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Vietnamese reef-building corals and reefs in the open part of the South China Sea

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ABSTRACT

The work analyzes and discusses survey results for Vietnamese reefs in the open part of the South China Sea. It shows the degree of exploration and species composition of reef-building scleractinian of this region. It has been determined that reefs and coral fauna residing on them have similar characteristics and high species similarity by the coral composition with other regions of Vietnam, and constitute a uniform complex of species in the equatorial zone of the Indo-Pacific region. Six species of scleractinian that have not been previously noticed at the reefs of Vietnam were found – *Acropora abrolhosensis, A. insignis, A. parilis, Stylophora subseriata, Merulina scabricula, Pachyseris gemmae.*

KEYWORDS

South China Sea;
Reefs;
Reef-building scleractinian;
Species composition.

INTRODUCTION

Vietnamese reef-building corals form various reef structures along the sea shore and around the islands. They are small adjacent reefs edging the sea shore, barrier reefs separated from the mainland (the island of Re and Jiang Bo reef) and atolls (Spratly Islands) in the open part of the South China Sea[1-3]. Among the Vietnamese reefs there are common reefs "true reef framework" and coral gardens "coral gardens"[4-6]. Different calcareous structures formed on the reefs may formed by coral settlements, usually called "coral layers", "coral communities or specialized settlements". Such formations usually characterize early stages of reef development, and do not have geomorphic and vertical bionomic zoning[7-9]. All Vietnamese reefs have distinct bionomic and in different manner apparent morphostructural zoning. Peculiarity of geomorphic and climatic conditions includes factors distinctly defining division of Vietnamese adjacent reefs into two types (figure 1).

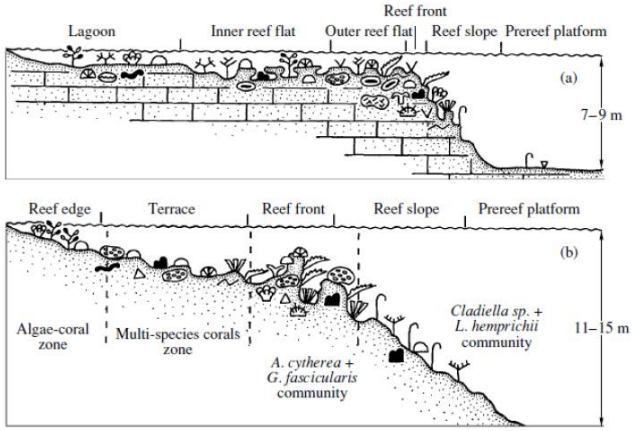

Figure 1 : Schematized profiles of structural (a) and unstructured (b) reefs. See the text for comments.

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The first type includes reefs with sharply defined reef zones (lagoon, reef flat etc.) with well-formed carbonate framework, so called structural reefs[10] common for the tropical zone of the World Ocean. The second type of reefs characterized by feebly marked morphostructural zoning, up to the absence of some zones. Calcareous deposits on such reefs represented by thin beds of coral settlements that almost do not change substrate profile – they are structureless[10] or crust[5,9] reefs. Vietnamese structural reefs are mainly formed in the closed sand bays and on the organogenic foundation of Holocene reefs[11], amorphous reefs – mostly on the headlands and in the open bays, primarily on the stony and rocky substrates[12-15]. Now all reef formation regions studied, from the northern border in the Gulf of Tonkin to the southern border in the Gulf of Siam, and to the Spratly Islands in the South China Sea, including large islands and banks. Thus, there was a need to generalize the information on the scope and distribution of corals, on peculiarities of reef formation in Vietnam and on their connection with the Indo-Pacific reef ecosystem.

