Systematics of the order Corallimorpharia (Cnidaria: Anthozoa)

by

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M.S., Ewha Womans University, 2001

Submitted to the Department of Ecology and Evolutionary Biology and the

Faculty of the Graduate School of the University of Kansas

In partial fulfillment of the requirements for the degree of

Doctor of Philosophy

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Abstract

Systematic position and status of Corallimorpharia in Hexacorallia have been controversial because members of Corallimorpharia have intermediate morphology between Actiniaria and Scleractinia. Inferences concerning monophyly and sister relationships of corallimorpharians using morphological and molecular characters have been inconsistent. The inconsistency may be caused by poor taxon sampling of Corallimorpharia. Doubts about the phylogeny of Corallimorpharia persist.

I conducted phylogenetic analyses using morphological and molecular data to provide a comprehensive investigation of phylogeny of Corallimorpharia. Morphological and molecular data were congruent, and all data sets support monophyly of Corallimorpharia, and sister relationship with Scleractinia. Within Corallimorpharia, two evolutionary lineages, cylindrical body corallimorpharians and discoidal body corallimorpharians, were recovered.

Due to the lack of unique morphological characters defining Corallimorpharia, the scleractinian skeleton, which is the only character to separate Corallimorpharia from Scleractinia, is essential to determine the hierarchical rank of Corallimorpharia in Hexacorallia. One hypothesis is that the scleractinian skeleton is not homologous in all scleractinians, and therefore is not phylogenetically meaningful in defining

Scleractinia. The hypothesis is supported by evidence from the fossil record, molecular phylogeny of Scleractinia, and environmental effects on calcification.

Therefore, I propose Corallimorpharia and Scleractinia are suborders of the order Madreporaria, as Schmidt (1974) suggested. In Corallimorpharia, there has been no consensus on the number of valid family and genera. I therefore provide a taxonomic revision at the genus-level based on re-examination of type material. I used five morphological character categories that are phylogenetically meaningful. The type species of each genus is redescribed for those known in less detail and diagnostic keys to genera and families are provided. I conclude that there are three valid families and 11 valid genera in suborder Corallimorpharia.

The revision at the genus level is the first step to revise classification at the species level. There is no consensus in the number of valid species in most corallimorpharians genera. There are 41 nominal species in Corallimorpharia. Taxonomic revision at the species level will provide information about diversity and biogeography of corallimorpharians.

Acknowledgments

This work would not have been possible without so many helps, funding and encouragements of many people in the Department of Ecology and Evolutionary Biology, the University of Kansas. I thank to my committee for great advice, suggestions, and comments on this research along the years. I greatly appreciate Dr. Daphne G. Fautin, main advisor on my life in Lawrence, Kansas. Her willingness to help, her faith in my abilities and her advice are some of greatest lessons I have learned in my graduate study. I would like to thank the late Dr. James S. Ashe, Dr. Bruce Lieberman, Dr. Catherine Loudon, Dr. Paulyn Cartwright, and Dr. Kirsten Jensen for their great advice, interest, time and encouragement. I would like to thank Dr. Paulyn Cartwright for sharing her laboratory. I specially thank Dr. Meg Daly at Ohio State University. Her advice, suggestions and comments strengthened my research and dissertation. I thank all people and institutions responsible for sending me specimens of corallimorpharians on loans from the collections of museums cited in this work.

I greatly appreciate my family and friends for their prayers, supports and encouragements along the years. My husband, Matthew C. Gim, is to be commended for his infinite patience and his gracious support during my graduate study. My parents, Intae Cha and Sunhee Yi, who always trust me, are the reason for me to do my best. My lovely nephew, Sangjun Chang, and his parents, my sister Yurim Cha and brother-in-law Hyunseung Chang have been great supporters for me. Eventhough I was apart from them so far, I could be able to live here because of their love and prayers. Thanks to my sister-in-law C.G. Gim, parents-in-law Paul J. Gim and Hannah Y. Gim, and all of my friends in Lawrence and in Seoul for their constant prayers and emotional encouragement.

