapod crustaceans would reveal that as many as 117 species of prawns, . 17 species of lobsters and 12 species of crabs inhabit the marine and contiguous estuarine areas which fall under the domain of commercial fishing. Besides these, at least four species of stomatopods also coexist in the sea forming a major constituent of the bottom biota of the inshore ecosystem. The nature of species assemblage varies greatly from one region to the other along the coast and so is the case in different bathymetric zones. Annexure I gives the list of species recorded from the marine and estuarine regions covered by the capture fisheries, their distribution, habitats and degree of exploitation.

Prawns

The rich fauna of prawns and shrimps belonging to the different families of Natantia comprise 63 species of littoral and 27 species of deepsea forms, besides several species of caridean prawns occupying the inland water bodies. The littoral species inhabiting the inshore waters upto about 50 meter depth are more numerous qualitatively and quantitatively than those inhabiting the offshore waters. The most predominant among the former group are the penaeid prawns *Penaeus indicus, P. penicillatus, P. merguiensis, P. monodon, P. semisulcatus, Metapenaeus dobsoni, M. monoceros, M. affinis, M.kutchensis, M.brevicornis, M.moyebi, Parapenaeopsis stylifera, P. hardwickii, P. sculptilis,* the solenocerid shrimp *Solenocera crassicornis,* the sergestids *Acetes indicus, A. japonicus, A.sibogae, A.erythraeus* and the caridean prawns *Nematopalaemon tenuipes, Exopalaemon styliferus* and *Exhippolysmata ensirostris.* These are subjected to intensive exploitation by commercial fishing units throughout the Indian coast. Though the outer continental shelf beyond this depth zone harbours several shrimp species (George, 1979; Miquel, 1984) the exploratory fishery surveys have indicated comparatively low densities of stocks for most of the existing species. The upper continental

slope between 200 and 500 m depth has proved to be potential fishing gounds, especially on the southwest and southeast coasts, where a number of species like *Heterocarpus woodmasoni, H.gibbosus, Plesionika spinipes, P.martia, P.ensis, Aristeus alcocki, Aristaeomorpha woodmasoni, Metapenaeopsis andamanensis, Penaeopsis jerryi, Solenocera hextii* etc. exist in sufficient quantities as to support commercial fisheries.

The estuaries and backwaters provide ideal homes for many shrimp species. A number of commercially important penaeid prawns like *P.indicus, M.monoceros* and *M.dobsoni* utilize this environment as their nursery grounds, while several caridean prawns inhabit permanently this environment or share it during the breeding period. The giant freshwater prawn *Macrobrachium rosenbergii* essentially migrates from the upper reaches of river systems to estuaries and backwaters during the breeding period to facilitate larval development.

Prawns are exploited commercially by a variety of fishing gears in the sea and inland waters. In the sea, they form a substantial portion of the catches of the indigenous gears such as fixed bag nets ('Dol'), seines, gill nets etc. which operate in the inshore areas. A number of innovative gears such as ring seines, trammel nets and minitrawls operated by motorized country crafts have also been introduced in the traditional sector since 1985 and they are being increasingly employed along the coasts of Kerala, Karnataka, Tamilnadu and Andhra Pradesh. Shrimp trawls of various dimensions are operated outside the traditional sector upto a depth of about 80-90 meters. They have come up as the major gear employed in the shrimp fishery of Indian coast at present. Small and medium trawlers (9-17 m boats) operate upto about 70 m depth and the larger trawlers (above 17 m OAL) operate mostly beyond the 50 m depth zone extending some times upto the edge of the continental shelf.

The estimated average annual production of prawns from the marine sector amounts to 2,37,000 t (1985-94) which forms about 70% of the total crustacean landings of the country. It may be seen that the prawn landings, after stagnating around 2 lakh tonnes till 1987, shows a steady improvement reaching the record level of 2.95 lakh t in 1991

and thereafter a declining trend till 1993 (Table 1). In 1994 the production substantially increased mainly due to the capture of non-conventional species. Nearly three-fouth of the prawn catch is recorded in Kerala and Maharashtra alone. Among the other maritime states, Gujarat, Andhra Pradesh and Tamilnadu together contribute about 20%, Karnataka, Orissa and West Bengal 5% and Goa, Pondicherry and Andamans 1%. In the All-India prawn landing, trawlers account for about 60% and the indigenous gears 40%. The fishery is supported by penaeid and nonpenaeid prawns, the former contributing about 65% and the latter 35%.

Table 1 : Estimated annual prawn landings of India, 1985-94

Year	Prawn landings (tonnes)	Year	Prawn landings (tonnes)
1985	189042	1990	244353
1986	210616	1991	295138
1987	190786	1992	278154
1988	202496	1993	244194
1989	222990	1994	292365

The trawl fishery is mainly supported by penaeid prawns (92%). The important species constituting the trawl catches are *S. crassicornis, M. kutchensis, P. stylifera* and *P. hardwickii* on the Gujarat coast, *M. affinis, M. monoceros, P. stylifera, P. hardwickii* and *P. sculptilis* on the Maharashtra coast, *M. monoceros, M. affinis, P. merguiensis* and *M. dobsoni* on the Goa and north Karnataka coast, *P. stylifera, M. dobsoni, P. indicus, M. monoceros* and *M. affinis* on the southwest coast, *P. indicus, P. semisulcatus* and *M. dobsoni* on the southwest coast, *P. indicus, P. semisulcatus* and *M. dobsoni* on the southeast coast, *M. monoceros, M. dobsoni, P. stylifera, M. brevicornis, P. indicus, P. monodon* and *M. affinis* on the Andhra coast and *M. monoceros, P. indicus, P. monodon, P. merguiensis* and *P. hardwickii* on the northeast coast. The fishery of indigenous gears is also multispecies in character, constituted by both the penaeid as well as nonpenaeid prawns. The fixed bag nets (Dolnets)

operating in the inshore waters of Gujarat and Maharashtra register the bulk of nonpenaeid landings in the country (70 - 75%) of which about three-fourth is constituted by *Acetes* spp. Among the penaeids encountered in the indigenous gears, the most dominant are *M. kutchensis, M. monoceros* and *P. penicillatus* on the northwest coast, *P. merguiensis, M. dobsoni, P. stylifera* and *P. indicus* on the southwest coast and *P. indicus, M. dobsoni, M. monoceros, M. brevicornis* and *P. monodon* on the east coast. Among nonpenaeids, besides *Acetes* spp., *N. tenuipes* and *E. ensirostris* contribute substantially to the landings of Dol nets on the Bombay-Saurashtra coasts and *E. styliferus* on the coast of West Bengal.