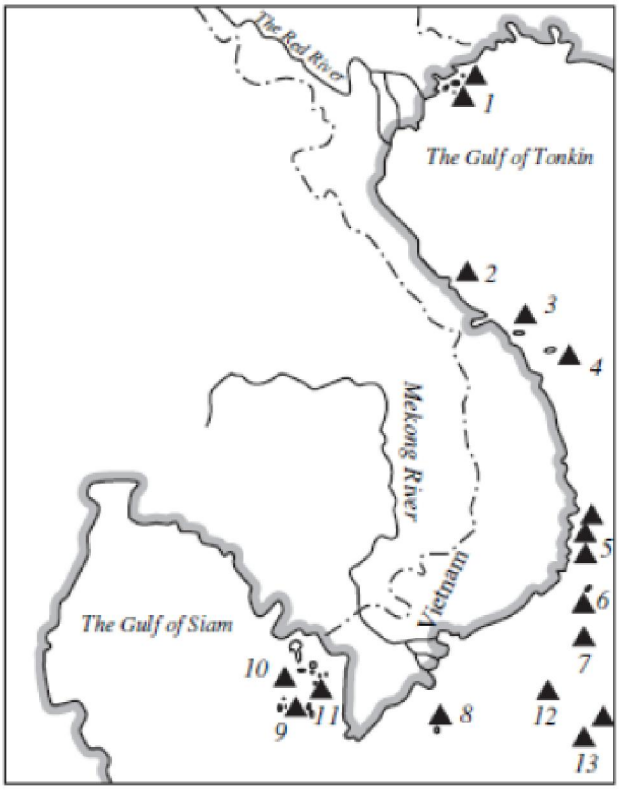

Figure 2 : Schematized map of the surveyed regions. 1-Bai Tu Long Archipelago, 2-Ze Island, 3-Danang Promontory and Cu Lao Cham Islands, 4-Re Island, Reef Khanh Hoa province, 6-Thu Island, 7-Ca Thuik Islands, 8-Con Dao Islands, 9-An Thoi Archipelago and Namsu Islands, 11-Rach Gia Bay, 12-Royal Bishop and Astrolab shoals, 13-Spratly archipelago.

Survey results for most of Vietnamese reefs given in a number of publications of the author of this article[5,6,14,16-19]. In the last decade of the past century and in the first decade of the present century Vietnamese reefs in the open part of the South China Sea studied, particularly at the islands of Ca Thuik, Con Dao, Thu and Lodd in the Spratly Archipelago (figure 2).

Below there is a generalized characteristic of coral communities of these reefs. Quick growth of the 70 million population of Vietnam, developing travel business, intensification of marine culture economies[20-22] increase the anthropogenic pressure on this unique ecosystem even more. Generalized data on the species composition, structure and existence conditions of coral communities of Vietnam allow evaluating the degree of their preservation or degradation, and preservation and recovery opportunities.

MATERIAL AND METHOD

Using SCUBA equipment we studied the species composition and distribution of scleractinian and mass species of macrobenthos (a little more than 400 species, including 228 species of corals), structure of communities in every zone of reefs at five islands (Big and Small Ca Thuik, Con Dao, Thu and Lodd). Surveys have been done according to the generally acceptable hydrobiological method, using frames and transects method[23-24]. Two hundred meters transects with the footage marking were mounted in the open and closed bays, on the headlands, near rocky, stony and sandy shores in order to maximally cover the diversity of reef communities in the region of survey. Along the transects, on every square meter the quantity of branchy, massive, incrusting and funnel-form colonies of scleractinian, degree of substrate covering with corals in the form of a frame divided into 100 squares, and the quantity of mass species of mollusks and echinoderms were accounted. In the mass accumulations of invertebrates the density of their settlement and biomass for every species on the area of 10-30 m^2 were accounted. Species diversity ratio was calculated by the formula: $H = -Ó[(n_i/N) \times (\ln n_i / N)]$, where H – biodiversity index, n_i - number of colonies belonging to the **i** species, N – total number of colonies[25]. Similarity level of different communities was determined by the Serensen's similarity parameters[26] using software program STATISTICA 6.0. During analysis of communities, 1250 photos of

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landscapes and macrobenthos taken by Olympus and Kodak cameras were used.

RESULTS AND DISCUSSION

There are physiographic zones well distinguished on the reefs of the open part of the South China Sea, as well as on the other reefs of Vietnam. They are well-known reef zones (lagoon, reef flat etc.) and comparable zones: algae-coral, poly- or monospecific coral settlements[5,11,12]. Lagoon, reef flat changing into well-marked reef slope develop in the bays with sandy or corallogenic shores. Coastal algae-coral zones with the species composition and structure of communities well comparable to the communities existing in lagoons form at the rocky, stony shores. Lagoons or algae-coral zones are 10 to 80 m long and up to 2-4 m deep. The width of reef flat or zones of poly- and monospecific coral settlements usually make 50-100 m with the depth of 3 to 12 m. Reef slope with the upper and lower parts, and slope platform on the surveyed reefs morphologically and by the species composition and structure of the community settling it are the same as at the most of Indo-Pacific reefs. The width of this reef zone makes 20-70 m, depth drop is 6 to 40 m.

Macrobenthos species diversity at all reefs was rather high, and varies from 315 to 355 species (including 228 species of corals). In general, scleractinian species diversity index made 25.6 (figure 3).

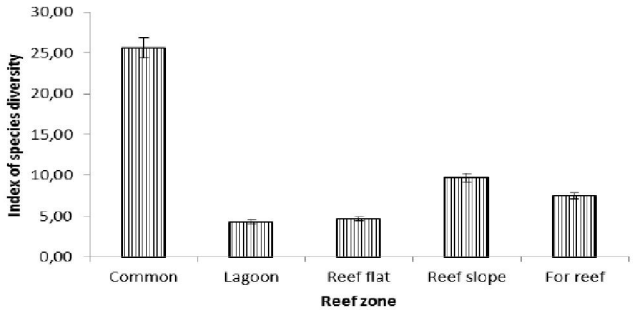

Figure 3 : Index of species diversity in different zone reefs.