This research was supported by National Science Foundation PEET (Partnerships Enhancing Expertise in Taxonomy) program (DEB 9978106) and Assembling the Cnidarian Tree of Life (EF-0531779) project; the Department of Ecology and Evolutionary Biology, KU; Natural History Museum and Biodiversity Research Center, KU.

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CHAPTER I. INTRODUCTION

Corallimorpharia is an order of anthozoan subclass Hexacorallia. Other members of Hexacorallia are Actiniaria (sea anemones), Ceriantharia (tube anemones), Zoanthidea (zoanthids), Antipatharia (black corals), and Scleractinia (stony corals). Members of Actiniaria, Corallimorpharia, and Scleractinia have paired monomorphic mesenteries that are added in couples around the circumference of the animal during ontogeny, while paired mesenteries in Zoanthidea are not monomorphic, and those in other hexacorallians are not paired and coupled (Figure 1-1).

Members of Corallimorpharia, often called coral-like sea anemones, are solitary or clonal polyps without a skeleton. The body is cylindrical (Figure 1-2, A and B) or discoidal (Figure 1-2C), and the size ranges from 5 to 10 mm oral disc width up to 450 mm. The column is smooth and soft or firm. The tentacles are retractile or non-retractile, and have or lack acrospheres (globular ends that contain dense nematocysts). In the coelenteric space, the mesenteries are numerous and often irregularly arranged. The musculature is very weakly developed. The nematocyst composition is spirocysts, holotrichs, and microbasic *b*- and *p*-mastigophores. Corallimorpharians are widely distributed from tropical to polar areas, and from shallow to deep water. The deepest record of a corallimorpharian species is *Nectactis singularis*, a specimen of which was collected at 5005 m (Gravier, 1922).

