

**FAUNISTIC COMPOSITION AND PATTERNS  
IN THE DISTRIBUTION OF SOFT CORALS (OCTOCORALLIA ALCYONACEA)  
ALONG THE CORAL REEFS OF SINAI PENINSULA**

**COMPOSITION FAUNISTIQUE ET SCHEMA DE DISTRIBUTION  
DES CORAUX MOUS (OCTOCORALLIA ALCYONACEA)  
SUR LES RECIFS CORALLIENS DE LA PENINSULE DU SINAI**

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**ABSTRACT**

Species composition and distribution of soft corals on the coral reefs around Sinai Peninsula (northern Red Sea) were studied. SCUBA observations and collections were carried out at various localities along the Gulf of Eilat, southern tip of Sinai and the Gulf of Suez. The study involved careful examination of a large variety of niches in shallow water, as well as in deeper reef zones (to a depth of 40 m). Soft coral assemblages were characterized at the different zones and habitats in terms of dominant species.

The collections comprised of approximately 2,250 specimens, raising up 183 the total number of soft coral species known from the Red Sea. The study established 18 new species and 29 new geographical records. Two of the new species belong to genera recorded for the first time from the Red Sea (i.e. Lemnalia and Metalcyonium). More than 50% of the species list are representatives of the family Alcyoniidae, while 31% belong to the Nephtheidae. The Xenidae are represented by 15% of the species. Only three siphonogorgian species (family Nidaliidae) were found in the study areas.

A major factor limiting the distribution of soft corals is the availability of hard substrate for settlement. Other factors that interact in determining their faunistic composition and abundance are concerned with resistance to harsh environments and life history parameters. Many alcyoniids monopolize space on reef areas which are exposed to low tides and wave surge. Space dominance by xenids is achieved due to their fecundity and asexual propagation. Local populations of nephtheids and their low recruitment proposed a low reproductive potential and short-distance distribution of planulae. In addition, competitive interaction with other benthic reef-organisms play an important role in the distribution of the Red Sea soft corals.

**RESUME**

Une étude sur la composition spécifique et la distribution des alcyonaires a été effectuée sur les récifs coralliens situés autour de la Péninsule du Sinaï (nord de la Mer Rouge). Des observations en plongée et des récoltes ont été effectuées dans différentes régions du Golfe d'Eilat, l'extrémité sud du Sinaï et le Golfe de Suez. Une grande variété de biotopes situés dans les eaux peu profondes ainsi que dans des zones plus profondes du récif jusqu'à 40 m ont ainsi été examinées. Les peuplements de coraux mous et leurs espèces dominantes ont été mis en évidence dans les différentes zones et habitats.

Environ 2250 spécimens ont été récoltés et le nombre total d'espèces de coraux mous connus en Mer Rouge a atteint 183. Cette étude a permis d'établir 18 nouvelles espèces et de signaler 29 espèces de plus pour la région. Deux des nouvelles espèces appartiennent à des genres signalés pour la première fois en Mer Rouge (Lemnalia et Metalcyonium). Plus de 50% des espèces de cette liste sont représentés par les Alcyoniidae, alors que 31% appartiennent à la famille des Nephtheidae. Les Xenidae sont représentés par 15% des espèces. Seules trois espèces de Siphonogorgian (famille des Nidaliidae) ont été observées dans la zone étudiée.

La surface de substrat dur disponible pour l'installation des espèces s'est révélée être un facteur important limitant la distribution des alcyonaires. Les facteurs historiques et la plus ou moins grande résistance des espèces à des conditions environnementales sévères sont d'autres facteurs qui agissent en synergie sur la composition faunistique et l'abondance des espèces au sein des peuplements.

Beaucoup d'Alcyoniidae monopolisent l'espace dans les zones des récifs situées en mode battu et exposées aux marées basses. La dominance des Xenidae pour l'occupation de l'espace est due à leur fécondité élevée et leur propagation par reproduction asexuée.

Les populations locales de Nephtheidae, et leur faible recrutement, traduisent ainsi un taux de reproduction faible et un potentiel de migration restreint des planulae. Enfin, la compétition avec les autres organismes benthiques joue un rôle important dans la distribution des Alcyonaires sur les récifs de Mer Rouge.

## INTRODUCTION

The soft-coral fauna of the Red Sea (Octocorallia: Alcyonacea) has been investigated for almost two hundred years. High numbers of new species and new zoogeographical records of alcyonaceans from this region are an indication of the diverse nature of the group in this area (references in Verseveldt, 1965). Kükenthal's study (1913), based on material collected during the "Pola" expedition, summarizes the early knowledge on the Red Sea Alcyonacea. Negligible information has been published on the Red Sea soft corals between Kükenthal's work and Gohar's publication (1940). In the course of the Israeli 1962 South Red Sea Expedition, 3 new species of alcyonacean corals were collected (Verseveldt, 1965). Later surveys of the coral reefs around the Sinai peninsula (northern Red Sea) yielded several new species and new records reported for the first time from the Red Sea (references in Benayahu and Loya, 1977). Several studies present ecological aspects of soft corals at the Gulf of Eilat (Fishelson, 1970; Mergner, 1979; Benayahu and Loya, 1977, 1981). Recent surveys deal with life history of some common Red Sea alcyonaceans (Benayahu and Loya, 1983, 1984a, b, c).

