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MARINE LIVING RESOURCES OF THE UNION TERRITORY OF LAKSHADWEEP —

An Indicative Survey With Suggestions For Development

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2. HISTORY OF MARINE RESEARCH IN LAKSHADWEEP

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INTRODUCTION

The Lakshadweep consisting of a number of islands, islets and submerged reefs lie scattered in the vast Arabian sea on the west coast of India. This geographic isolation has been a major impediment to maintain *status quo* with the progress and developmental activities on the mainland. Of recent, the stress has been to achieve a conduce growth of the economy of the islanders so as to improve their standard of living. Besides agriculture the traditional source of livelihood of the islanders is fishing which plays an important role in the economy. Since the land area is limited, the scope for large scale development of land based industries and agriculture is meagre, the future programmes have to be centred on the exploitation of marine living resources. Ever since human settlement in these islands a variety of marine living resources available in the lagoons and in the surrounding oceanic waters have been in different state of exploitation, mostly in a primitive way. Significant strides have been made in the field of fisheries thanks to the various developmental activities carried out by the Department of Fisheries, Lakshadweep. The Central Marine Fisheries Research Institute also has played a key role in research, development and management of the fisheries. Now, the various activities in research, development and management are anxious to break out of the introversion displayed so far.

There is general consensus that the living resources in and around the islands hold great potential for exploitation to a high magnitude. But from a resource point of view the Lakshadweep archipelago was not surveyed or investigated upon seriously till recently. Most of the studies made, so far, mainly centered around Minicoy. Information that is available on the living resources is confined to faunistic records, taxonomic studies, observations on the fishing craft and gear, accounts on the biology of tunas and live-baits, natural history and some environmental parameters. With the realisation of the importance and scope for further development, attention is now being paid to take stock of the marine living resources by proper survey to assess and monitor these resources to postulate management measures.

The present review is to document all available information on marine research in Lakshadweep. The paper highlights essential aspects concerning the marine biological, fisheries and oceanographic research carried out in Lakshadweep.

A historical resume of marine fisheries research in Lakshadweep has been given by James *et al.* (1986a). The marine biological and fisheries research in this area dates back to the latter half of the 19th century when attempts were made by some British naturalists to study the flora and fauna of the Lakshadweep and Maldive Archipelagoes. The surgeon naturalist A. Alcock set sail on 17th October 1891 by R. M. S. *Investigator* and for two months cruised the Lakshadweep sea. Apart from a graphic description of the islands Alcock (1894) gave an account of the deep sea fishes collected from the Lakshadweep sea. The Cambridge University Expedition under the leadership of Prof. J. Stanley Gardiner was a significant event in the marine biological and oceanographic research and the results were reported in two volumes of *'Fauna and Geography of the Maldive and Laccadive Archipelagoes* (J. S. Gardiner (Ed.) 1903-1906). The atoll of Minicoy has been described by Gardiner (1900). Later, Hornell (1910) and Ayyangar (1922) described briefly the tuna fishing methods in Lakshadweep. The importance of the marine living resources and the need for judiciously exploiting them has been realised which resulted in the establishment of a Research Centre of Central Marine Fisheries Research Institute (CMFRI) and the Department of Fisheries, Lakshadweep in 1958 and 1959 respectively. During the last three decades scientists of CMFRI, NIO and Fisheries Department of Lakshadweep have furthered our

knowledge on the environmental characteristics, fishery resources, fishing methods and fishery biology of important tunas and live-bait fishes, corals, coral reefs and ancillary resources.

STUDIES ON ICHTHYOFAUNA

Some of the early accounts on the ichthyofauna are that of Alcock (1894, 1092) and Alcock (1890, 1892, 1898, 1899, 1900). A noteworthy contribution towards the knowledge of the ichthyofauna was made by Balan (1958). He made a visit to the islands Agatti, Kavaratti, Amini and Kadmat in March 1954 and documented 80 species of fishes belonging to 65 genera. Later, Jones and Kumaran (1959) while describing the fishing industry of Minicoy listed 154 species of fishes from the lagoon and reef, many of which being new records. Jones (1960a, 1960b, 1969), Jones and Kumaran (1967a, 1967b, 1967c, 1971), Jones *et al.* (1969, 1970) elaborated the list of ichthyofauna. The publication of the *'Fishes of the Laccadive Archipelago'* by Jones and Kumaran (1980) remains to be the most comprehensive account on the fish fauna of the Lakshadweep. They have documented 603 species of reef fishes and bathypelagic forms. Due consideration has been given to the systematics of commercially important tunas and related fishes as well as the common live-bait fishes.