The following species used to dominate there: Alcyonarian *Sarcophyton trocheliophorum, Lobophytum pauciflorum, Junceella fragilis,* scleractinian *Seriatopora hystrix, Montipora grisea, M. hispida, M. aequituberculata, Isopora palifera, Acropora nobilis, A. cytherea, A. valenciennesi, Pachyseris rugosa, Porites cylindrica, P. rus, Goniopora stokesi,* mollusks *Arca ventricosa, Tridacna crocea, Malleus malleus,* echinoderms *Diadema setosum, Metalia sternalis, Brissus latecarinatus, Holothuria edulis, H. atra,* algae *Dictyota divaricata, Caulerpa racemosa,Sargassum polycystum, Padina australis, Laurencia obtusa.* Therewith, only three-five species of different macrobenthos representatives usually used to dominate at every reef. 41.2% of species composition of scleractinian has throughout distribution (TABLE 1).

Distinct lagoons formed only in rather big bays with sandy coasts and on the atolls of the Spratly Archipelago.

Sandy coast of lagoons usually put to sea in a sloping manner, and some algae bushes *Ulva reticulata, P. australis, L. papilosa* and single colonies of Alcyonarian *S. trocheliophorum,* scleractinian *Seriatopora, Montipora, Acropora, Porites, Goniastrea* appear at the distance of 20-30 m upon drawing away from the water cut. Algae may form thick brushes (up to 352 specimen/m^2 and biomass 4700 g/m^2). At the distance of 50 m and farther the amount of algae and corals usually grows. There are rare settlements of *S. hystrix* (on the area of up to 2x2 m) and colonies of *I. palifera.* Macrophytes play a noticeable role in the structure of community: *Turbinaria ornata* (15-40% of biomass), *Caulerpa racemosa* (10-30%), *Sargassum duplicatum* (7-15%). In the benthos community of lagoons the most numerous corals are *Acropora hyacinthus, A. florida, M. aequituberculata, M. hispida, Platygira daedalea, Leptoria phrygia, Porites rus, Pavona decussata* and *Hydnophora exesa*. There are rare hydroids *Millepora platyphylla, M. dichotoma*. The degree of substrate coverage with algae and corals reaches 40-60%. The following representatives of large macrobenthos make a constant component of algae-coral community of lagoons: mollusks – *Lambis lambis, Trochus niloticus, Cyprea arabica, C. tigris,* echinoderms *Linckia laevigata, D. setosum, H. edulis* and *H. atra,* which may have population density up to 10-15 species/m^2. In the wide lagoons of the islands Thu, Con Dao and atoll Lodd there are mono settlements of colonies *A. valenciennesi, A. microphthalma* spread over dozens of square meters (figure 4).

Domination of two species of staghorn corals in this zone differs it from other zones by low index of species diversity – 4.3.

Reef flat is made up by remains of colonies and live corals, cemented chalky algae, organogenic detritus and fragments of branchy corals. There is a developed sys-

Figure 4 : Monospecific settlement coral *Acropora* in the lagoon of the island Thu, depth 2 m

tem of longitudinal and transversal channels, the latter may reach 2-6 m wide and 15-40 m long. High level of coverage with corals (up to 50%) is ensured by monospecific settlements of *Acropora humilis, A. digitifera, A. microphthalma, A. nasuta, Porites cylindrica, M. foliosa,* hydroids *M. platyphylla, M. dichotoma,* chalky algae *Halimeda opuntia* In channels colonies and bioherms consisting of different species of *Acropora, Porites* (massive and branchy forms) *Seriatopora, Stylophora, Psammocora, Hydnophora, Montipora, Cyphastrea, Pachyseris* are frequent, Faviidae and Fungiidae are also rather frequent. There are 56-70 species of coral that can be met at the reef flat. The width of the zone is 120-300 m. In an ordinary low tide drained only a few protrusions reef flat.

The community of polyspecific coral settlements may be formed In the area of the inner reef flat. Here funnel-form and lamellar colonies of *A. cytherea* и *M. aequituberculata* are more frequent, forming up to 50% of substrate coverage. Accumulated coral fragments are inhabited by the following infauna rather thickly: crabs, gastropoda, bivalve mollusks, polychaete, and brittle stars – 110-160 species/m^2 in total with the biomass of 190-200 g/m^2. The biggest population is observed among gastropoda *Turbo bruneus* – 30 species/m^2, and the biggest biomass – among bivalve mollusks *Barbatia bicolorata* – 56 g/m^2. On the reefs at the sandy coasts in such settlements branchy *A. nobilis* and funnel-form *M. danae* usually prevail, with the chalky algae *Amphiroa fragilissima* taking free space among them. Infauna in coral fragments is poor.

