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Research Article

Species Composition and Distribution of Scleractinian on Reefs of Wan Phong and Nha Trang Bays (South Vietnam)

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Abstract

A study of coastal reefs in the little investigated shallow waters of Khanh Hoa province was conducted to determine the structural peculiarities and zonality of the reefs, species composition of corals, and some of the dominant species that form densely populated zones. There are more than 250 species of reef building corals. The geomorphological position, degree of breakers, and nature of the link between shore and open part of the sea of the coastal reefs of Khanh Hoa province may be divided into three groups: reefs of inland bays (sheltered from strong waves), reefs of bays between the mainland and large islands (partly subject to strong waves), and reefs of open capes and islands (frequent strong waves).While possessing a small vertical and horizontal range, the reefs of Khanh Hoa province preserve the features and patterns of the classically known reefs, all of which makes it possible to use them as a model in elucidating the overall patterns of development of reef ecosystems in the Indo-Pacific area.

Keywords: Species Composition,Distribution, Scleractinian, South Vietnam.

Introduction

The reef-building corals and reefs of Vietnam attracted scientific attention as early as the first half of the twentieth century by Séren and Dawydoff (Séren, 1937; Dawydoff, 1952). These works focused on the identification of species richness of corals and other reef invertebrates of South Vietnam. The first to analyze the zonation of reef-building corals in reefs was made by Loi for the Khanh Hoa province (Loi, 1967). He distinguished four scleractinian-dominated facieses for some Island-Reef as well as a list of scleractinian, which included 78 species.

These investigators determined the species composition of scleractinian and demonstrated its similarity to that of Australia and Indonesia (Latypov, 1982). Beginning in 1980, systematic studies of Vietnam corals and reefs have been performed in joint expeditions by the Institute of Marine Biology (Vladivostok), Nha Trang Institute of Oceanography, Haiphong Institute of Oceanology. 23 a reefs between 12° N and 13° N were explored. Generally, the region has found 119 species of scleractinian. Revealed morphological zoning and types of reef and bionomical

characteristics of the main groups of coral. It was shown that about morphology, species diversity of corals and their distribution, the investigated reefs are wholly comparable to many Indo-pacific reefs, including the Great Barrier Reef of Australia (Pichon, 1971; Loya, 1972; Veron and Hudson, 1978; Bouchon, 1981; Latypov, 1982, 1994). At the beginning of this century were conducted repeated studies on many transects that were explored in the early 80-ies of the last century (Latypov, Selin, 2013).Below present the morphological characteristics of different groups of reefs and the distribution peculiarities of their corals.

Materials and Methods

Study area

During the land expedition of 2004 and the cruise of the research vessel Akademik Oparin in 2005, 2007, 2013 species composition, abundance and biological state of scleractinian from some coral reefs of Khanh Hoa province in Wan Phong and Nha Trang Bays (Fig. 1), located at different distances from the city of Nha Trang and areas of intensive aquaculture, were studied with using SCUBA methods. Corals and accompanying macro fauna were taken stock of according to a standard method of frames and transects: along 100 m transects with footage marking, established perpendicular to a coastline from shore line to reef slope base (Loya, Slobodkin, 1971; Latypov, 1982). Depth of along transects was fixed diving depthometer "Seemann Sub". The transects guided on topographical features: capes, tops of hills, etc. The degree of substratum covering with corals and macroalgae was assessed on each meter of transect with use of a framework of 1 sq. m. divided into 100 squares, corals were photographed for identification of their species affiliation, and in rare cases of doubt, and their samples were taken. Number mass a species of mollusks and echinoderms counted on the area of 5 sq. m.

Analysis of data

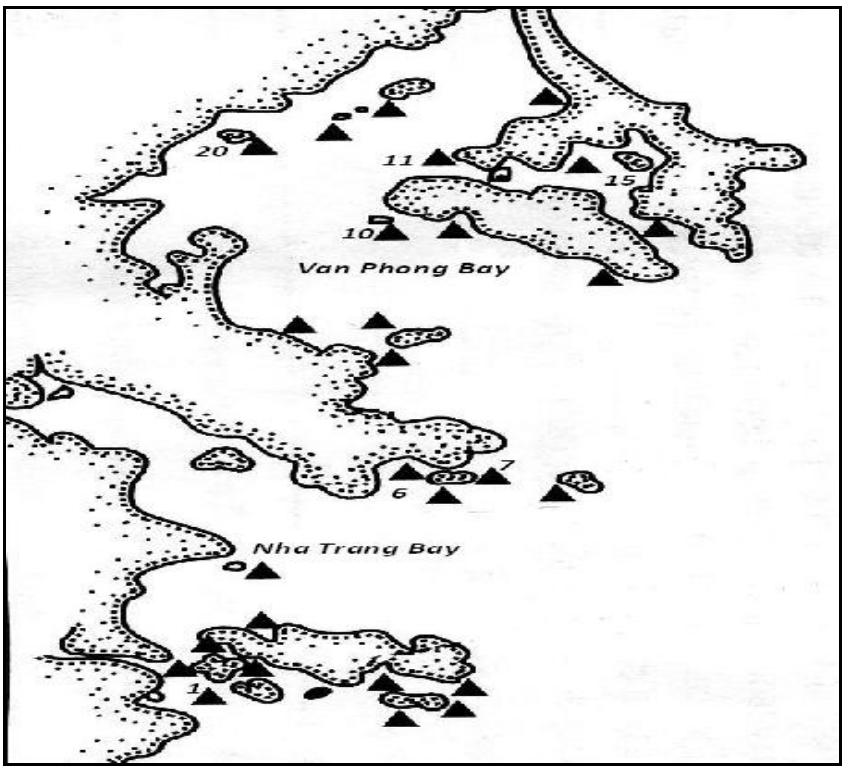
Coefficients of species diversity corals were calculated by the formula: $H = -\Sigma[(ni /N) x (lnni / N)]$, where *H* – Shannon Diversity Index, ***ni***- number of individuals belonging to i species, ***N*** – total number of individuals (Mandaville, 2002). Photographed and collected on transects corals (more 500 samples) defined on Veron and Latypov (Veron, Smith, 2004; Latypov, 1990, 1992; Latypov, Long, 2010). A total of 255 species was discovered in the region (Table 1).