EXPLORATORY SURVEY

As early as 1928 experimental trawling in the seas around Lakshadweep was carried out by the erstwhile Madras Fisheries Department, using Steam Trawler *Lady Goschen* (Sundara Raj, 1930). The material collected from *Basses de Pedro* Bank included quality perches such as *Lethrinus* spp., *Epinephelus* spp. and *Lutjanus* spp. A variety of invertebrates also have been collected.

A detailed account of the co-operative oceanographic cruises by R. V. *Kalava* is given by Jones (1959c). Valuable information on the oceanographic conditions and the fishery resources of the seas around Lakshadweep was collected during the cruises of this vessel. Larval fishes such as *Xiphias gladius, Istiophorus gladius, Katsuwonus pelamis, Euthynnus affinis* and *Auxis* sp. were collected (Jones, 1958a, 1958c, 1959a, 1959b, 1959d, 1960c, 1963). The results of the exploratory surveys of R. V. *Varuna* in the sea around the islands have been well documented by Silas (1968, 1969, 1972).

ASSESSMENT OF FISHERY POTENTIAL

Studies on the assessment of stock of tunas in the Lakshadweep and nearby seas were given priority in the research programmes of CMFRI in view of the fact that the steady increase in the landings and decrease in mean length of yellowfin tunas exploited by the Japanese tuna fishing fleet. Recent development of the purse seine fishery in the western Indian Ocean with reference to the repercussions on the stocks of migratory skipjack tuna have been pointed out by Jones (1986). The present estimate (1986) of the total marine fish production in Lakshadweep is 5535 tonnes of which tunas formed 4807 tonnes. This figure is quite low compared to the reported potential of 90,000 tonnes (Jones and Banerji, 1973) around the Lakshadweep The skipjack tuna resource of this area has been estimated to be 50,000 tonnes (George *et al.*, 1977).

STUDIES ON TUNAS AND RELATED FISHES

There is a well-established traditional system for the capture of tunas in Minicoy and some of the other islands by the pole and line fishing using live-baits. Scientific observations on the craft and gear and fishing methods were initially carried out by the erstwhile Madras Fisheries Department. Valuable observations on the fishing tackles and tuna fishing industry in the islands are that of Hornell (1910), Ayyangar (1922), Ellis (1924), Mathew and Ramachandran (1956), Jones (1958, 1960a, 1960b, 1964a, 1964b), Jones and Kumaran (1959), Varghese (1971), Puthran and Pillai (1972), Ben-Yami (1980), Silas and Pillai (1982, 1986), Ali (1983), Koya (1984), Madan Mohan *et al.* (1986), Nair (1986), Silas *et al.* (1986a) and Livingston (1987c, 1987d, 1987e).

Eversince the establishment of a Research Centre in Minicoy, the CMFRI has undertaken studies on tunas and live-bait fishes. Aspects such as the fishery, length frequency distribution, age and growth, length-weight relationship, maturity, spawning, food and feeding habits and other biological characteristics of the yellowfin and skipjack tunas have been studied by

Raju (1961, 1963, 1964a, 1964b, 1964c), Thomas (1964a. 1967), Thomas and Kumaran (1963), Appukuttan *et al.* (1977), Madan Mohan (1986a), Madan Mohan and Kunhikoya (1986a, (1986b), Madan Mohan *et al.* (1986a) and Varghese and Shanmugham (1987). Different types of tuna shoals have been described by Sials and Pillai (1982) and Livingston (1987a, 1987b). Madan Mohan (1986) gave a brief account of tuna shoals associated with flotsam. Studies on the population dynamics of tunas have been made by Silas *et al.* (1986b) and James *et al.* (1986c). The status and the various programmes of tuna fishery development and management in Lakshadweep have been discussed by Varghese (1986, 1987), Silas and Pillai (1986), James (1987), James and Pillai (1987) and James *et al.* (1987b).