There are less than 100 species of invertebrates per 1 m^2 with the biomass of about 20 g, with the prevalence of crabs *Erotosquilla sp* - 34 species/m^2 and biomass 10.8 g/m^2.

On the reefs with corallogenic substrate, in the prominent outer part of reef flat there are either monospecific settlements represented by various species of staghorn corals (*A. cytherea, A. nobilis, M. aequituberculata, M. danae* and others), or various combinations of either two of the listed species providing up to 80-100% substrate surface coverage.

Reef-front is a narrow strip of an old reef cemented by chalky algae with numerous caverns. The degree of coverage with live corals is less than 20%. Here there are isolated colonies of massive, massive branchy and crust-incrusting forms of *Psammocora, Pocillopora, Stylophora, Acropora, Favia, Favites, Goniastrea, Porites* being developed. There are thick beds of algae in the niches and caverns, including *Halimeda opuntia* and numerous sea urchins.

The community on the reef slope, as well as on all reefs of Vietnam, differs in the highest degree of substrate coverage with corals (80-100%) and the richest taxonomic diversity of the whole macrobenthos (60-70% of the species composition studied). It formed on the corallogenic substrate, at the depths of 3 to 4 m, and takes reef parts 40-60 m long, at the distance of 80-200 m from the coastal line. No apparent domination of one or two species is observed at all reefs (figure 5).

Peculiarity of reef slope community expressed by considerable prevalence of 3-4 macrobenthos species both by settlement density and size, and by the ability to form zones of monospecific settlements.

In the upper part of the reef slope bioherms (hilly polyspecific settlements) thickly covered with

Figure 5 : Polyspecific scleractinian settlements on the reef slope of the atoll Lodd, depth 20 m

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Scleractinian, Alcyonarian and crusted chalky algae are very frequent. Here scleractinian *Pocillopora, Acropora, Montipora, Porites, Goniast-rea, Diploastrea, Platygyra, Favia, Favites, Fungia, Herpolitha, Pachyseris, Lobophyllia, Hydnophora* and hydroid *Millepora* are the most frequent (90-115 species in total). Macrophytes are represented the most numerously by *Halimeda, Dictyota, Pocockiella,* and *Halophyla* – on the sandy gaps in channels. The width of the zone makes 50-70 m, depth drop is 3 to 8 m. Lower part of the slope is more flat. It is a gently sloping part of the bottom coated with the fragments of dead corals (mostly cylindrical) and organogenic dendrite with little impurities of medium-grained sand. Large bioherms have been thickly coated with scleractinian, Alcyonarian and single gorgonian. There are large (2-4 m in the size across) separate massive and massive branchy colonies of *Porites, Diploastrea, Hydrophora, Acropora, Goniastrea, Leptoria, Lobophyllia* between bioherms. Algae represented the most numerously by crusted *Coralinacea, Dictyota* and *Halinicda.* Spots of compact settlements of thin-branchy scleractinian *S. hystrix* met frequently. Both among corals and inside their colonies there are numerous mollusks, among which the most numerous are *A. ventricosa* with the average density of 1.5-2 species/m^2 and biomass up to 80 g/m^2, and *B. bicolorata* – 2 species/m^2 and biomass 10.4 g/m^2. Oysters *Lopha cristagalli* are very frequent. Colonies *P. lobata* can be frequently inhabited by large polychaete *Spirobranchus giganteus* (84 species at the biomass of 1127 g for a colony of 15x31x45 cm). On the toe of the reef slope there are mainly lamellar and incrusting forms of scleractinian *Pachyseris, Montipora, Merulina, Echinopora,* sometimes with formation of the zone of *Pachyseris rugosa,* providing 20-38% of the total substrate coverage with corals. Species diversity index in the reef slope zone was the highest and made 9.7.

On the soft soils of pre-reef platform communities of *Malleus malleus* + *Juncella fragilis* may be formed in front of the reefs, at the rocky coasts on the slimy sands with numerous coral fragments at the depth of 18-21 m. Its basis made up by bivalves *M. malleus* and gorgonian *J. fragilis,* which exceed other macrobenthos species by biomass in dozens of times, though do not have very high density. Density of *M. malleus* at the different reefs varies from 4,5 to 12,5 species/m^2 with the biomass from 1715 g/m^2 to 2017 g/m2, and density of *J. fragilis* – from 0,9 to 8,7 species/m^2 with the biomass from 2 to

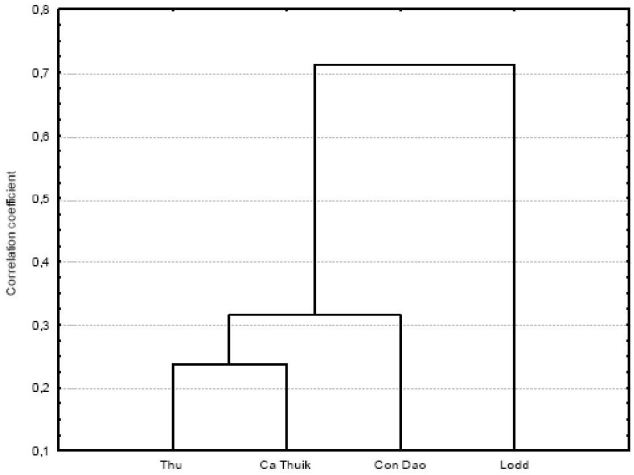

Figure 6 : Dendrogram of similarity species composition of coral South Vietnam.