The trends in state-wise annual production of penaeid prawns between 1985 and '94 would indicate that Kerala and Karnataka registered the greatest level of increase ranging from 70 to 100% after 1986. Introduction of more trawlers in the northern centres, night trawling, large-scale operation of ring seines, mini-trawls, trammel nets etc. along Kerala coast and the voyage fishing of trawlers in extended areas and operation of "Mattu bale" (ring seine) along Karnataka coast have largely contributed to this increase. Maharashtra showed a gradual decline in penaeid landings till 1989, but picked up in the subsequent years reaching a production level of 58,000 t in 1992. In Gujarat coast, though the landing remained more or less steady until 1989, it shot up by about 30% in 1990 and continued to increase reaching the highest level of 27,000 t in 1992. Intensive voyage fishing and daily-trip operations conducted by shrimp trawlers along the Saurashtra coast accounted for this increase. East coast contributed about 25% of the total penaeid prawn landings of the country. The annual trend and production remained more or less same as in the west coast regions, with improved catches during 1989-92 period.

As regard nonpenaeid prawns, the all-India annual production showed an increasing trend although a sharp fall occurred during 1987-88 period. The north western region contributed over 90% of this fishery. The small sergestid shrimp *Acetes* accounted for about 70 to 80% of the nonpenaeid catch. Normally this shrimp is almost exclusively caught by 'dol' nets. However,from 1989 onwards enormous quantities of *Acetes* are caught by shrimp trawlers in Gujarat coast, with

the result nonpenaeid landing in the state shot up reaching a record level of 61,000 t in 1991.

Prawn fisheries of considerable magnitude also exist in the inland waters such as rivers, creeks, bays, mangrove swamps, lagoons, estuaries and backwaters. The adult population of the giant freshwater prawn *Macrobrachium rosenbergii* and the river prawn *M. malcolmsonii* are fished extensively from the rivers and estuaries. The Hooghly - Matlah estuarine system, Chilka lake, Godavary estuary, Kakinada backwaters, Pulicat lake, Ashtamudi Lake, Cochin backwaters and the Rann of Kutch support lucrative fisheries for juvenile penaeid prawns of species like *P. indicus, P. monodon, M. dobsoni* , *M. kutchensis* and *M. monoceros*. It is estimated that about 20- 25 thousand tonnes of juvenile prawns are exploited every year from the brackishwater systems in the country.

The potential stock of prawns in the presently exploited zone is estimated to be about 2.32 lakh tonnes which include 1.78 tonnes of penaeid prawns and 0.54 lakh tonnes of nonpenaeids (Anon., 1991). The catch statistics shown in Table 1 would clearly indicate that the exploitation of prawns in the conventional fishing grounds of India has already exceeded the potential yield level in 1990 and that the shrimp resource is in a state of overexploitation. Among the potentially exploitable shrimp resources, the deep-sea prawns located on the upper continental slope (200-500 m depth) offer scope for commercial fishing in a limited extent. The potential yield of this resource is estimated to be about 5,000 t.

Lobsters

The lobster fauna of commercial fishing grounds comprises 11 species of littoral and 6 species of deep-sea forms. Among the littoral forms, the spiny lobsters *Panulirus polyphagus, P. homarus, P. ornatus* and *P. versicolor* are the most common and they have a discontinuous distribution of stocks along the Indian coast. The sand lobster *Thenus orientalis* occurs abundantly along with *P. polyphagus* in the trawling grounds of Maharashtra and Gujarat coasts, while *P. homarus* and *P. ornatus* are abundant along the coasts of Trivandrum, Kanyakumari

and Tinneveli districts respectively. The deep-sea spiny lobster *Puerulus sewelli* occupies the upper continental slope between 200 and 500m depth off the southwest and southeast coasts where it is found in sizable concentrations.

The spiny lobsters and sand lobsters amounting to an average of about 2600 t are caught annually from the inshore waters by mechanised and nonmechanised units. The landings show a steady declining trend from 1985 onwards after attaining the highest production of 4080 t. The maximum quantity is exploited from Maharashtra and Gujarat coasts by bottom trawling. The deep-sea lobster *P. sewelli* was intensively exploited by large trawlers during 1988-90, but the fishery did not last long due to overfishing.

Crabs

Out of about 640 species of marine crabs so far recorded from Indian waters only 12 species of edible crabs, namely *Portunus sanguinolentus, P. pelagicus, Charybdis feriatus, C. lucifera, C. annulata, C. natator, Scylla tranquebarica, S. serrata, Matuta lunaris, Sesarma tetragonum* and *Varuna litterata,* which inhabit the coastal waters and adjoining brackishwater environments, support commercial fisheries. The deep water swarming crab *C. smithii* is a potentially commercial species occurring throughout the Indian EEZ.

Being a commodity of lesser export value to the processing industry, the capture fishery does not focus on marine crabs in a big way now. However, substantial quantities of crabs are landed every year as by-catches of shrimp trawlers and indigenous fishing units throughout the country.

On a average, about 25000 t of crabs are exploited annually from the marine sector, of which over 50% is landed in Gujarat and Tamilnadu alone. In Kerala, crab landing shows a consistant increase since 1985 as a result of the capture of nonconventional species like *C. feriatus (= C. cruciata)* and *C. lucifera* by trawlers from the offshore fishing grounds. Commencement of live crab export in India from about the middle of eighties resulted in intensive exploitation of mud crabs (*Scylla*

spp.). in brackwishwater regions of many maritime states like Kerala, Tamilnadu and Andhra Pradesh.

Stomatopods

Stomatopods form an important occupant of the trawling grounds of inshore waters. Among the various species recorded from Indian coasts one species, namely, *Oratosquilla nepa* is the most common. Stomatopods are caught alongwith other crustaceans and fish in large quantities in shrimp trawls and Dol nets. With an estimated annual production of 60-90 thousand t, they constitute about 20% of the total crustacean landings. The west coast accounts for more than 90% of this catch.