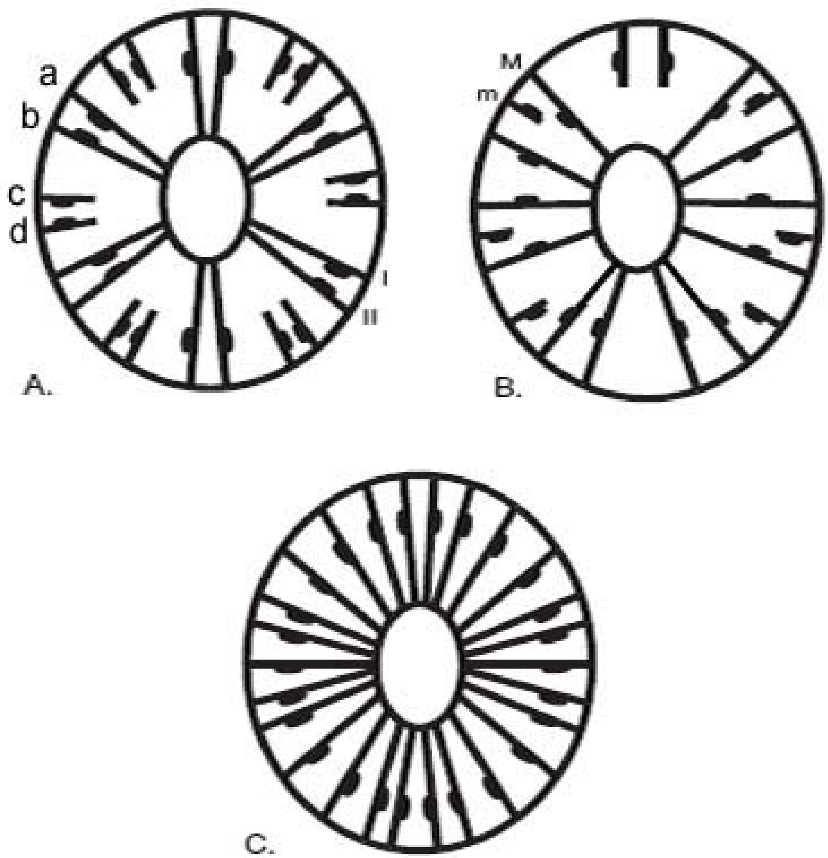


Figure 1-1. Schematic cross-section of hexacorallian orders (modified from Daly et al. 2003, p. 421, Figure 1). The radial lines represent mesenteries, the central oval represents the actinopharynx, and the filled oval on each mesentery represents the retractor muscle. A: hexamerously arranged paired, and coupled mesenteries in Actiniaria, Corallimorpharia, and Scleractinia. Mesenteries labeled a, b, I, and II are complete; c and d are incomplete; a and b, c and d, and I and II are paired; I and II are coupled with a and b; B: hexamerously arranged paired, and coupled mesenteries in Zoanthidea. Mesenteries labeled M and m are a dimorphic pair; C: unpaired coupled arrangement of Ceriantharia.

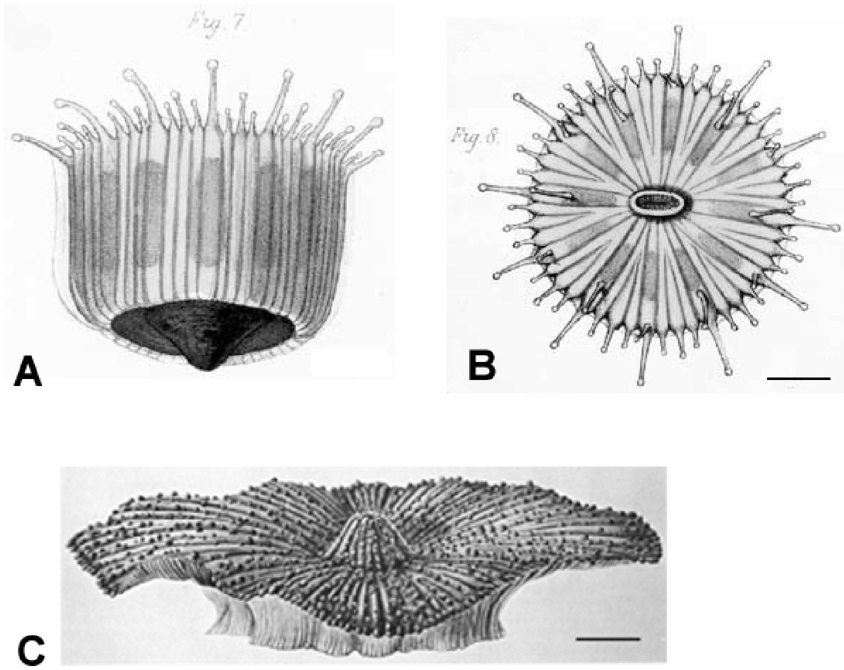


Figure 1-2. Body forms of corallimorpharians. A: side view of *Corallimorphus profundus* Moseley, 1877; B: oral disc of *Corallimorphus profundus* Moseley, 1877 (Moseley, 1877, Plate XLV, fig. 7, fig. 8); C: *Actinodiscus neglecta* (Duchassaing and Michelotti, 1860) (Cutress, 1979, p. 97, Fig. 3). Scale bar = 10 mm.

Corallimorpharians may dominate benthic communities in both temperate regions (Chadwick, 1991) and tropical regions (den Hartog, 1980). In particular, on coral reefs, corallimorpharians often and are abundant in shallow water, where they form aggregations (den Hartog, 1980; Chadwick-Furman and Spiegel, 2000; Muhando et al., 2002). Some corallimorpharians reproduce asexually so can increase their population relatively quickly. They can endure physical stresses such as exposure to air during low tides better than stony corals (Chadwick, 1991; Muhando et al., 2002). Some corallimorpharians are aggressive. Mesenterial filaments may be extruded through the tips of the discal tentacles and the mouth when the animal is disturbed (Elliot and Cook, 1989; Fautin and Mariscal, 1991; personal observation). Extruded mesenterial filaments may digest either a prey or a potential competitor for space -- often another anthozoan (Lang, 1973; Logan, 1984; Chadwick, 1987) – outside of the body. The aggressiveness, asexual reproduction, and high tolerance to environmental stress may be competitive advantages of corallimorpharians in shallow waters: corallimorpharians can rapidly occupy recently opened space caused by natural and/or anthropogenic disturbances on coral reefs (den Hartog, 1997; Langmead and Chadwick, 1999; Kuguru et al., 2004).