Results and Discussion

Bionomic characteristics of the reefs of the main geomorphological groups are presented below from the most typical sections.

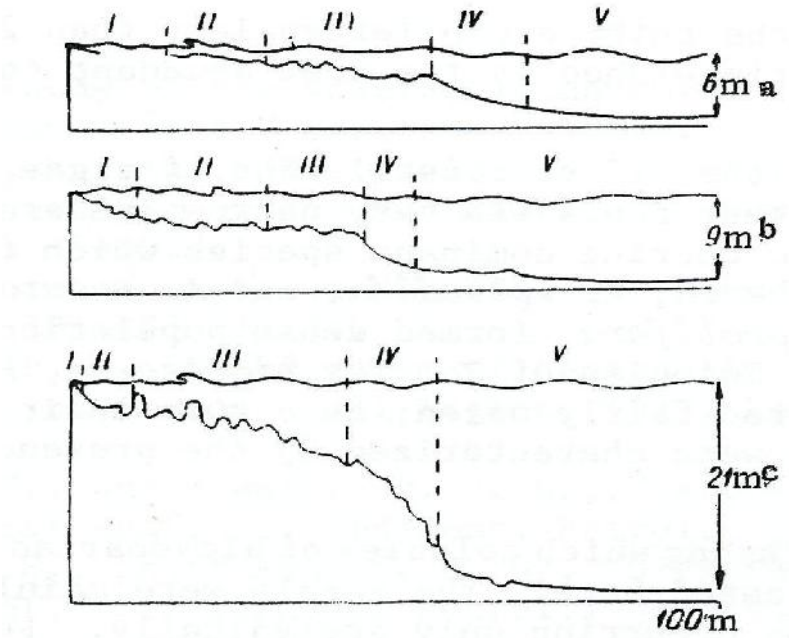
Reefs of Inland Bays (eastern part of Kummeo Island, transect 20, Fig. 2a). The fossil reef slopes to the sea. Starting from the lower horizon of the littoral is the zone of the algae *Sargassum* and *Turbinaria* (covering 80-90% of the substrate surface) among which the massive colonies *of Porites*, *Favia, Favites*, and *Goniastrea* are distributed, rarely the branching *Acropora* and solitary *Fungia.* The number of algae shrinks from meter 10 of thetransect (depth 1 m) and the role of corals grows. Dominating in the composition of the latterare *Porites cylindrica* (up to formation of dense populations) and the numerous *Montipora foliosa* "heads" of colonies of *Leptoria, Platygyra, Montastrea*, and *Goniastrea* are often encountered; less widely distributed are *Pocillopora* and rarely *Acropora*. This zone is 15-20 m wide.From meter 13 (depth 2 m) there is the developed zone of *Acropora nasuta* and *Porites lobata*, with many medium and large colonies of Leptoria, *Montastrea, Platygyra, Goniastrea,Favia, Favites*, and *Galaxea*, the laminar *Merulina, Montipora*, and *Pavona*, and large colonies of soft corals *Litophyton,Sarcophyton*, and *Melithaea*. This zone is 20-25 m wide.From meter 15 (depth 3 m) the dominating colonies are *Leptoria, Platygyra, Porites*, and*Montastrea* (1.5 m across and 1-1.5 m high). There are dense "glades" of soft corals, and bioherms (Fig. 3), comprised chiefly of massive and encrusting colonies; branching forms of colonies are rare. This distribution of corals remains unchanged up to meter 80 of the transect (depth 6m); it is only with the increase of depth from 4 to 6 m that the

Figure 1.Location of Van Phong and Nha Trang Bays and studies of reef. Numeric mark number of the transects:



1 – Mju Island, 6 – Jiang Bo Reef, 7 –cape Hon Do, 10 –Den Island, 11 – cape Co - co, 15–Ong Island, 20 – Kummeo Island, visited again.

Figure 2.Profile of different groups of reefs of Khanh Hoa province



(a, b, c) – transects 20, 1, and 10, respectively; I-IV – morphological zones (explained I text)

Figure 3. Appearance of bioherms in Den Island, depth 7 m

colonies and bioherms become smaller and the distance between them greater. At the end of the transect solitary massive and laminar colonies of corals and small bioherms occur on the even section of the bottom covered with fragments of dead corals with organogenic detritus and silt.

Reefs of Bays between Mainland and Large Islands (southeastern part of Mju Island, transect 1, Fig. 2b). The sharply precipitous coastline comprises huge pebbles and boulders that become heaps of large boulders and lumps at a depth of 0.5-1 m. From meter 10 along the transect (depth 2 m) sparse algae and isolated colonies of scleractinian, notably *Acropora*, *Pocillopora*, and *Porites*, are encountered. The abundance and diversity of corals increase the farther away from the coastline, sometimes constituting 20% of the coveringof the substrate. From meter 20 along the transect (depth 3 m) the abundance and diversity of corals increase and the well-distinguished dominants are two species of Acropora (zone of *Acropora nasuta* and *A. formosa*). Colonies of *Porites* and *Millepora* were widely distributed in this zone; diverse Faviidae and Fungiidae are often encountered, but the soft corals *Sinularia*, *Sarcophyton*, and *Litophyton* rarely. From meter 30 (depth 3 m) the largest species diversity of corals and variations of forms of their colonies occur. Abundant colonies of soft corals and laminar *Acropora* are highly conspicuous against this background. Some colonies of *Sarcophyton trocheliophorum* and *Acropora cytherea* reach 1.5-2 m in diameter; fairly large measurements are seen among *Porites lobata, Turbinaria peltata, Millepora dichotoma*, and *Echinopora lamellosa*.