The current work is concerned with species composition and patterns in the distribution of soft corals in the Sinai Peninsula reefs. The results of this study are based on twelve years of extensive collections of alcyonacean corals along the Gulf of Eilat, the southern tip of Sinai and the Gulf of Suez. Habitat preferences and distributional patterns of the most abundant species are presented and discussed in relation to biotic and abiotic factors.

## METHODS

The collection of the alcyonacean corals was mainly carried out by using SCUBA diving. The material was obtained at various localities along the coral reefs of the Sinai Peninsula (Figure 1). During several expeditions and field trips to numerous reef sites, most probably surveyed for the first time by reef scientists, a large variety of habitats were examined. Approximately 2,250 specimens were collected in shallow water, as well as in deeper reef zones to a depth of 40 m. The information gathered for every sample included depth of material collected and notes on their distribution and habitat.

## RESULTS

A systematic list of the Red Sea soft corals has never been published. However, based on the taxonomic literature, prior to this study, 136 species were recorded from this geographical region (Benayahu in prep.).

The collection reported in the present work yielded 18 new species (for taxonomical description see Verseveldt and Benayahu, 1978, 1983; Benayahu, 1982; Verseveldt, 1982). Among these new species, *Metalcyonium verseveldti* and *Lemnalia benayahui*, belong to genera recorded for the first time from the Red Sea. In addition, these publications reported 29 new geographical records found for the first time in this region. Therefore, 47 species can be considered either new species or new species records. Table 1 presents the generic affiliation of these species. These results point out that the majority of the new records are alcyoniids (77%), mainly *Sinularia* species. The nephtheids constitute 9% of the species while the xeniids are represented by only 2%. The 47 aforementioned soft corals present a 35% increase over the previously 136 known species. Hence, the current collection raised the total number of alcyonaceans of this zoogeographical area to 183.

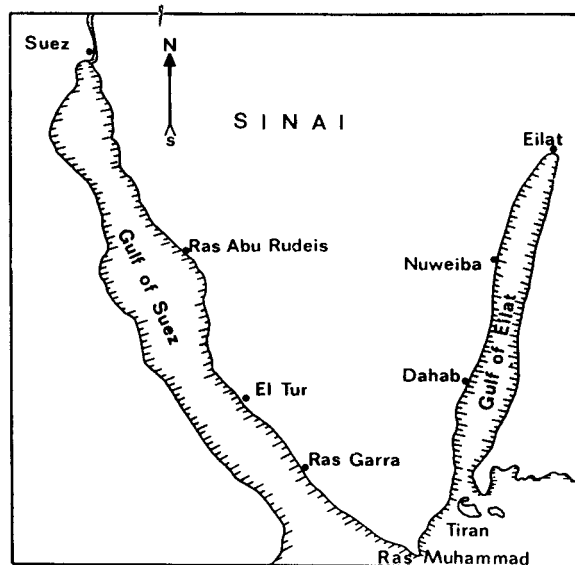


Fig. 1: Map of the study area.

Table 2 presents the generic affiliation of all species known from the Red Sea. More than half of the total number of species (52%) are representatives of the Alcyoniidae, 31% belong to the Nephtheidae and 15% are represented by the Xeniidae. Only three siphonogorgian species (<2%) of the Nidaliidae, were found in the study area.

Diverse assemblages of *Sinularia* are characteristic for shallow reef habitats, such as the reef flats and the upper fore-reef zones. They tend to create monospecific aggregates composed of numerous colonies, which locally may cover several square meters. The most abundant *Sinularia* in the

study area are S. leptoclados, S. polydactyla and S. gardineri. Other common species are S. candidula, S. erecta, S. grayi, S. humesi, S. compressa, S. heterospiculata and S. notanda. Their preferred habitat is the reef flats, but occasionally they create a continuous dense cover toward the upper fore-reef slopes (3-5m). Other Sinularia species such as S. querciformis, S. macrodactyla and S. rigida have never been collected from the reef flats, but only in deeper water.

Table 1. Generic affiliation of new species and new geographical records.