FACTORS AFFECTING BIODIVERSITY AND POPULATION ABUNDANCE

The natural population of crustaceans which support commercial fisheries is damaged in several ways by the activities of modern man. While some of the damages occur during the process of exploitation, others are caused by the destruction of habitats. The various kinds of human activities adversely affecting the crustacean fauna and their resources have been pointed out by Gopalan *et al.* (1983), Suseelan (1987), Kathirvel *et al.* (1988), Suseelan *et al.* (1989), Suseelan and Pillai (1993) and Suseelan and Nair (1994).

The intensive fishing for prawns inside the 50 m depth line persistently over the past several years has led most of the convensional fishing grounds of Indian coast to a state of over exploitation. This is evident from the fact that the annual shrimp production of the country has exceeded far beyond the catchable potential estimated for this depth zone (Anon., 1991) from 1991 onwards. Stock assessment of the major component species such as *M. monoceros, P. stylifera, P. indicus, P. semisulcatus and P. monodon* among penaeid prawns and *A. indicus* among nonpenaeids has also revealed that the coastal prawn resource of India is being fully exploited at present, and in certain cases overfishing is taking place in alarming dimensions (Suseelan & Pillai, 1993). The recent changes in fishing pattern involving night trawling, reduc-

tion of cod-end mesh size of trawl nets and introduction of minitrawls having very small mesh sizes (8-16mm) in the traditional sector are destructive to many species of shrimp since the catch of these nets include enormous quantities of juveniles/breeders, the exploitation of which can lead to recruitment overfishing. In states like Kerala, the occurrence of undersized prawns of *P. stylifera* (Karikkadi) in large proportions in the trawl catches has been found to be a common feature. On a modest estimate, at least 2000 t of juveniles of this species is landed by shrimp trawlers every year. If allowed to grow and attain marketable size, this catch of juveniles would have formed about 10500 t of adult prawns valued at Rs. 16 crores. Another classical example of juvenile destruction in the marine environment is in the Palk Bay where young ones of *P. semisulcatus* are indiscriminately captured by 'Thalluvalai' a kind of small conical bagnet draged along the shallow near-shore areas (Manickam *et al., 1989*). *P. semisulcatus* of the size 45-70 mm length is harvested to the tune of 2-10 kg/day along with sea grass and seaweeds (5 kg/day). This seagrass ecosystem is the nursery ground for *P. semisulcatus*. It is estimated that about 2500 indigenous fishing units are engaged in this type of fishing in 0-4m depth and over 3000 t of the juveniles of the species are exploited every year.

In the marine sector, besides biological damages to important shrimp species, the changed fishing pattern has also generated social problems in many parts of the country. The spurt in the landing of *Acetes* by shrimp trawlers along the Saurashtra coast in recent years is a typical example of the impact of mesh size reduction and encroachment of trawlers into the traditional fishing grounds, which in the long run may lead to sectoral conflicts.

Exploitation of juveniles and breeding population of commercially important prawns in estuaries and backwaters is a common feature in India. Large-scale destruction of young penaeid prawns by commercial nets like stake nets, dip nets, drag nets, cast nets, seines etc. is bound to reduce the shrimp stocks of the marine region. A more damaging practice commonly found in the estuarine systems is the widespread removal of young prawns for aquaculture purpose. The seed of large growing species of penaeid prawns like *P. indicus and P.*

mondon are collected in large numbers from these areas using close-meshed nets and utilized for culture when adequate supply of seed from prawn hatcheries is not available. As the shrimp population of estuaries and backwaters is invariably multispecies in character the seed collected from these areas include several species growing to different sizes. In the absence of any method to selectively collect the seed of desired species, millions of young ones of smaller species obtained in the seed collections are often discarded. This is a colossal wastage of resource and highly detrimental to the estuary-dependant species. Among caridean prawns *M. rosenbergii and M. malcolmsonii* are the most sought after species on account of their large size. During their breeding migration from rivers to estuaries these prawns are exploited in large numbers and used for export. As majority of the females caught in the estuarine systems are in 'berried' condition several thousands of developing embryos are also destroyed along with every single breeder that is killed.

The declining trend in the landing of lobsters in India should be a matter of great concern because of the high export value of the resource. The stocks of important species such as *P. homarus* in Kanyakumari District, *P. ornatus* in Tinneveli coast and *P. polyphagus* and *T. orientalis* in Gujarat and Maharashtra coasts face overfishing. As the peak fishing season falls during the breeding period for all these species, excessive removal of berried females in capture fisheries severely hampers the renewable capacity of the stocks. A more damaging practice noticed in the past few years is the capture of baby lobsters in large quantities from their natural habitats for culture purpose. This practice has almost come to the level of a regular and established trade of the coastal fishermen especially in Gujarat and Tamilnadu. This is highly injurious to the lobster population of coastal waters. Our experience from the large scale exploitation of the deep -sea lobster resource in the recent past is an eye-opener to exercise caution while tapping the limited stocks available on the upper continental slope. In the case of the deep-sea form also, the abundance of lobsters in the fishing grounds coincides with the breeding season of the species (*P. sewelli)* when appreciable quantities of berried females are encountered

in the catches. It is also observed that large number of small sized lobsters are also caught in April-May and October (Kathirvel *et al.* 1988). The exploitation of such berried females and sub-adult population in large quantities is more harmful in deep sea forms than in shallow water species since the growth rate and fecundity of the former are comparatively low.

Among brachyuran crabs subjected to commercial exploitation, the most affected species are the mud crabs *Scylla tranquerbarica* and *S. serrata* which are fished extensively in the estuarine regions. With the development of live crab export in the country, mud crab farming is gaining importance in many maritime states like Kerala, Tamilnadu and Andhra Pradesh. The seed requirement for this purpose is met entirely from the wild stock. The sudden spurt in demand for live crabs for export on one side and the emerging seed trade for crab aquaculture on the other side have resulted in heavy exploitation of wild population of mud crabs in recent years, and indications are that the crab population has already dwindled in most of the brackishwater systems of these states.