From meter 40 (depth 3.5 m) the species composition of corals starts to deteriorate, the size of their colonies becomes reduced, and from meter 45 there is a discernible declivity of the reef. Depth increases (from 4 to 6-8 m), species diversity dramatically decreases, and the composition of corals and diversity of their growth forms change. Branching forms decrease and laminar and encrusted forms increase. Flat brittle colonies of *Micedium*, *Pachiseris*, *Merulina*, and others dominate. From meter 50 (depth 8 m) there is a flattening out of the silty-sandy section of the bottom with spare small lumps of insular rock whose surface is populated (up to 20% of the substrate surface) by colonies *of Porites, Favia, Favites, Goniopora, Pectinia, Merulina, Micedium, Seriatopora, Lobophyllia, Symphyllia, Traahyphyllia.* Up to meter 70 solitary corals are encountered after which they are not observed until the end of the transect.

Reefs of Open Capes and Islands (southern part of Den Island, transect 10, Fig. 2c). The cliffs jut into the sea. The littoral zone is covered with an algal "bloom" of crust and prostrate colonies of

Millepora, encrusted and laminar colonies of *Acropora,* and branching spherical colonies of *Pocillopora.* Peaks of living and dead laminar colonies of *Acropora* crust *Porites* and *Millepora,* and soft corals occur along the first meters of the transect (depth 1-2 m). Soft corals, *Acropora* and solitary *Pocillopora* settle in crevices. The coral populations are spotty and rarely cover more then 20% of the substrate surface. Large lumps of insular rock (2-3 m high) abundantly covered on all sides with corals are observed from 10-15 m of the transect (depth 3-4 m). The most widely distributed of these are *Millepora platyphyla, M. dichotoma*, *Porites lobata, P. australiensis* (chiefly encrustedforms), *Acropora, Favites, Favia, Goniastrea, Galaxea, Pachisteris, Micedium, Echinopora,*and *Pavona*. The upper surface of outliers and lumps is completely covered with colonies of corals, mainly of the genera *Millepora, Acropora,* and *Porites*. Small settlements of branching *Acropora formosa* and *A. nasuta,* rarely the laminar *A. cytherea,* occur at the foot.

The bottom between the lumps is strewn with pale medium-grained sand and fragments (up to 1m) of colonies of corals, mainly the branched forms. Silt is also present. On the bottom elevations and the larger fragments there are colonies of *Acropora, Favites, Goniastrea, Leptoria, Montipora, Galaxea, Echinopora, Turbinaria, Pachiseris,* and *Lobophyllia,* with the frequent occurrence of solitary *Fungia, Herpolitha*, and *Polyphyllia*. This distribution of corals is observed along the transect for a distance of 25-30 m. From meter 50 (depth 10 m) the size of the lumps and outliers decreases and the distance between them increases. In the distribution of corals the attention is immediately caught by the reduction in abundance of *Acropora* and *Millepora* and the appearance of *Gorgonaria*.

The colonies of *Acropora* and *Pocillopora* become thin-branched and decrease in size and Poritidae and Faviidae become more flattened or bark-like encrusted. The scleractinian *Turbinaria, Pachiseris, Echinopora, Pectinia,* and *Goniopora,* and the soft and gorgonian corals *Litophyton, Sarcophyton, Dendronephtya, Melithaea,* and *Ellisella* are frequently encountered; most often occurring are colonies of *Dendrophyllia* which have increased in size. From meter 65 (depth 20 m) there are small solitary lumps of insular rock which are populated, by few gorgonians and isolated colonies of *Pocillopora, Acropora, Micedium, Pachiseris, Goniapora, Pectinia, Leptastrea,*and *Lobophyllum.* From 78 m (depth 21 m) is a flattened section of the bottom which is markedly silty and contains fragments of dead corals and mollusk valves on which small solitary colonies of gorgonians are observed.

All the sections of coastal reefs of Khanh Hoa province which we investigated had approximately the same structure and distribution of corals as described above. Total identified 255 species of ref-building corals. They are characterized by a high level of biodiversity (Fig. 4), except the littoral and reef off the island of Mju. A reef near Mju Island is situated in the immediate vicinity to Nha Trang city and port, which surrounded from every quarter with mariculture farms (more 40) and tourist complexes. Great level of human influence is increasing eutrophication of water column adjacent to the island of Mju and silting of the substrate around it (An et al., 2000; Huan, Huang Son, 2000; Pavlov et al., 2004; Latypov, 2006). Here the changes in reef community composition are especially obvious due to heavy silting of substratum, corals and other representatives of macrobenthos in the area of the reef slope. In the surrounding waters, values of sedimentation flow are extremely high: 35.3-48.6 $g \cdot m^2 \cdot day^{-1}$. For the past two decades the degree of substratum covering by corals reduced (Fig. 5), number and size of colonies of reef-building scleractinian decreased, and abundance of algae *Halimeda opuntia, H. discoidea* and *Ch. implexa* increased. Species diversity of corals, especially of *Acropora,* reduced. Various species of lamellar and branched *Acropora* and *Montipora,* common here earlier, were considerably replaced by mono settlement of fine-branched *Montipora porites*. Alga *Ch. Implexa* settled in all reef zones, occupying actively substratum and space between coral branches, and its covering made 60-75% of substratum area. Coral covering of substratum

overall rarely exceeds 40-50%. As before, small (2-5 cm) regenerating colonies of scleractinian *Montipora, Porites, Favites,* hydroids *Millepora*, which diversity and abundance, nevertheless, 1.5-2 times dropped, can be met on branched debris of dead corals.