Genera	New Species	New Records
Family Alcyoniidae		
<u>Cladiella</u>	1	4
<u>Lobophytum</u>	1	
<u>Metalcyonium</u>	1	
<u>Sarcophyton</u>	4	3
<u>Sinularia</u>	9	13
Family Nephtheidae		
<u>Dendronephthya</u>		2
<u>Lemnalia</u>	1	
<u>Litophyton</u>		1
<u>Scleronephthya</u>	1	
<u>Stereonephthya</u>		4
Family Xenidiidae		
<u>Xenia</u>		2

Although 30 Cladiella species are known from the Red Sea, only 10 species were collected in the present survey. Cladiella pachyclados is the most common species in all reef localities. Its colonies are aggregated on the reef flats, but often some may also be found in deeper zones. Other abundant Cladiella species are: C. brachyclados, C. digitulata, C. elongata, C. madagascarensis and C. sphaerophora. The richest Cladiella assemblages were found at the coral reefs of the Gulf of Suez.

Among the 14 Sarcophyton species (Table 2), S. glaucum is the most conspicuous soft coral. Colonies of this species create aggregations found below the reef flats, in lagoons or reef slopes (2-8 m). Each aggregation contains colonies of a wide size range. Large colonies of S. glaucum with a disk diameter of 20-50 cm, are scattered to a depth of 40 m. S. gemmatum, a new species found in the present survey (Verseveldt and Benayahu, 1978) is widespread along the

entire gradient depth. These colonies very often bear small buds arising from the stalk or from the lower part of the disk. It is assumed that they detach from the colony and serve for asexual propagation. The study indicates that the other new species, S. pauciplicatum was collected only from reef flats, while S. auritum has a wider depth distribution (1-35 m).

Table 2. Generic affiliation of all soft corals of the Red Sea.

Genera	Number of Species
Family Alcyoniidae	
<u>Alcyonium</u>	2
<u>Cladiella</u>	30
<u>Lobophytum</u>	6
<u>Metalcyonium</u>	1
<u>Parerythropodium</u>	1
<u>Sarcophyton</u>	14
<u>Sinularia</u>	42
Family Nephtheidae	
<u>Dendronephthya</u>	29
<u>Lemnalia</u>	1
<u>Litophyton</u>	5
<u>Nephthea</u>	11
<u>Paralemnalia</u>	3
<u>Scleronephthya</u>	2
<u>Stereonephthya</u>	5
<u>Umbellulifera</u>	1
Family Nidaliidae	
<u>Siphonogorgia</u>	3
Family Xenidiidae	
<u>Anthelia</u>	2
<u>Cespitularia</u>	1
<u>Heteroxenia</u>	3
<u>Symphodium</u>	1
<u>Xenia</u>	20

All 6 Lobophytum species are shallow water dwellers. Aggregates of L. pauciflorum and L. crassum grow only on reef flats or in back-reef lagoons. The distribution of L. depressum is restricted to a narrow zone, 2-6 m deep, on steep upper fore-reefs. These colonies very often overgrow many stony corals and cause their elimination.

The two Alcyonium species of the Red Sea: A. flaccidum and A. utinomii have a moderate abundance. They were collected from substrates below the reef flats to a maximal depth of 12 m. Parerythropodium fulvum is a common soft coral at the study area. The abundance of this encrusting species gradually decreases with depth

(Benayahu and Loya, 1983). Parerythropodium is very often attached on overhanging substrates and in reef crevices. Metalcyonium verseveldti was found only once, in the southern tip of Sinai. Although many more dives were conducted in order to obtain information on its abundance, it has not been recorded since.

Dendronephthya is the most diverse genus among the Nephtheidae. Ten species were collected, however the collection contains more material which is still unidentified. The most common species are D. curvata, D. ehrenbergi, D. hartmeyer, D. hemprichi and D. sinaiensis. In contrast to most alcyoniids Dendronephthya species have never been found on reef flats. At the northern part of the Gulf of Eilat Dendronephthya is rare, found only in crevices of the reef or sometimes under the shade of coral heads. However, at the southern part of the Gulf and at the southern tip of Sinai many localities are densely populated by Dendronephthya species. Their abundance is typically increased in deep reef zones. It is worth mentioning that D. pharonis and D. grandiflora are dwellers of soft sediment surfaces, anchored by their ramifying holdfasts.

Nephthea species are inhabitants of lagoons and depressions on reef flats. The most abundant species in the studied localities are: N. acuticonica, N. albida and N. chabrolli. Among the 5 Litophyton species, L. arboreum is the most common. Its clumps are growing at a depth range of 3-18 m.

Four new Stereonephthya records in the Red Sea were collected in the study (Table 1). All of them are rare alcyonaceans, however S. cundabiluensis, the previously known species, is abundant. Scleronephthya corymbosa is often found on concave surfaces below the edge of the upper fore-reef zones. At deeper habitats it inhabits overhanging substrates and caves. Paralemnalia eburnea and P. thyrsoides are found in all studied depth gradients, mainly in association with Xenidiidae. Lemnalia benayahu is common at the reefs of the Gulf of Suez, but has never been found at the Gulf of Eilat.