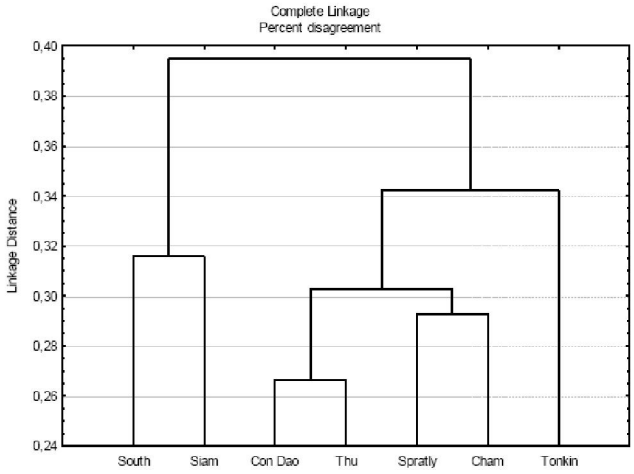

Figure 7 : Dendrogram of similarity species composition of coral different region of the Vietnam.

313.3 g/m^2. Various polychaete and decapoda are a permanent component of the community making up to one third of the total community population. Quantity of scleractinian here did not exceed 20-25 species, or 10-123% of their composition at the studied reef. Species diversity index made 7.5.

Among the main background species, brittle stars *Amphicmlus laevis* and *Ophiactis savignyi* can be always met in this community. In spite of high population of polychaete (over 100 species/m^2), their share in the total biomass is almost insignificant and makes 0.03-0.05%. There are single bushes of sea grass *H. ovalis* in the sandy gaps.

General picture of community formation is much similar, but their qualitative and quantitative composition varies greatly. The number of mass species varies from 19 to 106. The degree of similarity of different communities keeps within 24.8-37.5, and is slightly less

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TABLE 1 : Species composition of scleractinia on different reefs