In General, the studied reefs are characterized by relatively high degree of similarity in their species composition of scleractinian (Fig. 6). The slight differences consisted essentially of the extension of the reef body from the coastline along the vertical and horizontal and the extent to which the substrate surface was covered with corals and dominant species capable of forming abundant settlements over 100% of the substrate surface. Reefs of the first group were the longest (often 60-80 m, rarely more than 100 m);the shortest reefs were those in the third group (often less than 25 m), especially nearcliffs.

The second group was distinguished by the most abundant corals covering the substrate. Reefs of the first group had the widest coastal zone of algae - up to several tens of meters- while this zone in the other reefs was very narrow (several centimeters on rocky substrate). The most frequently occurring dominant species which formed dense populations were *Acropora* (*A. formosa, A. cytherea, A. valenciennesi*, and *A. nasuta*). *Porites cylindrica*, alone or together with *Montipora foliosa*, formed dense populations up to 40 m wide at three reefs (7, 15, and 20 transects). Colonies of *Porites nigrescens, Pavona frondifera*, and *Millepora dichotoma* were encountered fairly often; as a rule their width did not exceed 10- 12 m. All the investigated reefs were characterized by the presence of five (Fig. 2, I-V) typical morphological zones.

Algae -Coral Zone (I) . Algae, among which colonies of alcyonarian and scleractinian coralswere distributed, distinctly dominated here. The corals were mainly spherical and microatollin form, the branching forms occurring only sporadically. Fungiidae were also encountered sporadically. In sheltered bays these zones could be 20-30 m wide, while thickets of *Sargassum* and *Turbinaria* could reach 100% of the surface substrate covering. "Heads" of *Porites, Favia, Goniastrea, Platygyra*, and *Leptoria* as well as occasional "bushes" of *Acropora* were observed in these thickets. In general appearance, collection of' coral taxa, and forms of their colonies, this type of zone is comparable to lagoons of many Indo-Pacific reefs (Pichon, 1981; Morton, 1974; Dai, 1993; Latypov, 2008). It is located from the lower zone of the littoral to adepth of 1.5-2 m.

Zone of Dominant Corals (II). Dense, taxonomically abundant populations of corals usually develop in this zone. Dominant species of *Acropora, Porites, Pavona, Montipora, Heliopora*, and *Millepora* or massive populations of corals of one species (*Acropora nasuta, A. cytherea, Porites cylindrica, Pavona frondifera, Montipora grisea*, and others) are distinctly characteristic. The zone may be 3-5 or 15-25 m wide and lies at a depth of 1.5-6 m. A zone of this type is comparable with the reefflet zone (Loya, 1972; Bouchon, 1981; Latypov, 2009, 2012).

Zone of Outliers and Canals (III). This is a strongly disarticulated zone with numerous outliers, protuberances, canals, and niches, distinguished by the largest species diversity of corals and modified forms of colonies. At the peaks of some outliers there may be corals covering 100% of the substrate surface and at the base small settlements of branched and laminar colonies of *Acropora formosa* and *A. cytherea* are possible. The zone is 5-20 m wide (rarely 30-35 m) and lies at a depth of 3-12 m. This zone is in good comparison with the buttress zone of Pacific Ocean reefs (Phips and Preobrazensky, 1977; Pichon, 1981; Latypov, 1999).

Reef Slope (IV). Although this zone is small the drop in depth is always well expressed. It is characterized by a paucity and change in species composition of corals and modified forms and colonies. There are gorgonian corals whose diversity and abundance increases. Branching and massive forms of scleractinian are reduced and their spatial orientation changes. There is an increase in thin laminar and encrusted colonies (*Pectinia,*

Table.1 List of species in different transects

Species	L	1	6	7	10	11	15	20
Acantastrea echinata(Dana, 1846)		+		+	+	+	+	+
Acantastrea hemprichii (Erhenberg, 1834)			+		+	+		+
Acantastrea hillae(Wells, 1955)			+				+	+
Acropora abrotonoides(Lamarck, 1816)		+		+	+	+	+	+
Acropora anthocercis(Brook, 1892)			+		+	+		+
Acropora aspera(Dana, 1846)	+	+		+	+	+	+	+
Acropora cerealis(Dana, 1846)			+			+		
Acropora clathrata(Brook, 1981)		+		+			+	+
Acropora cytherea (Dana, 1846)	+	+	+	+	+	+	+	+
Acropora dendrum(Bassett-Sminh, 1890)							+	+
Acropora digitifera(Dana, 1846)	+	+	+	+	+	+	+	+
Acropora divaricata(Dana, 1846)				+		+	+	+
Acropora florida(Dana, 1846)		+	+		+	+		+
Acropora formosa(Dana, 1846)	+		+	+	+	+	+	+
Acropora gemmifera (Brook, 1892)		+			+	+		
Acropora glauca(Brook, 1893)				+	+	+	+	+
Acropora globiceps(Dana1846)							+	+
Acropora grandis(Brook, 1892)			+	+	+	+	+	+
Acropora granulosa(Edw. &Haime, 1860)		+		+		+	+	+
Acropora horrida(Dana, 1846)			+		+	+		+
Acropora humilis(Dana, 1846)	+	+	+	+	+	+	+	+
Acropora irregularis(Brook, 1892)							+	+
Acropora hyacinthus(Dana, 1846)		+	+		+	+		
Acropora loripes(Brook, 1892)				+		+	+	+
Acropora lutkeni(Crossland, 1952)				+	+	+	+	+
Acropora millepora (Ehrenberg, 1834)	+	+	+	+	+	+	+	+
Acropora monticulosa (Brüggemann, 1879)			+					+
Acropora multiacuta(Nemenzo, 1967)					+	+		
Acropora nasuta(Dana, 1846)		+	+	+	+	+	+	+
Acropora nobilis (Dana, 1846)		+	+					+
Acropora pulchra(Brook, 1891)		+		+	+	+	+	+
Acropora robusta (Dana, 1846)		+	+	+		+	+	+
Acropora samoensis(Brook, 1891)							+	+
Acropora sarmentosa(Brook, 1891)		+	+		+	+		
Acropora secale (Studer, 1878)		+		+			+	+
Acropora solitariensis (Veron & Wallace,1984)						+		
Acropora speciosa (Quelch, 1886)					+	+	+	+
Acropora tenuis(Dana, 1846)	+	+		+			+	+
Acropora valenciennesi (Edw. &Haime, 1860)				+		+	+	+
Acropora valida (Dana, 1846)			+		+	+		
Acropora vaughani (Wells, 1954)				+	+	+	+	+
*Acropora yongey (*Veron & Wallace, 1984)				+	+	+	+	+
Alveopora marionensis (Veron &Pichon, 1982)						+	+	+
Anacropra forbesi(Ridley, 1884)						+		+
Astreopora listeri(Bernard, 1896)	+		+	+			+	+