The brackishwater ecosystems such as estuaries, back waters, salt water lakes, mangroves etc., which form the nursery grounds of penaeid prawns, are increasingly encroached upon for various purposes. Large-scale reclamation of water areas, construction of barrages, salt water barriers, spill ways etc. are some of the important activities which adversely affect the growth and survival of prawns in their early life. The extensive backwaters of Kerala, which harbour immense wealth of juvenile prawns, are reported to have undergone considerable shrinkage over the past few decades due to authorised and unauthorised reclamation process (Gopalan *et al., 1989).* The Thanneermukkom barrage commissioned in 1976, was constructed in the Vembanad lake in Kerala to prevent saline water entering the extensive paddy fields of Kuttanad in Central Kerala. Since the tidal flow was totally arrested by the barrage and the salinity reduced to almost zero level beyond Thanneermukkom, the distributional range of penaeid prawn juveniles in the lake became considerably reduced. The Thanneermukkom barrage is also believed to have caused deple-

tion of *M. rosenbergii* stock in the Central Travancore rivers as well as in the Vembanad Lake. Berried females of this species migrate during September-November to the lower reaches of the lake where egg-hatching and larval development are completed within 30-35 days. Upstream migration of juveniles usually commences by about December-January, almost synchronising with the closure of the barrage. This is supposed to have resulted in obstructing the movement of juveniles into the reverine environment and eventually depleting the resource.

Aquatic pollution can be a potential threat to crustaceans in the estuarine regions which constantly receive various kinds of pesticides, industrial effluents carrying heavy metals and toxic chemicals, municipal and domestic sewages, oils and oil dispersants, heated water and radio-active wastes. The pollutants can cause large-scale mortality, reduced rate of growth and survival, uptake and accumulation of toxic substances making the animal unfit for human consumption and reduced quality and export value of the product.

CONSERVATION AND MANAGEMENT

It may be seen from the foregoing account that the crustacean species which bring in considerable foreign exchange to the country are threatened in several ways for their sustained survival and productivity in the natural habitats. Almost all the important species which constribute to the commercial fishery is endangered in one way or the other by the activities of man and a careful thinking is most appropriate to form suitable conservation measures and implement them before further damage is inflicted on the fauna and its environment. Among other related shellfishes which are endangered by the activities of man are the horseshoe crabs of the northeast coast (Appendix - I).

As in the case of most other tropical fisheries, the conservation measures generally adopted for crustaceans include (1) Restriction of fishing effort (2) Imposition of closed seasons for fishing, (3) Allotment of catch quotas, (4) cod-end mesh regulations for fishing nets, and (5) Restriction on capturing juveniles from nursery grounds. Because of the fact that our resources are multispecies, each species growing to different sizes and having somewhat different breeding periods and

stock sizes in the same fishing ground, successful implementation of most of these conservation measures is difficult. In India, at present, the conservation measures legally practised for crustacean resources are limited to the restrictions in the operation of fixed nets (Stake nets & Chinese dip nets) in the backwaters of Kerala. These regulations, which are primarily aimed at protecting the young prawns from indiscriminate fishing, prohibit the operation of stake nets during high tide period and the use of mesh sizes less than 20 mm for the cod-end of stake nets/Chinese dip nets. In the marine sector also certain common restrictions are in force such as, prohibition on the use of cod-end mesh sizes less than 35 mm for bottom trawls, ban on night trawling, prohibition of operation or delimitation of the area of operation of some of the fishing nets such as purse-seine, ring seine, pelagic trawl, mid water trawl, bottom trawl etc.

The above mentioned fishery regulations are undoubtedly well-framed and they should be strictly enforced not only in Kerala but in the entire coastline of India as the conservation problems are common to all maritime states. In the marine sector, the stocks of many important species of prawns and lobsters have suffered serious damages due to uncontrolled fishing, which necessitates corrective measures on priority basis. For shrimps like *P. semisulcatus* which have restricted distribution and are facing depletion in areas like Gulf of Mannar and Palk Bay, efforts to repopulate and strengthen the natural stock have to be considered through large-scale searanching. Similar efforts are also required on other endangered species like sand lobsters (*T. orientalis)* and spiny lobster species after proper hatchery technologies are developed in the country. In order to protect the juvenile population of these valuable species, minimum legal size may also be fixed for the capture fishery. Complete closure of fishing for short durations during the peak breeding period of lobsters may also be considered in notified areas. A restriction on the export of undersized prawns and lobsters will discourage capture of smaller size groups of these resources by commercial nets and this will go a long way in improving their fishery.

The deep-sea crustaceans are more prone to destruction than the littoral forms if fished without any control, as has happened in the case

of the lobster *P. sewelli*. Therefore, fleet size and catch quota should be fixed on the basis of estimated catchable potential for commercial exploitation of such nonconventional resources.

In the estuarine systems, large-scale destruction of juvenile prawns is a growing threat throughout the country. As the prawn fishery of the adjoining marine environment is largely dependant on the emigrating subadults from estuarine systems, the reduction in juvenile prawn stock brought about by the various environmental and external influences will have serious impact on the coastal fishery. Though complete prohibition of shrimp fishing in these areas may not be possible due to socio-economic problems, alternate methods of protection of the young prawns in the estuarine systems have to be considered. Closing the areas for shrimp fishing during certain seasons, limiting the operation of fixed nets like stake nets, dip net etc. together with appropriate mesh restrictions, and a total ban of export of count sizes of shrimps below a fixed minimum level are some of the methods for conserving the penaeid prawns in this environment. With the fast developing tempo of brackishwater prawn farming in the country, the dependence on nature for seed of fast growing species like *P. monodon* and *P. indicus* is bound of continue unless and until the alternate sources are strengthened. It is therefore essential to establish adequate number of prawn hatcheries and legally prohibit seed collection from estuaries. Indiscriminate capture of berried females is highly destructive in the case of the freshwater prawn *M. rosenbergii* and the mud crabs *Scylla* spp. This practice should be discouraged through appropriate fishery regulations in the inland waters. Largescale ranching would be a worthwhile proposition to improve the depleted stocks and this may be attempted concurrently with fixing minimum legal sizes for the capture fishery. The growing enthusiasm for mud crab farming can jeopardise the wild population of *Scylla* spp in brackishwater systems. Hence it is imperative that efforts are intensified to develop a viable technology for hatchery production of mud crab seed in the country.