Species	Lodd	Con Dao	Ca Thuik	Thu
Stylocoeniella armata Ehrenberg, 1834	+	-	-	-
Psammocora contiqua (Esper, 1797)	+	+	+	+
P. profundacella Gardiner, 1898	+	+	+	+
P. superficialis Gardiner, 1898	+	-	+	+
P. explanulata Van der Horst, 1922	-	+	+	+
P. digitata Edward & Haime, 1851	+	+	+	-
Pocillopora damicornis Linnaeus, 1758	+	+	+	+
P. verrucosa Ellis & Solander, 1834	+	+	+	+
P. eudouxi (Edwards & Haime, 1860)	+	+	+	+
P. woodjonesi Vaughan, 1918	+	+	+	+
Seriatopora hystrix Dana, 1846	+	+	+	+
S. caliendrum Ehrenberg, 1834	+	-	+	+
Stylophora pistillata (Esper, 1897)	+	+	+	+
S. subseriata (Ehrenberg, 1834)	+	-	-	+
Madracis kirbyi Veron & Pichon, 1976	-	-	-	+
Isopora palifera (Lamarck, 1816)	+	+	+	+
Acropora abrolhosensis (Veron, 1985)	+	+	+	+
A. brueggemanni (Brokk, 1893)	-	+	-	+
A. palmerae Wella, 1954	+	-	+	+
A. danai (Edwards & Haime, 1860)	-	+	+	-
A. nobilis (Dana, 1846)	+	+	+	+
A. formosa (Dana, 1846)	+	+	+	+
A. insignis (Nemenzo, 1967	+	-	-	+
A. microphthalma (Verrill, 1869)	+	+	-	+
A. valenciennesi (Edwards & Haime, 1860)	+	+	+	+
A. horrida (Dana, 1846)	-	-	+	+
A. vaughani Wells, 1954	-	+	-	+
A. aspera (Dana, 1846)	+	+	+	+
A. hyacinthus (Dana, 1846)	+	+	+	+
A. cytherea (Dana, 1846)	+	+	+	+
A. austera (Dana, 1846)	+	-	+	-
A. pulchra (Brook, 1891)	+	+	+	+
A. millepora (Ehrenberg, 1834)	+	+	+	+
A. selago (Studer, 1878)	+	+	+	+
A. delicatula (Brook, 1891)	-	+	+	+
A. tenuis (Dana, 1846)	+	+	-	+
A. cerealis (Dana, 1846)	+	+	+	+
A. nasuta (Dana, 1846)	+	+	+	+
A. diversa (Brook, 1891)	-	+	+	+
A. valida (Dana, 1846)	-	+	-	-
A. insignis (Nemenzo, 1967	+	-	-	+
A. lutkeni Crossland, 1952	-	+	-	-
A. humilis (Dana, 1846)	+	+	+	+
A. digitifera (Dana, 1846)	+	+	+	+
A. gemmifera (Brook, 1891)	+	+	+	+
A. squamata Latypov, 1992	-	-	+	+
A. florida (Dana, 1846)	+	+	+	+
A. verweyi Veron & Wallace, 1984	-	-	+	+
A. sarmentosa (Brook, 1891)	+	+	+	-
.Acropora spp.	-	-	-	+
Astreopora ocellata Bernard, 1896	+	+	-	-
A. gracilis Bernard, 1896	-	+	-	+
A. myriophthalma (Lamark, 1816)	+	+	+	+
Montipora tuberculosa (Lamark, 1816)	+	+	+	+
M. monasteriata (Forskal, 1775)	+	+	+	+
M. hoffineisteri Wells, 1954	+	-	+	+
M. spongodes Bernard, 1897	+	+	-	+
M. undata Bernard, 1897	+	+	-	+
M. danae (Edwards & Haime, 1860)	-	+	+	+
M. elschneri Vaughan, 1907	-	-	+	+
M. marshalensis Wells, 1954	-	-	+	+
M. turtgescens Bernard, 1897	+	+	-	-
M. angulata (Lamark, 1816)	-	+	+	+
M. venosa (Ehrenberg, 1834)	-	+	-	+
M. caliculata (Dana, 1846)	+	+	+	+
M. hispida (Dana, 1846)	+	+	+	+
M. efflorescens Bernard, 1897	+	+	+	+
M. australiensis Bernard, 1897	+	+	+	+
M. grisea Bernard, 1897	+	+	+	+
M. informis Bernard, 1897	+	-	+	+
M. subtilis Bernard, 1897	-	-	+	+
M. foliosa (Pallas, 1766)	+	+	+	+
M. aequituberculata Bernard, 1897	+	+	+	-
M. digitata (Dana, 1846)	+	+	+	+
M. nodosa (Dana, 1846)	-	+	+	+
Montipora spp.	-	-	+	+
Pavona cactus (Forskal, 1775)	+	-	-	-
P. frondifera Lamark, 1801	+	+	+	+
P. clavus (Dana, 1846)	+	+	-	+
P. decussata (Dana, 1846)	-	+	+	+
P. minuta Wells, 1954	+	+	-	-
P. explanulata (Lamark, 1816)	+	+	+	+
P. maldiviensis (Gardiner, 1905)	-	+	+	+
P. venosa (Ehrenberg, 1834)	-	+	+	+
Leptoseris esplanata Yabe & Sugiyama, 1936	+	-	+	+
Pseudosiderastrea tayamai Yabe, & Sug., 1936	+	+	+	+
Coscinarea columna (Dana, 1846)	+	+	+	+
Cycloseris cyclolites (Lamark, 1816)	-	+	+	+
C. costulata (Ortmann, 1889)	+	+	+	+
C. patellioformis (Boschma, 1923)	+	+	+	-
C. vaughani (Boschma, 1923)	+	+	-	+
Fungia fungites (Linnaeus, 1758)	+	+	+	+
F. corona Doderlein, 1901	-	+	-	+
F. danai Edwards & Haime, 1851	+	-	+	+
F. concina Verrill, 1864	-	+	+	+