OBJECTIVES

The purpose of this study was to evaluate the systematic position and status of the Corallimorpharia within Hexacorallia. To clarify its membership, I revised the classification of the order. The revision includes identifying new characters for genus-level diagnosis and redescriptions of genera based on type species. The data gathered from the revision were used for phylogenetic analyses.

PHYLOGENY OF THE CORALLIMORPHARIA

The systematic position and taxonomic status of the Corallimorpharia have been debated. Corallimorpharians have morphology intermediate between the members of the orders Actiniaria and Scleractinia (Dunn, 1982). A corallimorpharian resembles a sea anemone in lacking a calcareous skeleton, and the tentacle arrangement of most corallimorpharians is similar to that of an actiniarian of the family Stichodactylidae, in that multiple tentacles arise from the space between members of a mesenterial pair and one tentacle arise from the space between mesenteries of two adjacent pairs (Duerden, 1898; den Hartog, 1980). However, the internal anatomy of a corallimorpharian is less similar to that of a sea anemone than to that of a stony coral. Most actiniarians have well-developed basilar muscles and ciliated filaments on the mesenteries (Dunn, 1981). By contrast, a corallimorpharian and a stony coral lack well-developed basilar muscles and ciliated filaments (den Hartog, 1980).

Additionally, the composition and distribution of nematocysts of corallimorpharians are more like those of scleractinians than those of actiniarians; both scleractinians and corallimorpharians bear many large holotrichs in their mesenterial filaments (Duerden, 1898; den Hartog, 1980).

Four possible hypotheses of the systematic position of corallimorpharians have been considered: Corallimorpharia is monophyletic and forms an order (Figure 1-3C); Corallimorpharia forms a monophyletic group but belongs entirely within Actiniaria (Figure 1-3A) or Scleractinia (Figure 1-3B); Corallimorpharia is not monophyletic and belongs partly to Actiniaria and partly to Scleractinia (Figure 1-3D).

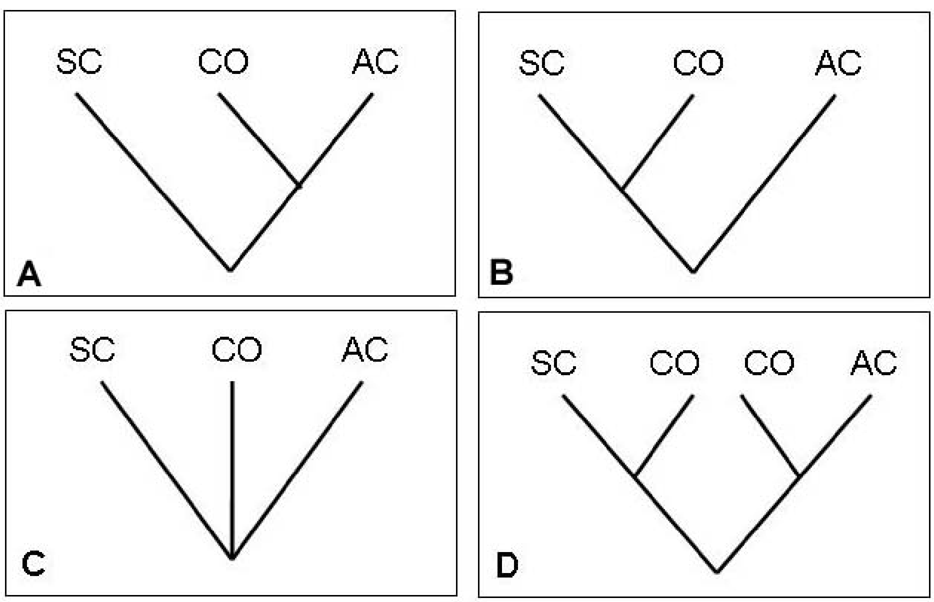


Figure 1-3. Hypothesis on phylogeny of the Corallimorpharia. AC indicates Actiniaria; CO indicates Corallimorpharia; SC indicates Scleractinia.