Astreopora myriophthalma (Lamarck, 1816)		+	+		+	+		
Astreopora ocellata(Bernard, 1896)		+		+	+	+	+	+
Barabattoia mirabilis (Yabe &Sug., 1941)			+	+	+	+	+	+
Caulastrea furcata(Dana, 1846)			+		+	+		
Caulastrea tumida(Matthai, 1928)				+			+	+
Coscinaraea columna(Dana, 1846)				+	+	+	+	+
Coscinaraea exesa(Dana, 1846)		+			+	+		
Ctenactis echinata(Pallas, 1766)				+	+	+	+	+
Cycloseris costulata(Ortman, 1889)							+	+
Cycloseris cyclolites(Lamarck, 1801)					+	+		
Cynarina lacrymalis(Edw. &Haime, 1848)			+					+
Cyphastrea chalcidicum(Forskål, 1775)		+	+	+	+	+	+	+
Cyphastrea japonica (Yabe & Sugiyama, 1932)					+	+	+	+
Cyphastrea microphthalma (Lamarck, 1816)		+	+			+		
Cyphastrea serailia(Forskål, 1775*)*		+	+	+	+	+	+	+
Dendrophyllia robusta (Bourne, 1905)			+					+
Diaseris fragilis(Alcock, 1893)					+	+		
Diploastrea heliopora (Lamarck, 1816)		+	+	+	+	+	+	+
Echinophyllia aspera(Ellis &Solander, 1786)		+		+	+	+	+	+
E. echinoporoides(Veron &Pichon, 1980)			+	+		+	+	+
E. nichihirai(Veron &Pichon, 1990)							+	+
E. orpheensis(Veron &Pichon, 1979)		+	+		+	+		
Echinophyllia patula(Hodgson & Ross, 1981)							+	+
Echinopora gemmacea(Lamarck, 1816)		+		+	+	+	+	+
Echinopora hirsutissima(Edw. &Haime, 1849)		+	+					
Echinopora lamellosa(Esper, 1795)		+	+		+	+	+	+
Euphyllia ancora(Veron &Pichon, 1980)								+
Euphyllia cristata(Chevalier, 1971)			+		+	+		
Euphyllia divisa(Veron &Pichon, 1980)						+	+	+
E.glabrescens(Chamisso&Eysenhard, 1821)		+		+	+	+	+	+
E. fimbriata(Spengler, 1799)		+			+	+		+
*Euphyllia grandiseptata*Latypov, 2014							+	+
Euphyllia yaeyamaensis(Shirai, 1980)							+	+
Favia camranensis Latypov, 2013	+			+		+	+	+
Favia favus(Forskål, 1775)		+	+	+	+	+	+	+
Favia laxa(Klunzinger, 1879)							+	+
Favia lizardensis(Veron &Pichon, 1977)			+		+	+		
Favia maritima (Nemenzo, 1971)		+		+			+	+
Favia matthai(Vaughan, 1918)				+	+	+	+	+
Favia maxima (Veron et al., 1977)	+	+	+		+	+		+
Favia pallida(Dana, 1846)		+	+	+	+	+	+	+
Favia rotumana(Gardiner, 1889)	+	+	+		+	+		
Favia speciosa(Dana, 1846)		+	+	+	+	+	+	+
Favia stelligera(Dana, 1846)					+	+	+	+
Favia veroni(Moll & Best, 1984)	+				+	+	+	+
Favites abdita(Ellis &Solander, 1786)		+	+	+	+	+	+	+
Favites chinensis(Verrill, 1866)			+		+	+		+
Favites complanata(Ehrenberg, 1834)	+	+	+		+	+	+	+