Annexure I

Commercial/Potentially Commercial species of Crustacea, their distribution, important habitats and present level of exploitation in India.

Species	Distribution	Habitats	Level of Exploitation
PRAWNS			
Penaeidea :			
Fam. Solenoceridae			
Hymenopenaeus aequalis	SW coast, Andamans	Marine - DS	Nil
Hymenopenaeus neptunus	Bay of Bengal	Marine - DS	Nil
Solenocera alticarinata	SW coast	Marine - OCS & DS	Low
Solenocera annectens	Andamans	Marine - DS	Nil
Solenocera choprai	West & East coast	Marine - OCS	Low
Solenocera crassicornis	West & East coast, Andamans	Marine - INS	High
Solenocera koelbeli	SW coast & East coast	Marine - OCS	Low
Solenocera halli	West & East coast, Andamans	Marine - OCS & DS	Nil
Solenocera hextii	West & East coast	Marine - OCS & DS	Low
Solenocera pectinata	West & East coast	Marine INS & OCS	Low
Solenocera waltairensis	Andhra coast	Marine - INS	Low
Fam. Aristeidae			
Aristaeomorpha woodmasoni	SW coast & Andamans	Marine - DS	Low

Contd.

Species	Distribution	Habitats	Level of Exploitation
Aristeus alcocki	West & East coast	Marine - DS	Low
Aristeus virilis	Andaman waters	Marine - DS	Nil
Plesiopenaeus edwardsianus	SW coast	Marine - DS	Nil
Fam. Penaeidae			
Atypopenaeus stenodactylus	West & East coast	Marine - INS	Low
Metapenaeopsis andamanensis	West & East coast	Marine - OCS & DS	Low
Metapenaeopsis barbata	Andhra coast	Marine - INS	Nil
Metapenaeopsis borradailei	Lakshadweep	Marine - INS	Nil
Metapenaeopsis coniger	West & East coast	Marine - OCS & DS	Low
Metapenaeopsis gallensis	East coast	Marine - INS	Nil
Metapenaeopsis hilarula	SW coast & East coast, Andamans	Marine - INS	Nil
Metapenaeopsis mogiensis	SW Coast & East coast	Marine - INS	Low
Metapenaeopsis palmensis	Andamans	mairne - INS	Nil
Metapenaeopsis philippii	SW coast & East coast	marine - OCS & DS	Nil
Metapenaeopsis stridulans	West & East coast, Andamans	Marine - INS & OCS	Moderate
Metapenaeus affinis	West & East coast, Andamans	Marine - INS, Estuarine	High
Metapenaeus alcocki	NW & Andhra coast	Marine - INS	Nil
Metapenaeus brevicornis	West & East coast, Andamans	Marine - INS, Estuarine	High
Metapenaeus dobsoni	West & East coast, Andamans	Marine - INS, Estuarine	High

Contd.

Species	Distribution	Habitats	Level of Exploitation
Metapenaeus elegans	Andamans	Marine - INS	Nil
Metapenaeus ensis	NE coast, Andamans	Marine - INS, Estuarine	Moderate
Metapenaeus krishnatrii	Andaman waters	Marine - INS	Nil
Metapenaeus kutchensis	NW coast	Marine - INS	Moderate
Metapenaeus lysianassa	West & East coast, Andamans	Marine - INS	Low
Metapenaeus monoceros	West & East coast	Marine - INS & OCS, Estuarine	High
Metapenaeus moyebi	SW & SE coast, Andamans	Marine - INS, Estuarine	Moderate
Metapenaeus stebbingi	NW coast	Marine - INS	Nil
Parapenaeopsis acclivirostris	West & East coast	Marine - INS	Low
Parapenaeopsis cornuta	West & East coast	Marine - INS	Low
Parapenaeopsis coromandelica	SE coast	Marine - INS	Moderate
Parapenaeopsis hardwickii	West & East coast	Marine - INS	Moderate
Parapenaeopsis indica	Andhra coast	Marine - INS	Nil
Parapenaeopsis maxillipedo	West & East coast	Marine - INS	Moderate
Parapenaeopsis nana	East coast	Marine - INS	Low
Parapenaeopsis sculptilis	West & East coast	Marine - INS	Moderate
Parapenaeopsis stylifera	West & East coast, Andamans	Marine - INS & OCS	High
Parapenaeopsis tenella	East coast, Andamans	Marine - INS	Nil
Parapenaeopsis uncta	SW & SE coast	Marine - INS	Nil
Parapenaeus fissurus	East coast	Marine - OCS	Nil

Contd.

Species	Distribution	Habitats	Level of Exploitation
Parapenaeus investigatoris	SW & SE coast, Andamans	Marine - DS	Nil
Parapenaeus longipes	West & East coast	Marine - INS & OCS	Low
Penaeopsis jerryi	SW & SE coast	Marine - OCS & DS	Low
Penaeus canaliculatus	West & East coast, Lakshadweep, Andamans	Marine - INS	Moderate
Penaeus indicus	SW coast & East coast	Marine - INS	High
Penaeus japonicus	West & East coast	Marine - INS	Low
Penaeus latisulcatus	West & East coast	Marine - INS	Low
Penaeus merguiensis	West & East coast, Andamans	Marine - INS, Estuarine	Moderate
Penaeus monodon	West & East coast, Andamans	Marine - INS & OCS, Estuarine	High
Penaeus penicillatus	West & East coast	Marine - INS	Moderate
Penaeus semisulcatus	West & East coast, Andamans	Marine - INS & OCS	High
Trachypenaeopsis minicoyensis	Lakshadweep	Marine - INS	Nil
Trachypenaeus curvirostris	West & East coast, Andamans	Marine - INS & OCS	Moderate
Trachypenaeus granulosus	SW & East coast	Marine - INS & OS	Moderate
Trachypenaeus sedili	SW & East coast	Marine - INS	Low
Fam. Sicyoniidae			
Sicyonia lancifera	West & East coast	Marine - INS	Nil

Contd.