Corallimorpharia has been considered a subgroup within Actiniaria by some (Figure 1-3A). Andres (1883) united all the forms that have radially arranged tentacles, including some corallimorpharians, in family Stichodactylinae [sic] of order Actiniaria. Duerden (1898, 1900) considered corallimorpharians closely related to stichodactyline anemones based on similarities of tentacle arrangement between corallimorpharian genus *Ricordea* Watlz, 1922 and actiniarian genus *Stichodactyla* Brandt, 1835. The stichodactylines have been assigned to various higher systematic ranks by later authors: Haddon and Shackleton (1893) and Haddon (1898) called them an order, Carlgren (1900) a tribe, and Duerden (1900) a sub-order.

However, recognizing similarities of internal anatomy and nematocysts between Scleractinia and species currently included in the Corallimorpharia, scientists such as Krempf (1904), Stephenson (1921, 1922), Weill (1934), and Hand (1966) considered Corallimorpharia as a subgroup in Scleractinia (Figure 1-3A). Krempf (1904) concluded that corallimorpharians represent scleractinian corals without a skeleton, and he proposed the names Sclerocorallia for Scleractinia and Asclerocorallia for Corallimorpharia. Stephenson (1922) suggested classifying the Corallimorpharia among the Madreporaria (= Scleractinia). Schmidt (1972, 1974) concluded that Corallimorpharia and Scleractinia should be included in a higher group, Madreporaria, based on the composition of nematocysts. den Hartog (1980) concluded that Corallimorpharia should be included in the Scleractinia as a sub-order. Romano and Cairns (2000) and Won et al. (2001) inferred Corallimorpharia may belong to monophyletic Scleractinia based on a mitochondrial gene (16S mtDNA) (Romano and Cairns, 2000) and a nuclear ribosomal gene (18S rDNA) (Won et al., 2001, Figure 1-4C). Medina et al. (2006) supported the monophyly of Corallimorpharia, but within Scleractinia (Figure 1-4E). Although Duerden (1898) had noticed the similarity of Corallimorpharia and Scleractinia, he maintained the corallimorpharians in the Stichodactylinae.

Corallimorpharia also has been considered a separate group, equal in rank to Actiniaria and Scleractinia (Figure 1-3C). Carlgren (1940, 1943, 1949) listed four differences between the two groups: the calcareous skeleton, the tentacular arrangement, the cnidom, and the structure of the mesoglea. Wells and Hills (1956) accepted Carlgren's perspective. Daly et al. (2003) (Figure 1-4D) concluded that Corallimorpharia is an order as currently accepted based on phylogeny using combined data sets of morphological and molecular data, they but stated the need for more extensive taxon sampling.

Corallimorpharia has been considered as a non-monophyletic group (Figure 1-3D) by some. Fautin and Lowenstein (1994) supported the non-monophyly of corallimorpharians and paraphyletic assemblage of corallimorpharians and scleractinians based on radioimmunological data (Figure 1-4A); Chen et al. (1995) suggested a polyphyletic assemblage of corallimorpharians and actiniarians based on sequences of nuclear large subunit ribosomal gene (28S rDNA) (Figure 1-4B).

Inferences concerning monophyly and sister relationships of corallimorpharians using morphological and molecular characters have been inconsistent. The inconsistency may be caused by poor taxon sampling of Corallimorpharia. Doubts about the phylogeny of Corallimorpharia persist.