Favites flexuosa (Dana, 1846)			+		+	+		+
Favites halicora(Ehrenberg, 1834)				+			+	+
Favites russelli(Wells, 1954)					+	+		
Favia rotundata(Veron&Pichon, 1977)		+	+	+	+	+	+	+
*Favites solidocolumellae*Latypov, 2014					+	+		+
Fungia concina(Verrill, 1864)	+					+		
Fungia danai(Edwards &Haime, 1851)				+			+	+
Fungia fungites (Linnaeus, 1758)		+	+	+	+	+	+	+
Fungia repanda(Dana, 1846)	+				+	+		
Fungia scruposa(Klunzinger, 1879)							+	+
Fungia scutaria(Lamarck, 1801)	+	+		+	+	+	+	+
Galaxea astreata(Lamarck, 1816)		+	+	+	+	+	+	+
Galaxea fascicularis (Linnaeus, 1767)			+	+	+	+	+	+
Gardineroseris pavonoides sp. nov.	+				+	+		+
Gardineroseris planulata(Dana, 1846)				+			+	+
Goniastrea aspera(Verrill, 1865)	+	+	+	+	+	+	+	+
Goniastrea australiensis (Edw. &Haime, 1857*)*				+	+	+	+	+
*Goniastrea edwardsi(*Chevalier, 1971)	+	+	+	+	+	+	+	+
Goniastrea favulus(Dana, 1846)	+		+			+		
Goniastrea pectinata (Ehrenberg, 1834)		+	+	+	+	+	+	+
Goniastrea retiformis(Lamarck, 1816)		+	+			+	+	+
Goniopora fruticosa(Saville-Kent, 1893)					+	+		
Goniopora lobata (Edwards &Haime, 1851)		+		+			+	+
Goniopora stokesi(Edwards &Haime, 1851)		+		+	+	+	+	+
Goniopora tenuidens(Quelch, 1886)				+		+	+	
Heliofungia actiniformis (Quoy& Gaimard,1833)								+
*Herpolitha limax(*Esper, 1797)				+			+	+
Holomitra robusta (Quelch, 1886)		+	+	+	+	+	+	+
Hydnophora exesa(Pallas, 1766)		+	+	+		+	+	+
Hydnophora microconos (Lamarck, 1816)		+	+		+	+		+
Hydnophora rigida(Dana, 1846)	+	+	+	+	+	+	+	+
Isopora cuneata(Dana, 1846)		+			+	+		+
Isopora palifera(Lamarck, 1816)	+			+	+	+	+	+
Leptastrea pruinosa(Crossland, 1952)	+	+	+	+	+	+	+	+
Leptastrea purpurea(Dana, 1846)			+			+		
Leptastrea transversa(Klunzinger, 1879)		+	+	+	+	+	+	+
Leptoria phrygia (Ellis &Solander, 1786)		+	+	+	+	+	+	+
Leptoseris explanata(Yabe & Sugiyama, 1941)		+	+		+	+	+	+
Leptoseris mycetoseroides(Wells, 1954)				+		+	+	+
Leptoseris scaba(Vaughan, 1907)			+		+	+	+	+
Leptoserisvar.mycetoseroides (Wells, 1954)					+	+		
Leptoseris yabei(Pillai &Scheer, 1976)						+		
Lithophyllon mokai(Hoeksema, 1989)		+		+	+	+	+	+
Lithophyllon undulatum(Rehberg, 1892)				+		+	+	+
Lobophyllia grandis sp. nov.		+	+	+	+	+	+	+
L. hattai(Yabe, Sygiyama&Eguchi, 1936)					+	+		
Lobophyllia hemprichii (Ehrenberg, 1834)		+	+	+	+	+	+	+
Lobophyllia pachysepta(Chevalier, 1975)		+		+	+	+	+	+

Lobophyllia robusta (Yabe & Sugiyama, 1936)					+	+		
Madracis kirbyi(Veron &Pichon, 1976)		+		+			+	+
Merulina ampliata (Ellis &Solander, 1786)					+	+		
Montastrea annuligera(Edw. &Haime, 1849)		+	+	+	+	+	+	+
Montastrea colemani(Veron, 2000)				+			+	+
Montastrea curta(Dana, 1846)			+		+	+		
*M. valenciennesi (*Edw. &Haime, 1848)			+	+			+	+
Montipora aequituberculata(Bernard, 1897)		+		+	+	+	+	+
Montipora angulata(Lamarck, 1816)			+		+	+		
Montipora caliculata(Dana, 1846)	+				+	+		
Montipora crassituberlata(Bernard, 1897)				+	+	+	+	+
Montipora digitata(Dana, 1846)			+	+		+	+	+
Montipora foliosa (Pallas, 1766)		+	+	+	+	+	+	+
Montipora grisea(Bernard, 1897		+		+			+	+
Montipora hispida (Dana, 1846)		+	+		+	+		
Montipora hoffmeisteri(Wells, 1954)			+	+	+	+	+	+
Montipora millepora (Crossland, 1952)				+	+	+	+	+
Montipora molis(Bernard, 1897)			+				+	+
Montipora monasteriata(Forskål, 1775)	+				+	+		
Montipora nodosa(Dana, 1846)				+	+	+	+	+
Montipora porites (Veron, 2000)					+			+
Montipora spongodes(Bernard, 1897)		+	+	+		+	+	+
Montipora tuberculosa (Lamarck, 1816)							+	+
Montipora turgescens(Bernard, 1897)		+		+	+	+	+	+
Montipora turtlensis(Veron & Wallace, 1984)	+						+	+
Montipora undata(Bernard, 1897)					+	+		
Montipora verrucosa (Lamarck, 1816)				+	+	+	+	+
Montipora vietnamensis (Veron, 2000)			+			+		
Mycedium elephantotus(Pallas, 1766)		+		+			+	+
Oulastrea crispata(Lamarck, 1816)		+	+	+	+	+	+	+
Oulophyllia bennettae(Veron &Pichon, 1977)					+	+		
Oulophyllia crispa(Lamarck, 1816)		+		+		+	+	+
Oxypora lacera(Verrill, 1864)			+			+	+	+
*Pachyseris gemmae*Nemenzo, 1955		+			+	+		
Pachyseris rugosa (Lamarck, 1801)				+			+	+
Pachyseris speciosa(Dana, 1846)		+	+		+	+		
Pachyseris monticulosa sp. nov.		+	+	+	+	+	+	+
Pavona cactus (Forskål, 1775)				+			+	+
Pavona clavus(Dana, 1846)					+	+		
Pavona decussata(Dana, 1846)		+	+			+		+
Pavona explanulata(Lamarck, 1816)			+	+			+	+
Pavona frondifera(Lamarck, 1801)			+		+	+		
Pavona maldivensis(Gardiner, 1905)		+	+	+		+	+	+
Pavona varians(Verrill, 1864)					+	+		+
Pectinia alcicornis(Saville-Kent, 1871)				+			+	+
Pectinia lactuca(Pallas, 1766)		+	+		+	+	+	+
Pectinia paeonia (Dana, 1846)	+		+	+		+	+	+
Physogyra lichtensteini(Edw. &Haime, 1851)	+	+	+	+	+	+	+	+