Species	Distribution	Habitats	Level of Exploitation
Fam. Sergestidae			
Acetes erythraeus	West & East coast	Marine - INS, Brackishwater	Moderate
Acetes indicus	West & East coast	Marine - INS, Brackishwater	High
Acetes japonicus	West & East coast	Marine - INS	Low
Acetes johni	SW & SE coast	Marine - INS	Low
Acetes sibogae	West & East coast	Marine - INS, Estuarine	Low
CARIDEA :			
Fam. Palaemonidae			
Exopalaemon styliferus	West & East coast	Marine - INS Brackish & Freshwater	Moderate
Leandrites celebensis	SW coast	Marine - INS, Estuarine	Moderate
Leptocarpus fuminicola	NE coast	Fresh & Brackishwater	Moderate
Leptocarpus potamiscus	West & East Coast	Marine - INS, Brackishwater	Low
Macrobrachium birmanicum	East coast	Freshwater & Brackishwater	Low
Macrobrachium choprai	NE coast	Freshwater	Low
Macrobrachium dayanum	NE coast	Freshwater	Nil
Macrobrachium divakarani	SW coast	Backwaters	Low
Macrobrachium equidens	West & East coast, Andamans	Brackish & Freshwater	Low
Macrobrachium idae	SW coast & upper East coast	Brackish & Freshwater	Moderate

Contd.

Species	Distribution	Habitats	Level of Exploitation
Macrobrachium idella	SW & East coast	Brackish & Freshwater	High
Macrobrachium javanicum	East coast	Freshwater	Nil
Macrobrachium josephi	SW coast	Estuarine	Nil
Macrobrachium lamarrei	SW & East coast	Fresh & Brackishwater	Low
Macrobrachium lanchesteri	East coast	Fresh & Brackishwater	Nil
Macrobrachium latimanus	East coast	Fresh & Brackishwater	
Macrobrachium latimanus	East coast	Freshwater	Nil
Macrobrachium malcolmsonii	West & East coast	Fresh & Brackishwater	High
Macrobrachium mirabile	North East coast	Fresh & Brackishwater	Low
Macrobrachium rosenbergii	West & East coast	Fresh & Brackishwater, Marine - INS	High
Macrobrachium rude	SW & East coast	Fresh & Brackishwater	Moderate
Macrobrachium scabriculum	SW & East coast	Fresh & Brackishwater	Low
Macrobrachium striatus	SW coast	Fresh & Brackishwater	Low
Macrobrachium villosimanus	NE coast	Freshwater	Low
Nematopalaemon tenuipes	West & East coast	Marine - INS, Brackishwater	High
Fam. Atyidae			
Caridina gracilirostris	West & East coast	Brackish & Freshwater	Low
Caridina propinqua	NE coast	Brackish & Freshwater	Nil

Contd.

Species	Distribution	Habitats	Level of Exploitation
Fam. Hippolytidae			
Exhippolysmata ensirostris	West & East coast	Marine - INS, Brackishwater	Moderate
Lysmata vittata	West & East coast	Marine - INS	Low
Fam. Alpheidae			
Alpheus crassimanus	NE coast	Brackish & Freshwater	Low
Alpheus malabaricus	SW & NE coast	Brackish & Freshwater	Low
Alpheus palaudicola	SW & NE coast	Brackish & Freshwater	Low
Alpheus rapax	SW & NE coast	Brackish & Freshwater	Nil
Fam. Ogyridae			
Ogyrides striaticauda	SW coast	Backwaters	Low
Fam. Crangonidae			
Pontocaris pennata	West & East coast, Andamans	Marine - OCS & DS	Nil
Fam. Pandalidae			
Plesionika alcocki	SW & East coast, Andamans	Marine - DS	Nil
Plesionika ensis	SW & East coast	Marine - DS	Nil
Plesionika martia	SW & East coast, Andamans	Marine - DS	Low

Contd.

Species	Distribution	Habitats	Level of Exploitation
Plesionika sindoi	SW coast, Andamans	Marine - DS	Nil
Plesionika spinipes	SW & SE coast	Marine - DS & OCS	Low
Plesionika williamsi	SW coast	Marine - DS	Nil
Heterocarpus gibbosus	West & East coast, Andamans	Marine - DS	Low
Heterocarpus sibogae	SW coast, Andamans	Marine - DS	Nil
Heterocarpus woodmasoni	SW coast, Andamans	Marine - DS	Low
Fam. Oplophoridae			
Oplophorus typus	West & East coast, Andamans	Marine - DS	Nil
Acanthephyra sanguinea	West & East coast, Andamans	Marine - DS	Nil
Fam. Pasiphaeidae			
Pariphaea alcocki	West & East coast	Marine - DS	Nil
LOBSTERS			
Fam. Nephropidae			
Acanthacaris tenuimana	West coast	Marine - DS	Nil
Nephropsis stewarti	West & East coast, Andamans	Marine - DS	Nil

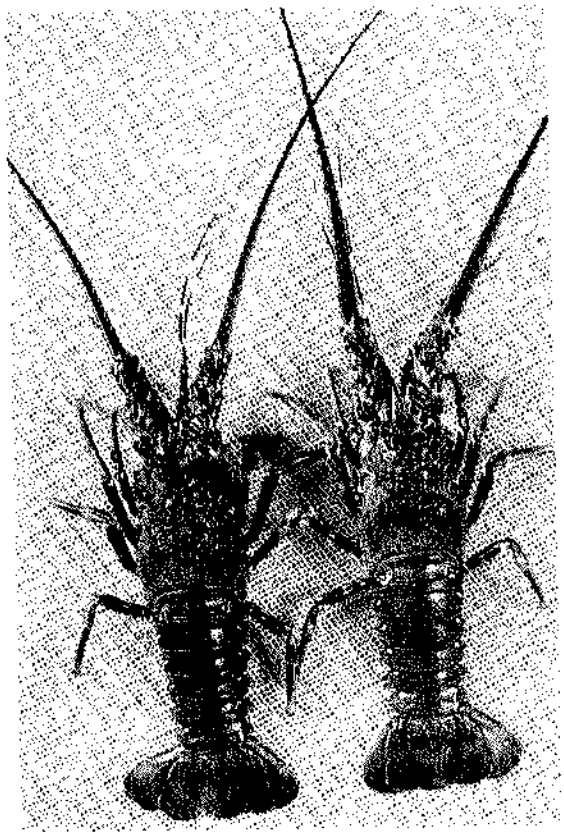
Contd.