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F. horrida Dana, 1846	-	+	+	+
F. repanda (Dana, 1846)	+	+	+	+
F. scutaria Lamark, 1801	+	+	+	+
Pleuractis paumotensis Stutchbury, 1833	+	-	+	-
Ctenactis echinata (Pallas, 1766)	+	+	-	+
Herpolia limax (Houttuyn, 1772)	+	+	+	+
H. weberi (Van der Horst, 1921)	+	+	+	+
Sandololitha robusta (Quelch, 1884)	+	+	+	+
S. dentata Quelch, 1884	+	-	+	+
Polyphyllia talpina (Lamark, 1801)	+	+	-	+
Diaseris fragilis Alcock, 1893	+	+	+	+
Lithophyllon mokai Hoeksema, 1989	+	+	+	+
L. undulatum Rehberg, 1892	+	-	+	+
Podobacia crustacea (Pallas, 1766)	+	+	+	+
Porites lobata Dana, 1846	+	+	+	+
P. solida (Forskal, 1775)	-	+	-	+
P. murrayensis Vaughan, 1918	-	+	+	+
P. australiensis Vaughan, 1918	+	+	+	+
P. lutea Edwards & Haime, 1858	+	+	+	+
P. stephensoni Grassland, 1952	+	+	-	+
P. densa Vaughan, 1918	+	+	+	+
P. *rus* (Forskal, 1775)	+	+	+	+
P. *mayeri* Vaughan, 1918	-	+	+	+
P. cylindrica Dana, 1846	+	+	-	+
P. *nigrescens* Dana, 1846	+	+	-	+
Porites sp.	-	-	+	+
Goniopora stokesi Edwards & Haime, 1851	+	+	+	+
G. lobata Edwards & Haime, 1860	+	+	-	-
G. columna (Dana, 1846)	+	+	-	+
G. djiboutiensis Vaughan, 1907	-	+	+	+
G. pandoraensis Veron & Pichon, 1982	-	+	+	+
G. stutchburyi Wells, 1955	+	+	-	-
G. somaliensis Vaughan, 1907	-	+	+	+
G. tenuidens Quelch, 1886	-	+	+	-
G. fruticosa Savile-Kent, 1891	+	+	+	+
Alveopora allingi Hoifmeister, 1925	+	+	+	-
A. cattalai, Wells, 1954	+	-	+	+
A. verriliana, Dana, 1872	-	+	-	-
Caulastrea tumida, Matthai, 1928	+	-	-	+
Barabattoia mirabilisYabe & Sugiyama, 1941	+	+	+	-
Favia stelligera (Dana, 1846)	-	-	+	-
F. favus (Forskal, 1755)	+	+	-	+
F. speciosa (Dana, 1846)	+	+	+	+
F. pallida (Dana, 1846)	-	+	-	+
F. amicorum (Edwards & Haime, 1850)	+	+	+	+
F. matthai Vaughan, 1918	+	+	+	+
F. rotumana (Gardiner, 1899)	-	+	+	+
F. laxa (Klunzinger, 1879)	+	+	-	-
F. maxima Veron & Pichon, 1977	+	+	+	+
F. lizardensis Veron & Pichon, 1977	+	+	-	+
F. maritima (Nemezo, 1971)	+	+	+	+
F. veroni Moll & Best, 1984	-	+	+	+
F. amicorum (Edwards & Haime, 1850)	-	+	+	+
Favites chinensis (Verrill, 1866)	-	-	-	+
F. abdita (Elis & Solander, 1786)	+	+	+	+
F. flexuosa (Dana, 1846)	+	+	-	+
F. rotundata Veron & Pichon, 1977	+	+	+	-
F. halicora (Ehrenberg, 1834)	+	+	+	+
F. complanata (Ehrenberg, 1834)	+	+	+	+
F. pentagona (Esper, 1795)	+	+	+	+
Favites sp. 2	_	-	-	+
Goniastrea edwardsi Chevalier, 1971	+	-	+	-
G. retiformis (Lamarck, 1816)	+	+	+	-
G. aspera (Verrill, 1865)	+	+	+	+
G. pectinata (Ehrenberg, 1834)	+	-	+	+
G. australiensis (Edwards & Haime, 1857)	+	+	+	+
G. palauensis (Yabe, Sugiyama & Eguchi, 1936)	+	+	+	+
Platygyra daedalia (Ellis & Solander, 1786)	+	+	+	+
P. *lamellina* (Ehrenberg, 1834)	+	+	+	+
P. sinensis (Edwards & Haime, 1849)	+	+	+	+
P. pini Chevalier, 1975	+	+	+	+
Oulophyllia crispa (Lamarck, 1816)	+	+	+	+
Leptoria phrygia (Ellis & Solander, 1786)	+	+	+	+
Hydnophora rigida (Dana, 1846)	-	+	+	+
H. exesa (Pallas, 1766)	+	+	+	-
H. microconos (Lamarck, 1816)	+	+	+	+
Oulastrea crispata (Lamarck, 1816)	+	+	+	+
Leptastrea purpurea (Dana, 1846)	+	+	+	+
L. transversa Klunzinger, 1879	+	+	-	-
L. pruniosa Crossland, 1952	_	+	+	+
L. bottae (Edwards & Haime, 1849)	-	+	+	+
Plesiastrea versipora (Lamarck, 1816)	+	+	+	+
Cyphastrea serailia (Forskal, 1775)	+	+	+	+
C. chalcidicum (Forskal, 1775)	+	+	+	+
C. microphthalma (Lamarck, 1816)	+	+	+	+
C. japonica Yabe & Sugiyama, 1932	_	-	-	+
Montastrea curta (Dana, 1846)	+	+	+	+
M. magnistellata Chevalier, 1971	-	+	+	+
Echinopora lamellosa (Esper, 1795)	+	+	+	+
Diploasrea heliopora (Lamarck, 1816)	+	+	+	+
Merulina ampliata (Ellis & Solander, 1786)	+	+	+	+
M. scabriscula (Dana, 1846)	-	-	-	+
Echinopora lamellosa (Esper, 1795)	+	+	+	+
E. hirsutissima Edwards & Haime, 1849	-	+	+	+
Moseleya latistellata Quelch, 1884	+	+	+	+
Trachyphyllia geoffroyi (Audouin, 1826)	+	+	+	+