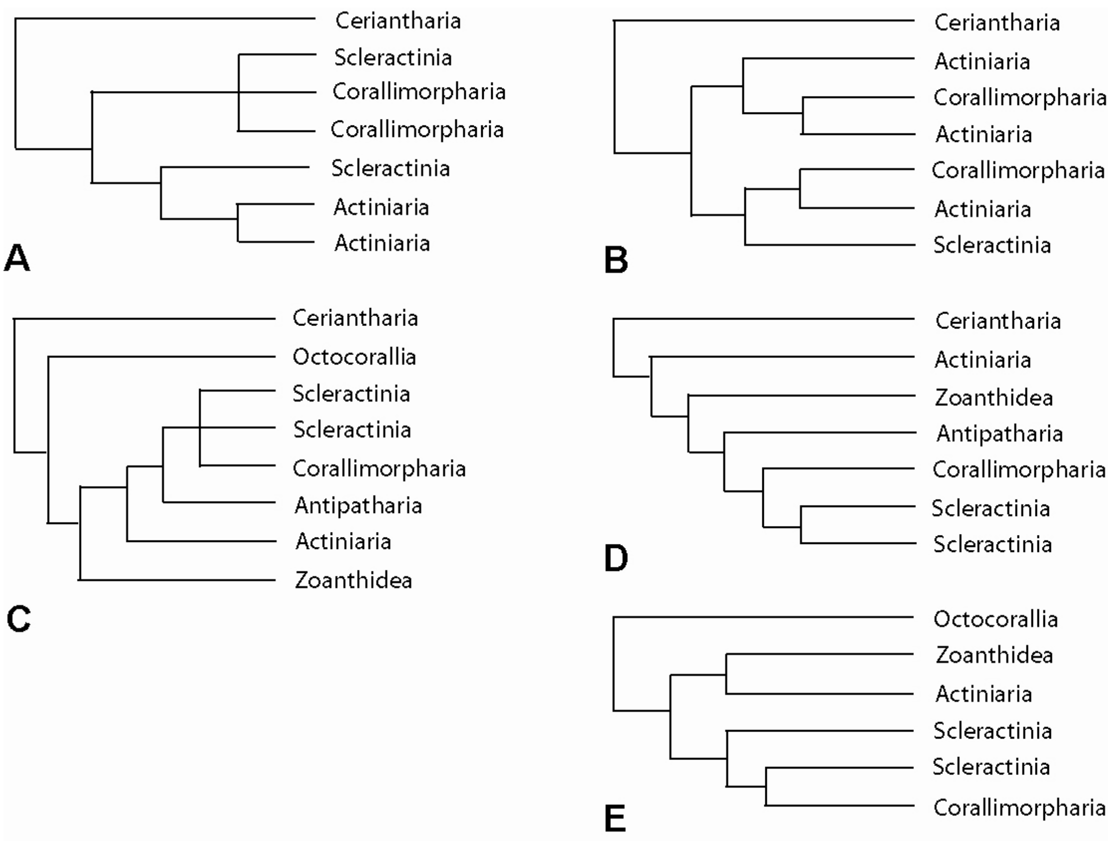


Figure 1-4. Phylogenetic hypothesis of systematics of the Corallimorpharia. A: Fautin and Lowenstein, 1994; B: Chen et al., 1995; C: Won et al., 2001; D: Daly et al., 2003; E: Medina et al., 2006.

My study aimed to include representatives of every valid genus in Corallimorpharia to resolve phylogenetic questions of monophyly and sister relationships of the order. The study was conducted using morphological and molecular characters (see Chapter IV). I compiled a data matrix of molecular (18S rDNA, 28S rDNA, and 16S mtDNA), and 33 morphological characters of corallimorpharians, actiniarians, and scleractinians. Morphological characters include internal anatomy of scleractinian polyps, which is is the only character that is available to compare among the three orders. Scleractinian polyp anatomy has not been studied extensively and information about it is almost absent in the literature except for some studies in the late nineteenth century (eg., Duerden, 1898) because characters traditionally used for taxonomy and phylogeny of Scleractinia are features of the calcareous skeleton. The data were analyzed under maximum parsimony and maximum likelihood criteria, parsimony analysis for morphology, and parsimony and likelihood analyses for molecular data sets.