RESEARCH ON LIVE-BAIT RESOURCES

The success of the pole and line fishery purely depended on the easy and timely availability of the live-baits in required quantity. Pioneering works on the faunal composition and exploitation of tuna live-baits of Lakshadweep, especially of Minicoy are those of Jones (1958, 1960a 1960b, 1961a, 1961b, 1964a), Jones and Kumaran (1980) and Thomas (1964b). During the cruises of R. V. *Kalava* the occurrence of *Spratelloides delicatulus* around many islands have been observed, and Jones (1960a) rightly pointed out its tmportance as a potential live-bait. Subsequently Jones (1961a, 1961b) recorded *S. japonicus*. Later, Jones (1964a) described 45 species of live-bait fishes belonging to 30 genera and 19 families based on the results of the primary survey. Detailed account on the fishing methods, storage and utilisation of the live-baits are also available (Jones, 1958). Another noteworthy work on the live-baits is that of Thomas (1964b). During 1960-61 he made observations on the fluctuations of live-bait fishes in Minicoy and pointed out that 11 species were being regularly exploited. The study included the length frequency distribution of *Lepidozygus tapeinosoma*, *Archamia fucata*, *Caesio caeruleus*, *C. tele*, *C. crysozoma*, *Dipterygonotus leucogrammicus*, *Chromis caeruleus*, and *Spratelloides* sp. Other studies on the ecology and biology of reef fishes at Minicoy with special reference to live-baits are also available which included *Spratelloides delicatulus* and *S. japonicus* (Madan Mohan and Koya, 1986c), *Chromis caeruleus* (Madan Mohan *et al.*, 1986b), *Dascyllus aruanus*, *Acanthurus triostegus* and *Abudefduf glaucus* (Pillai *et al.*, MS., Pillai, 1983). Unusual and massive recruitment of the reef fish *Ctenochaetus strigosus* to the Minicoy atoll has been shown by Pillai *et al.* (1984b). The microhabitat and coral association of the live-bait fishes of the lagoon of Minicoy has been elucidated by Pillai (1983a). He, further, pointed out the impact of mass mortality of corals on reef associated fishes. Functional mechanism of co-existance of some of the species of live-baits have been shown by Pillai *et al.* (1986). The correlation between the lunar cycle and the occurrence of pelagic baitfishes was demonstrated by Madan Mohan (unpub.). The present exploitation potential and plan for development of the live-bait fishes of Lakshadweep have been described by Nair (1986), Pillai *et al.* (1986) and James *et al.* (1987a). The ecological stress in Minicoy lagoon and its impact on tuna live-baits has been pointed out by Pillai and Madan Mohan (1986). Population characteristics of tuna live-baits in the Lakshadweep have been studied by Gopakumar and Pillai (1988).

The increase in the number of pole and line units consequent on mechanisation of boats has resulted in higher catches of tunas and hence the demand for live-baits also increased. This will have adverse effect on the stock of some of the common live-baits. Jones (1964b) thought of *Tilapia mossambica* as an alternate for live-baits and introduced it to Minicoy. Now the species has established itself in all the freshwater ponds, wells and some of tne marine tidal pools. Studies have revealed the unsuitability of this species as an alternate for live-baits.

STUDIES ON OTHER FIN FISH RESOURCES

The highly productive waters around the islands, the submerged banks and the crevices of coral boulders and reefs are ideal habitats for a large number of economically important fishes (Jones and Kumaran, 1980) which offers scope for extensive fishing by simple crafts and gears. Nearly one fourth of the landings in Lakshadweep at present is accounted for by fishes belonging to important groups such as elasmobranchs, perches, carangids, half beaks belonids, red mullets and seer fishes. An account

of the fishery resources of Laccadive Archipelago has been given by Jones (1968). Silas (1968) described the oceanic and demersal fishery resources of the Laccadive Sea. Problems, prospects and developmental programmes in fisheries sector, the need for diversification of the fishing effort for exploiting various resources have been pointed out by Varghese (1974), Haneefa Koya (1982), Kumaran and Gopakumar (1986), Varghese (1986, 1987a, 1987b). James (1987) and James *et al.* (1986b, 1987b). Silas and George (1970) have described the larval and post larval development and distribution of the mesopelagic fish *Vinciguerria nimbaria*.