Galaxea astreata (Lamarck, 1816)	+	+	+	+
G. fascicularis (Linnaeus, 1797)	+	+	+	+
Acantasrea echinata (Dana, 1846)	+	+	+	+
Lobophyllia sp.	+	-	-	+
L. hemprichii (Ehrenberg, 1834)	+	+	+	+
L. corymbosa (Forskal, 1775)	+	+	+	+
L. costata (Dana, 1846)	+	+	+	+
L. hattai Yabe, Sugiyama & Eguchi, 1936	+	+	+	-
Symphyllia recta (Dana, 1846)	+	+	-	+
S. radians Edwards & Haime, 1849	+	_	+	+
S. valenciennessi Edwards & Haime, 1849	+	+	+	+
S. agaricia Edwards & Haime, 1849	+	+	-	-
S. hassi Pillai & Scheer, 1976	+	+	+	+
Euphyllia fimbriata (Spengler, 1799)	-	+	+	+
Plerogyra sinuosa (Dana, 1846)	+	-	+	+
Turbinana peltata (Esper, 1794)	+	+	+	+
T. frondens (Dana, 1846)	+	+	-	+
T. reniformis Bernard, 1896	+	+	+	+
T. mesenterina (Lamarck, 1816)	+	+	+	+
T. crater (Pallas, 1766)	+	+	+	+
T. contorta Bernard, 1896	-	+	+	+
T. radicalis Bernard, 1896	+	+	+	+
T. patula (Dana, 1846)	-	+	+	-
T. stellulata (Lamarck, 1816)	-	+	+	+
Dendrophyllia japonica Rehberg,	+	+	+	+
D. sphaerica Nemenzo, 1981	+	+	-	-
Tubastrea aurea (Quoy & Gaimard, 1833)	-	+	-	-
T. coccinea (Ehrenberg, 1834)	+	+	-	+
T. diaphana (Dana, 1846)	-	+	-	-
T. nicranthus (Ehrenberg, 1834)	+	-	+	+
Heteropsammia cochlea (Spengler, 1781)	+	+	-	-
Bathyactis palifera Lamarck, 1816	-	+	+	+
Heterocyathus aequiscoctatus E. & Haime, 1849	-	-	_	+
Millepora dichotoma Forskal, 1775	+	-	-	+
M. platyphylla Hemrich & Ehrenberg, 1834	+	+	-	+

in the communities of soft soil – 11.2-24.6. Complexes of scleractinian species differ in some differences in the degree of similarity, with the difference of extreme values 34.5-41.3. For taxocenoses of mollusks, the degree of similarity is not lower than 32.0 in 50% of communities. Macrophytes with the highest variety in the degree of their species similarity (from 7.1 to 30.7) reduce the degree of similarity of communities. It should be noted that similarity of different neighboring communities at one reef is higher than that of similar communities at different reefs[12,27]. A high level of similarity of corals is marked between different reefs of South Vietnam and between species compositions Scleractinia of its different regions (figure 6, 7).

CONCLUSIONS

In general, there are 190 to 261 species of scleractinian in the different regions on Vietnamese reefs, which may be compared to the composition of these corals found on the reefs in the open part of the South China Sea. Coral communities at the islands of Con Dao, Thu, Ca Thuik and Lodd are in rather good condition. Both on the structural and structureless reefs coral communities characterized by high species diversity.

This region inhabited by over 200 species of scleractinian spread in the groups of 90-115 species by separate zones of the reef. Reefs are characterized by high degree of substrate coverage with live corals, and high species diversity of Acroporidae, which proves the optimal conditions for their development and growth. As the structure of reefs has been thoroughly studied before, and has not undergone considerable changes according to our observations[12,15,27], special attention has been paid to taxonomic surveys during the last years. It allowed detecting six species of scleractinian *(Acropora abrolhosensis, A. insignis, A. parilis, Stylophora subseriata, Merulina scabricula, Pachyseris gemmae)* that has not been observed at the reefs of Vietnam before.

It has been noticed before that the species composition of coral fauna, its richness and high diversity, as well as degree of similarity with the coral fauna of the south-western Indo-Pacific allow relating it to the Indonesian-Philippine center of origin of Indo-Pacific tropical corals[5,17,18,28,29]. Species composition and structure of coral communities of Vietnamese coral reefs in the open part of the South China Sea do not contradict to, but instead make this affirmation even more reliable.

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