Species	Distribution	Habitats	Level of Exploitation
Fam. Palinuridae			
Linuparus somniosus	Andaman waters	Marine - DS	Moderate
Palinustus mossambicus	SW coast	Marine - DS	Nil
Panulirus homarus	West & East coast, Andamans	Marine - INS	High
Panulirus longipes	East coast, Andamans	Marine - INS	Moderate
Panulirus ornatus	West & East coast, Andamans	Marine - INS	High
Panulirus penicillatus	West & East coast, Andamans	Marine - INS	Low
Panulirus polyphagus	West & East coast, Andamans	Marine - INS	High
Panulirus versicolor	West & East coast, Andamans	Marine - INS	Moderate
Puerulus sewelli	SW & SE coast	Marine OCS & DS	High
Scyllarus rubens	West & East coast	Marine - INS	Nil
Scyllarus batei	West & East coast	Marine - INS	Nil
Scyllarus rugosus	West & East coast	Marine - INS	Nil
Scyllarus sordidus	West & East coast	Marine - INS	Low
Thenus orientalis	West & East, Andamans	Marine - INS & OCS	High
Polycheles spp.	SW coast	Marine - DS	Nil
CRABS			
Fam. Portunidae			
Charybdis feriatus	West & East coast	Marine - INS & OCS	High

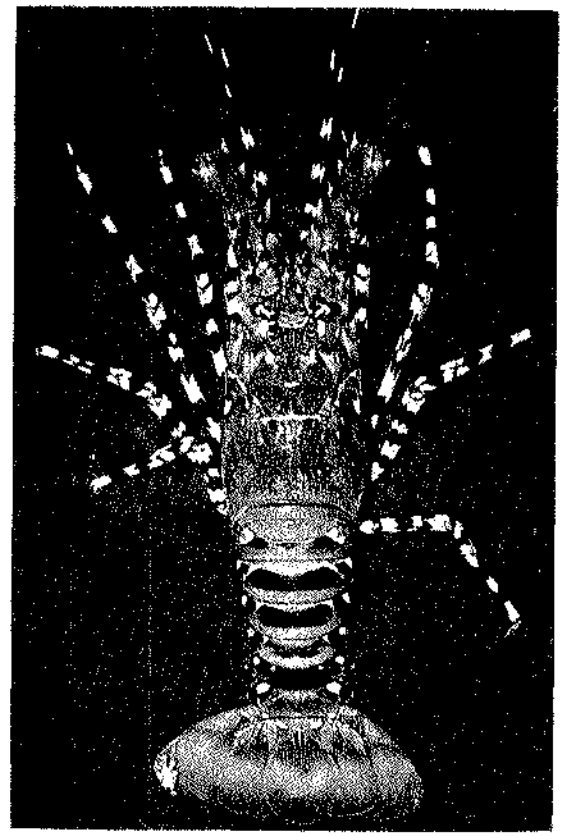
Species	Distribution	Habitats	Level of Exploitation
Charybdis lucifera	West coast	marine INS & OCS	High
Charybdis annulata	West & East coast	Marine INS	Low
Charybdis natator	West & East coast	Marine - INS	Low
Charybdis smithii	West & East coast, Andamans	Marine - OCS & DS	Low
Matuta lunaris	West & East coast	Marine - INS	Low
Portunus pelagicus	West & East coast, Andamans	Marine - INS	High
Scylla tranquebarica	West & East coast	Marine - INS & Brackishwater	High
Scylla serrata	West & East coast, Andamans	Marine - INS, Brackishwater	High
Sesarma tetragonum	West & East coast	Brackishwater	Low
Varuna litterata	West & East coast	Marine - INS & Estuarine	Moderate
STOMATOPODS			
Harpiosquilla raphidea	West & East coast	Marine - INS	Moderate
Oratosquilla nepa	West & East coast	Marine - INS	High
Oratosquilla holoschista	SW & East coast	Marine - INS	Low
Oratosquilla woodmasoni	West & East coast	Marine - INS	Low

INS - Inshore sea (0-50 m), OCS - Outer Continental Shelf (50 - 200 m), DS - Deepsea (Beyond 200 m depth)