Platygyra daedalia(Ellis &Solander, 1786)					+	+		
Platygyra lamellina(Ehrenberg, 1834)		+	+	+	+	+	+	+
Platygyra pini(Chevalier, 1975)		+	+	+	+	+	+	+
Platygyra sinensis(Edw. &Haime, 1849)				+			+	+
Plerogyra sinuosa(Dana, 1846)			+	+	+	+	+	+
Plesiastrea versipora(Lamarck, 1816)					+	+		
Pleuractis paumotensis (Stuthbury, 1833)	+	+		+			+	+
Pocillopora capitata(Verrill, 1864)			+			+		
Pocillopora damicornis(Linnaeus, 1758)					+	+	+	+
Pocillopora eydouxi(Edwards &Haime, 1860)	+	+	+	+	+	+	+	+
Pocillopora kelleheri(Veron, 2000)	+	+	+	+	+	+	+	+
Pocillopora meandrina(Dana, 1846)					+	+		
Pocillopora verrucosa (Ellis &Solander, 178)			+				+	+
Pocillopora woodjonesi(Vaughan, 1918)		+	+	+	+	+	+	+
Podabacia crustacea(Pallas, 1766)					+	+		
Polyphyllia novaehiberniae(Lesson, 1831)		+	+	+	+	+	+	+
Polyphyllia talpina(Lamarck, 1831)							+	+
Porites annae(Crossland, 1952)	+	+	+	+	+	+	+	+
Porites attenuata(Nemenzo, 1955)				+			+	+
Porites australiensis (Vaughan, 1918)			+		+	+		
Porites cylindrica (Dana, 1846)		+		+		+	+	+
Porites deformis(Nemenzo, 1955)	+		+	+	+	+	+	+
Porites lichen (Dana, 1846)							+	+
Porites lobata (Dana, 1846)		+	+		+	+		+
Porites lutea(Edwards &Haime, 1860)		+	+	+	+	+	+	+
Porites mayeri(Vaughan, 1918)		+		+	+	+	+	+
Porites monticulosa (Dana, 1846)				+			+	+
Porites murrayensis(Vaughan, 1918)					+	+		
Porites nigrescens(Dana, 1848)			+					
Porites rus (Forskål, 1775)		+	+	+	+	+	+	+
Porites solida(Forskål, 1775)				+		+	+	+
Porites sp. 2					+	+		
Porites stephensoni(Crossland, 1952)				+			+	+
Psammocora contigua(Esper, 1979)			+					
*P. digitata (Edwards &*Haime, 1851)		+	+	+	+	+	+	+
Psammocora nierstraszi(Van der Horst, 1921)		+		+	+	+	+	+
Psammocora profundacella(Gardiner, 1898)					+	+		
Pseudosiderastrea tayamai(Yabe &Sug., 1935)		+	+		+	+	+	+
Sandalolitha dentata(Quelch, 1884*)*		+	+	+	+	+	+	+
Sandalolitha robusta (Quelch, 1886)	+				+	+		
Scolymiaaff.vitiensis(Brüggemann, 1877)		+	+	+	+	+	+	+
Seriatopora hystrix(Dana, 1846)	+				+	+		
*Seriatopora caliendrum*Ehrenberg, 1834		+	+	+	+	+	+	+
Stylocoeniella guentheri(Basset-Smith, 1890)		+		+	+	+	+	+
Stylophora pistillata(Esper, 1797)				+			+	+
Symphyllia agaricia (Edwards &Haime, 1849)		+		+	+	+	+	+
Symphyllia erythraea (Klunzinger, 1879)				+			+	+
Symphyllia radians (Edwards &Haime, 1849)					+	+		

Symphyllia recta (Dana, 1846)		+	+	+		+	+	+
S. valenciennesii (Edw. &Haime, 1849)			+		+	+		
Trachyphyllia geoffroyi (Audouin, 1826)				+	+	+	+	+
Tubastrea aurea (Quoy&Gaimard, 1833)		+					+	+
Tubastrea coccinea (Ehrenberg, 1834)					+	+		
Tubastrea diaphana (Dana, 1846)				+			+	+
Tubastrea micrantha (Ehrenberg, 1834)							+	+
Turbinaria bifrons (Brüggemann, 1877)		+	+	+	+	+	+	+
Turbinaria contorta (Bernard, 1896)					+	+		
Turbinaria crater (Pallas, 1766)				+			+	+
Turbinaria frondens (Dana, 1846)					+	+		
Turbinaria mesenterina (Dana, 1846)				+			+	+
Turbinaria peltata (Esper, 1794)					+	+		
Turbinaria radicalis (Bernard, 1896)		+	+	+	+	+	+	+
Turbinaria reniformis (Bernard, 1896)							+	+
Millepora dichotoma(Forskål, 1775)	+	+		+		+	+	+
Millepora platyphyla Hemp.&Ehren., 1834)i	+	+	+		+	+		
Heliopora coerulea(Pallas, 1766)			+		+		+	+
					+		+	
Number of species 255	34	109	114	134	159	192	172	193

Note. L–littoral, the numbers 1, 6, ... 20-correspond to the numbers of transects

Figure 4. Variations of a specific diversity on the investigated reefs.