Many of the reef fishes are colourful and attractive and have good demand for home aquaria in different parts of the world. Cheap to very expensive ornamental fishes offer scope for export on a limited scale and can be attempted with suitable arrangements for storage, transportation and marketing (Anon, 1985; Tomey, 1985, 1986; George *et al.*, 1986; James, 1987 and James *et al.*, 1986b, 1987b).

FISHERY ENVIRONMENTAL STUDIES

The Central Marine Fisheries Research Institute was first to initiate detailed oceanographic investigations on the environmental features of this region. During the cruises of R. V. *Kalava* and R. V. *Varuna* a lot of information on the physical, chemical and biological parameters of the marine environment and also some oceanographic features such as currents, water masses, upwelling etc. have been collected. The importance of the waters in this region with their special ecological conditions have been shown by Jones (1959c). The investigations of Ramasastry (1959) and Jayaraman *et al.* (1959) have revealed the existance of four distinct water masses in the Arabian Sea. The influence of the nutrient rich Antarctic bottom water in the Lakshadweep sea area was indicated by Prasad (1951) and Jayaraman *et al.* (1960). Other noteworthy contributions to the knowledge on oceanographic features of this area are those of Patil and Ramamirtham (1963). Rao and Jayaraman (1966), Rao and Jayaraman (1970), Sankaranarayanan (1973), Rao *et al.* (1976), Sen Gupta *et al.* (1979) and Ramamirtham (1979). A brief account of the environmental features of the sea around Lakshadweep has been given by Nair *et al.* (1986).

The early studies on the primary production of tuna grounds of the Lakshadweep are by Prasad and Nair (1964). The productivity of the reefs has been estimated by Nair and Pillai (1972). Qasim *et al.* (1972) made a comprehensive study on the primary production of the ambient waters and reefs of Kavaratti atoll. The primary production of the seagrass beds of Kavaratti atoll has been determined by Qasim and Bhattathiri (1971). Other major investigations on primary production of Lakshadweep waters are those of Bhattathiri and Devassy (1979) and Qasim *et al.* (1979). Nair *et al.* (1986) briefly described the productivity of the seas around Lakshadweep.

The earliest work on zooplankton is that of Wolfenden (1906) on copepods. Studies on zooplankton assemblages around some of the northern islands have been studied by Jones (1959). Silas (1972) estimated the zooplankton biomass closer to the reefs of the islands during the cruises of R. V. *Kalava*. Based on the studies on the Deep Scatterihg Layer (DSL) closer to the islands Silas (1972) suggested that the DSL constituted an important source of forage to the pelagic fishes. Tranter and Jacob (1972) made quantitative study of the zooplankton of Kavaratti and Kalpeni atolls. In spite of the importance of the zooplankton in the reef ecology, these organisms have received vary little attention. What little information available are due to the works of Gardiner (Ed.) (1906), Wolfenden (1906), Prasad and Tampi (1959), Goswamy (1973, 1979, 1983), Silas (1972), Tranter and Jacob (1972), Madhu Pratap *et al.* (1977), Nair and Rao (1973), Mathew (1982), Rengarajan (1983) and Silas and Mathew (1987). Qasim (1970) described some characteristics of a *Trichodesmium* bloom in the Laccadives.

The importance of satellite imageries from Landsat and Indian Remote Sensing Satellites and ocean colour sensing from Coastal Zone Colour Scanner (CZCS) of NIMBUS-7, which can provide general level of productivity, details of water masses in the area and aggregation of of fish schools, has been shown by Silas *et al.* (1985).

MARINE INVERTEBRATE FAUNA

The marine fauna and flora of Lakshadweep islands are unique and diverse. The early information on the marine fauna are mostly