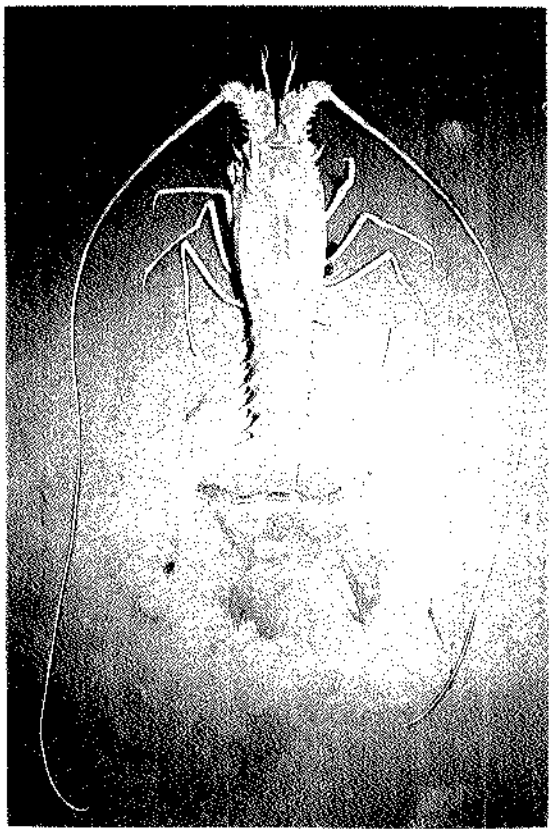
Parapenaeopsis stylifera



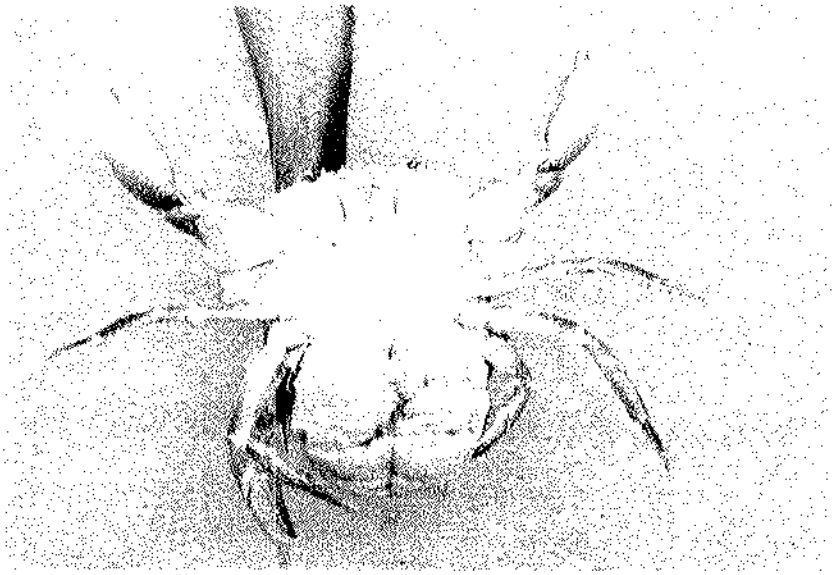
Panulirus homarus



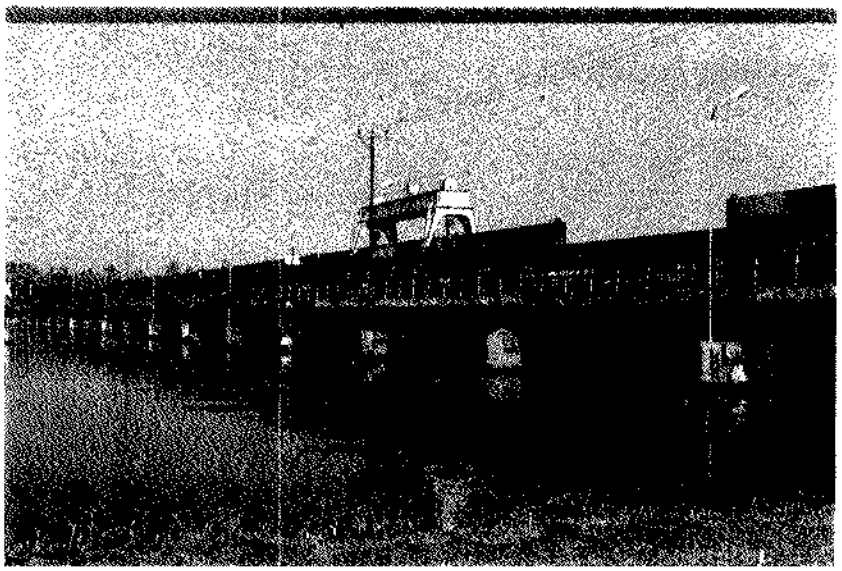
Panulirus ornatus



Pteridus scavelli

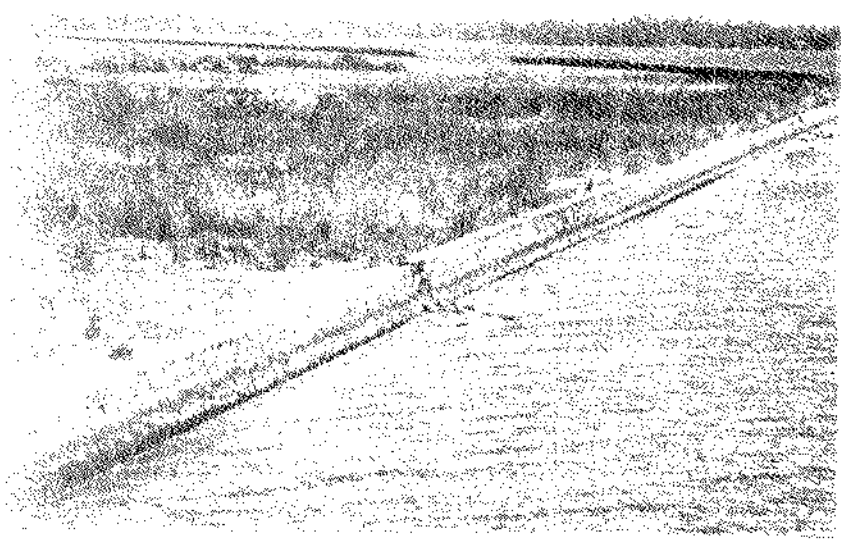


Scylla tranquebarica - Berried female



Thanneermukkom barrage in Vembanad Lake

Reclamation of shrimp nursery areas at Cochin



Another view of extensive reclamation in Cochin backwater

Appendix

Horse shoe crabs (King crabs)

The marine arachnid, king crabs, have emerged as economically important for various biomedical applications. In Indian waters two species, *Tachypleus gigas* and *Carcinoscorpius rotundicauda* occur commonly in the deltaic regions of Ganges and Mahanadi on the Northeast coast. They breed in the summer months within the intertidal zone and lay eggs in muddy sand, particularly in creeks of stonney river mouths subjected to tidal influence. *C.rotundicauda* ascends estuaries in large numbers during breeding season when it is exploited on commercial scale.

The King crabs are already considered as a living fossil and hence care should be taken to preserve them in the nature. It is recently reported, however, that, because of biotic interference, there has been a sharp drop in the number of these animals at Chandipur in Orissa. As this arachnid is found to be of tremendous biomedical use, it should be exploited without causing any damage to the natural population of our waters. The chemical reagent "lysate" is produced from the blood of this crab. Lysate is used to test the magnitude of adulteration in medicine or any other substances. The Western countries discovered the medicinal properties of the king crab and medicines and vaccines produced from its blood are used in treatment of veneral diseases, AIDS and heart diseases. In countries like United States, China and Japan, 50 percent of the blood of the crab is extracted with hypodermic needles and the animal is released back into the nature. It quickly recovers from its loss of blood. Let us also follow this method of taking the best out of this animal and save the human life from dreadful diseases without killing the goose that lays golden eggs (Suseelan & Nair, 1994).