Species of Siphonogorgia are rare in the study area. At the straits of Tiran (Fig. 1) and at the southern tip of Sinai S. fragilis, S. mirabilis and S. variabilis are found in a variety of niches with low illumination.

The Xenidiidae form the most conspicuous group of soft corals in all studied localities. Usually they densely cover large areas below the surf zone. The most common Xenia species are: X. blumi, X. garciae, X. hicksoni and X. macrospiculata. Heteroxenia fuscescens, H. ghardaqensis and H. coheni are also widespread. H. ghardaqensis dominates

reef patches at the southern tip of Sinai and at the Gulf of Suez. Anthelia glauca, A. fishelsoni and Sympodium caeruleum inhabit empty spaces between Xenia colonies, especially in crevices and on fragments of dead branched stony corals.

#### DISCUSSION

The present study indicates that the coral reefs of the Sinai Peninsula contain a diverse alcyonacean fauna. Although the study of the Red Sea soft corals has a long history, many new species and new geographical records were obtained in the last years (Table 1).

The soft coral fauna of the Red Sea is part of the Indo-Pacific zoogeographical region. Many species that had been originally described from the Red Sea, were reported later also from other localities at the Indian and Pacific Oceans. For example, the well-known species Sinularia leptoclados was first described from the Red Sea. Today, it is known from numerous Indo-Pacific sites (Verseveldt, 1980). The close resemblance between the Red Sea fauna and that of the Indian Ocean is well expressed by the fact that a large number of species that had been first described from Madagascar, were found lately in Sinai reefs (i.e., Sinularia vrijmoethi and S. terspili: Verseveldt, 1971). On the other hand, Xenia macrospiculata which had been described by Gohar (1940) from the Egyptian coast of the Red Sea, was later also recorded in Madagascar. It is very likely that there are endemic alcyonaceans in the Red Sea. However, further research is required for such generalities concerning the faunal characteristics of this region.

Patchy distribution is one of the most remarkable features of many alcyonaceans (Benayahu and Loya, 1977; Tursch and Tursch, 1982), thus leading to varied species composition and abundance in different localities. Such a spatial distribution results from short pelagic phase of the planulae and their gregarious behavior (Benayahu and Loya, 1984c). In addition, asexual reproduction which is common in many soft corals causes development of monospecific aggregations (Benayahu and Loya, 1984b).

The main factor that limits alcyonacean distribution is the availability of firm substrate suitable for settlement. Depth distribution and zonation of the different species is determined by biotic and abiotic factors (see also Dinesen, 1983). The present survey indicates presence of distinct soft coral assemblages in different reef structures and habitats. The main space utilizers on the reef flats and upper fore-reef zones are Sinularia, Sarcophyton, Lobophytum and Parerythropodium. Similar

distribution of alcyoniid genera was recorded on reef flats of the Great Barrier Reef, Australia (Dinesen, 1983). This faunal predominance suggests resistance to wave surge, temperature fluctuations and tidal emergence. Patches of hard substrate in back-reef lagoons are covered mainly by xeniids. They also flourish in turbid habitats of the Gulf of Suez. Therefore, these findings support the assertion that xeniids preferably settle in calm waters and resist sedimentation (Fishelson, 1970). Nephtheidae and Xenidae are conspicuously abundant in reef areas below 5 m, while Alcyoniidae are generally sparse (Benayahu and Loya, 1981).

The reefs at the southern Gulf of Eilat and the southern tip of Sinai are the most diverse in soft corals compared with other localities. In shallow water they are dominated by accumulations of numerous alcyoniids. In deeper zones there is a marked increase of soft coral diversity. Steep slopes are predominated by Dendronephthya and Stereonephthya assemblages intermingled with xeniids. Such reefs are endowed with excellent irradiance penetration and tidal currents which enrich the water with plankton supply (Klinker et al., 1976). Deep reefs with low illumination and strong currents are the habitat of well adapted species of Siphonogorgia and certain nephtheids, while development of other alcyonaceans is suppressed.

Competitive interactions with other reef organisms clearly play an important role in determining the distribution of soft corals (Benayahu and Loya, 1981; Sammarco et al., 1983). Abundance of alcyonaceans might be largely determined by differences in life history parameters, mainly reproductive strategies. Successful space exploitation by xeniids is achieved by high fecundity and asexual reproduction (Benayahu and Loya, 1984b). It is suggested that rare occurrence of many nephtheids and nidaliids is due to their low reproductive potential and short-distance dispersal of planulae.

Further exploration of the Red Sea reefs will undoubtedly reveal more new alcyonacean records. Life history studies would probably provide additional explanation for the distributional patterns of the various species. Nevertheless, the current survey dispels any doubts about the rich and highly diverse soft coral fauna of this geographical area.

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