based on the various articles published in the two volumes of *'Funa and Geography of Maldives and Laccadive Archipelagoes'* (J. S. Gardiner (Ed.) 1903-1906). Results of the detailed ecological survey of the marine fauna of the Minicoy atoll have been given by Nagabhushanam and Rao (1972). The studies carried out on the marine fauna are mainly from Minicoy which included foraminifera (Chapman, 1895): Corals (Gardiner, 1903b, 1906a, 1906b, 1906c; Cooper, 1906b; Pillai, 1971a, 1971 b, 1972, 1983a, 1983b, 1985, 1986,1987), Sponges (Thomas, 1973, 1979, 1980a, 1980b); turbellaria (Faidlaw, 1903), Coelenterates (Borradaile, 1906d; Browne, 1906a, 1906b; Mamman, 1963; Rengarajan, 1987), nemertines (Punnet, 1903a), cephalochordata (Cooper, 1903; Punnet, 1903b), enteropneusta (Punnet, 1906), echiuroids (Shipley, 1903a), Sipunculoids (Shipley, 1903b), Stomatopods (Fanchester, 1903) crabs (Alcock, 1895, 1896, 1898, 1899, 1900; Borradaile, 1903a, 1903b, 1903c, 1903d, 1906a, 1906b, 1906c; Sankarankutty, 1961), lobsters (Meiyappan and Kathirvel, 1978; Pillai *et al.* 1984a), cirripedia (Borradaile, 1903c), amphi-, poda (Walker, 1906), alphids (Coutiere, 1903, 1905, 1906), molluscs (Eliot, 1906; Hoyle, 1906; Smith, 1906; Hornell, 1910; Buston, 1940; Appukuttan, 1973; Rao *et al.*, 1974; Namboodiri and Sivadas, 1979; Nair and Dharmaraja, 1983; Panicker, 1978) and echinoderms (Bell, 1902; Gardiner, 1803a; Buston, 1940; Sivadas, 1977; Murty *et al.*, 1970; Mukhopadhyay and Samana, 1983, James, 1966; Nagabhushanam and Rao, 1972; Daniel and Haldar. 1974 and Rao and Misra, 1983).

ANCILLARY LIVING MARINE RESOURCES

There are a number of ancillary living marine resources which include seaweeds, crustaceans, molluscs, sponges, echinoderms, reptiles such as turtles, birds etc. Informations on these resources are based on the faunistic observations on one time or intermittant collections by different workers. An account of the ancillary resources have been given by George *et al.* (1986).

Algae: The marine algal distribution is generally sperce and heterogenous. From a resource assessment angle the marine algae have been surveyed (Anon, 1979) by Central Salt and Marine Chemicals Research Institute. Ansari (1980) observed the benthic micro and macrofauna of seagrass (*Thalassia hempricheii*) bed. Jagtap and Untwale (1984) gave an account of the chemical composition of marine macrophytes, their surrounding water and sediment from Minicoy. Untwale and Jagtap (1984) described the marine microphytes of Minicoy.

Crustacea: The prawns and crabs are not fished in Lakshadweep, The brachyuran crabs and lobsters of Lakshadweep have baen studied by Alcock (1895, 1896, 1898 1899, 1900) and Borradaile (1903, 1906). Alcock reported 41 species of crabs and Borradaile 52 species of crabs and two species of lobsters. Sankarankutty (1961) recorded 36 species out of which 27 were from Minicoy and the rest from some of the other islands. Meiyappan and Kathirvel (1978) published some new records of crabs and lobsters from Minicoy. Pillai *et al.* (1985) recorded *Panulirus versicolor* from Minicoy and opined that this species is most common with a seasonal distribution pattern. According to Meiyappan and Kathirvel (1978) *P. Penicillatus* was the most common lobster in Minicoy in the late seventies.

Mollusca: Early records on the molluscan fauna are that of Smith (1906) and Burton (1940). Appukuttan (1973) observed nine species of coral boring bivalves causing destruction to the fringing reef of the islands, Appukuttan and Pillai (MS) have listed 48 gastropods and 12 bivalves. Among the gastropods Top shells (Trochidae), Spider conch (Strombidae), Cone shells (Conidae), Cowries (Cypraedae) and Helmet shells (Cassidae) are commercially important and are exploited by the local fishermen.

Sponges: Thomas (1973, 1979, 1980a, 1980b) made observations on the sponge fauna and reported 41 species including some shell boring forms from Minicoy. The common Indian bath sponge, *Spongia officianalis* has been observed in Minicoy. Many of the sponges are rich in bromine and iodine.