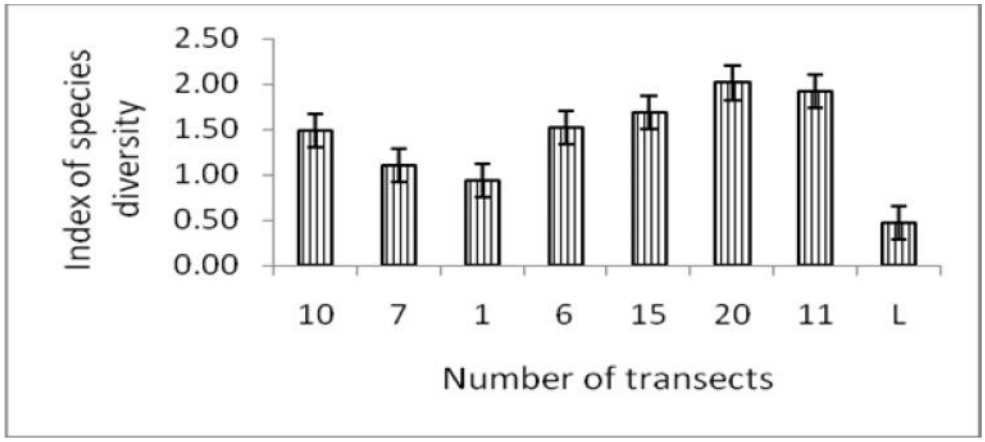


Figure 5. Variations of a substratum covering of corals on reef Mju Island

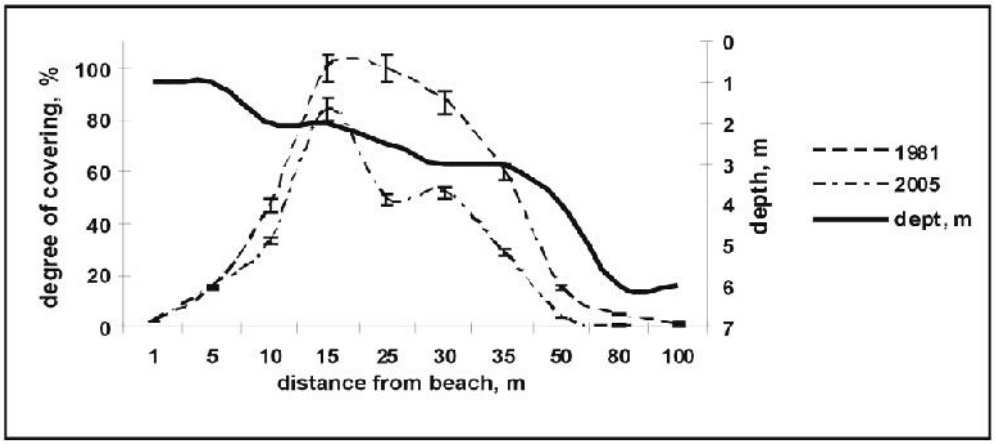
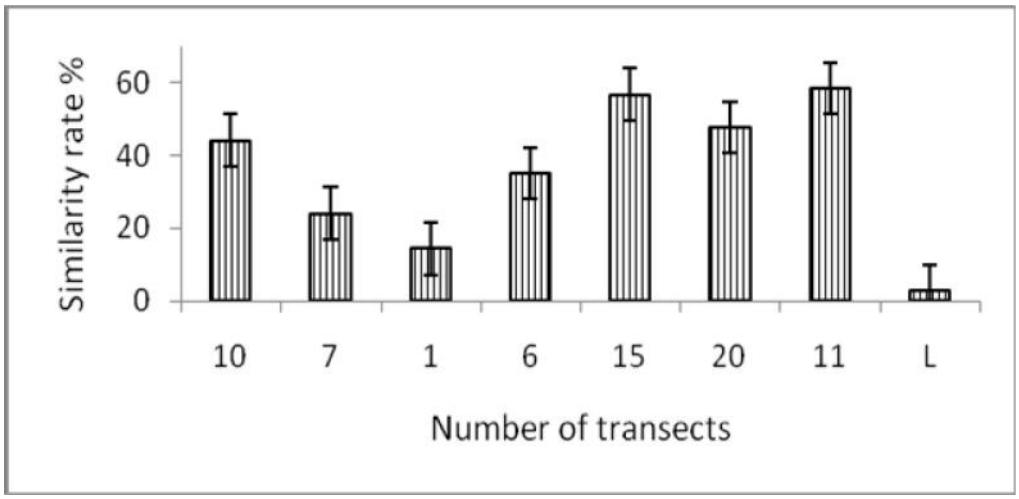


Figure 6.The degree of similarity in species composition on different reefs. Along the axis of abscissa number transects



Echinopora, Micedium, Echinophyllia, and others). This zone is 1-.

For reef Platform (V). This even section of the bottom has sandy or organogenic rubbly deposits containing silt in different quantities. There are very few live corals. These live only on the elevated sections of the bottom and are represented for the most part by small colonies and solitary corals. This zone may start from depth 5-6 m.

In morphology, species diversity of corals and their distribution, the investigated reefs are wholly comparable to many Indo-pacific reefs, including the Great Barrier Reef of Australia. Reefs of the province Khanh Hoa belong to the fertile Center of the origin of coral, which is evidenced by their high similarity of species composition of coral reefs in Thailand, Indonesia and Australia (72.4%, 62.8% and 60.8, 6%, respectively, Pichon, 1971; Veron and Hudson, 1978; Bouchon, 1981; Sakai et al., 1986; Latypov, 2008, 2011, and others). While possessinga small vertical and horizontal range, the reefs of Khanh Hoa province preserve the features and patterns of the classically known reefs, all of which makes it possible to use them as a model in elucidating the overall patterns of development of reef ecosystems in the Indo-Pacific region.

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