Echinodermata: A number of holothurians suitable for *Beche-de-mer* are available in the lagoons of the islands. Early observations by Gardiner (1903) recorded both surface living as well as large numbers of white variety living in the sand. Later, Burton (1940) observed several

species of holothurians in every pool in Chetlat. *Holothuria atro, H. scabra, Actinopyga mauritiana* and *A. echinites* are most abundant species in Minicoy. James (MS) recorded ten species from Kiltan. Quantitative assessment of the resources has not been made and the available information points out lesser chances for large scale exploitation of this resource for the *Beche-de-mer* industry.

Turtles and Birds: Bhaskar (1984) has reported four species of turtles which occur and nest in Lakshadweep. They are the hawksbill (*Erethmochelys imbricata*), the olive-ridley (*Lebidechelys olivacea*), the green turtle (*Chelonia mydas*) and the leather-back (*Dermochelys coriacea*).

The whole sand bank of Pitti island was found literally covered with young of two species of terns (Alcock, 1902). The only specific studies on birds are that of Betts (1938) who reported 44 species including several shore and water birds such as plovers, terns, sand pipers, shear waters, teals and herons.

CONSERVATION OF THE ECOSYSTEM

Conservation of the ecosystem and the marine resources assumes paramount importance in any future plans for the development and as well to the very existance of these islands. The coral colonies which harbour a variety of flora and fauna are prone to natural senescence. A plethora of events both natural and man-made have been creating havoc to the ecosystem. Indescriminate dredging and blasting of the corals and sea erosion and the consequent siltation have resulted in the death of corals leading to imbalances in the reef ecosystem. The details about the oil spill in the Kiltan from oil tanker 'Transhuron' have been described by Qasim *et al* (1974). The lagoon environment of Minicoy has undergone visible change in the last decade due to natural causes and human interference (Pillai, 1983a, 1985, 1986). Possible threats to marine environment and ecology of Lakshadweep (Laccadive Islands) have been described by Sivadas (1987). The need for preserving these delicate ecosystems has been pointed out by James (1987) and James *et. al.* (1986b, 1987 b). The islands and the lagoons with the corals and a wide variety of flora and fauna are beautiful' idyllic and exhillarating and is a coral paradise (Anon, 1984). Declaration of a few undisturbed and undamaged areas in the region as marine parks and reserves are necessary (James, 1987; James *et al*, 1987b). This would have the advantage of not only preserving the nature but also providing excellent tourist attraction.

POTENTIAL FOR MARICULTURE

Limited experiments conducted in Bangaram lagoon for pearl oyster culture showed encouraging results. Further research will be required to study the technical feasibility and economic viability before large-scale programmes can be introduced (Varghese, 1987a; James, 1987; James *et al*. 1986b). It may also be worthwhile to undertake investigations on the feasibility of introducing aquaculture programmes suitable to the island conditions (James *et al.*, 1986b). James (1987) has pointed out the need for undertaking culture of live-bait fishes. Experiments are underway in the Research Centre of CMFRI at Minicoy. There exist amble scope for culture of finfishes in cages, seaweed culture, creation of artificial reefs and sea-ranching of commercially important fishes as well as holothurians.

DEVELOPMENT AND MANAGEMENT

The problems of Lakshaweep are varied and peculiar by virtue of its geographic location, density and variations of the marine living resources. developing suitable crafts. and gears as means of exploitation, meeting the requirements of manpower including trained personnel, making available the credit needed and providing infrastructure facilities for fish processing, transportation and marketing are some of the important aspects concerned with the development of marine fisheries (Jones, 1986; Sagar 1986; James, 1987; James and Pillai, 1987; James *et. al.*, 1986b; James *et. al.* 1987b; Silas and Pillai, 1986).

A wealth of information on the marine flora and fauna are now availabie. Except for continuous monitoring of some of the important resources such as tunas, live baits. corals and seaweeds most of these studies on the flora and fauna are based on intermittant observations at Minicoy and a few other islands by various authors from time to time. A realistic estimate

of the various resources both quantitative and qualitative is essential for any future plans for development and the CMFRI has conducted a short and time bound survey. This will remain as a bench mark for future surveys and developmental programmes. The various teams have collected information on various resources and their potential, could identify problems and prospects of fisheries development and areas and species for mariculture. Proper implementation of the suggestions and recommendations, it is hoped, would definitely give an uplift to the fisheries sector and finally the economy of the islanders.

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