I inferred that Corallimorpharia is a monophyletic taxon, and according to cladistic inference based on combined data set, Scleractinia is the sister group of Corallimorpharia. The calcareous exoskeleton is traditionally considered as an essential attribute of membership in Scleractinia (Duerden, 1898; Stephenson, 1921); therefore all extent hexacorallian polyps with a calcareous skeleton belong to Scleractinia. However, the traditional view has been challenged based on the morphological similarities between a corallimorpharian polyp and a scleractinian polyp, and molecular phylogeny of Scleractinia. Studies on molecular phylogeny of Scleractinia support the idea that the skeleton may have arisen multiple times, and may not be homologous between major clades of corals (Fautin and Lowenstein, 1994; Romano and Palumbi, 1996; Romano and Cairns, 2000; Stanley and Fautin, 2001). In fact, the phylogenetic value of the calcareous skeleton has been re-evaluated in the cnidarian class Hydrozoa: the ability to form a calcareous skeleton is no longer considered a major taxonomic feature. All hydrozoans with a calcareous skeleton were initially grouped in Hydrocorallina, but each of two subgroups, Milleporina and Stylasterina, is now considered more closely related to a skeletonless taxon than to the other. Thus calreous skeletons have been lost or have evolved independently (Petersen, 1979; Lindner, 2003). Similarly, Foraminifera, previously thought to include only shelled amoebae, includes naked species (Pawlowski et al., 1999).

TAXONOMIC REVISION OF THE CORALLIMORPHARIA

There are literature inventories of corallimorpharians (Stephenson, 1922; Carlgren, 1949; den Hartog, 1980; den Hartog et al., 1993; Fautin, 2006). However, the species composition and the number of valid families and genera have been unclear due to the inconsistency in usage of names. The descriptions of some genera were too short and simple to distinguish genera, so it has been difficult to place species in the proper genus.

I examined the type specimens of type species of all 16 nominal genera. Examination of type specimens allowed me to identify new characters to distinguish each genus, to emend descriptions of genera of uncertain validity, and to gather morphological characters for phylogenetic analyses. Information on type specimens is available from "Hexacorallians of the World" (Fautin, 2006). In case no type specimens were designated or type material is damaged, I examined non-type specimens of type species borrowed and collected. I collected specimens of *Actinotryx sanctithomae* Duchassing and Michelotti, 1860, *Ricordea florida* Duchassing and Michelotti, 1860, and *Rhodactis rhodostoma* (Hemprich and Ehrenberg in Ehrenberg, 1834), the type species of three genera. Collecting specimens from the field provided much information such as color, habitat, and symbiotic associations.

Based on comparative morphology of the type species, I agree with authors such as Stephenson (1922), Carlgren (1949), den Hartog (1980), and den Hartog et al. (1993) on the status of nine genera. Seven genera, *Corynactis, Corallimorphus, Pseudocorynactis, Nectactis, Sideractis*, *Ricordea,* and *Amplexidiscus,* are valid; two genera, *Sphincteractis* and *Isocorallion,* are invalid. The validity of the seven remaining genera is questionable. All those genera are in family Discosomatidae. Most genera in the family have been confused with and are in partial synonymy each other because the brief original descriptions provide only limited criteria for distinguishing genera.

The validity of the seven genera is evaluated based on five phylogenetically meaningful morphological character categories. The explanations of the characters, diagnostic features, and detailed discussion of each of the seven genera are in chapter IIII. The type species of each genus is redescribed for those known in less detail, its cnidae are diagnosed, and taxonomic/nomenclature issues are discussed.

I recognize five genera in family Corallimorphidae, *Corynactis, Pseudocorynactis, Corallimorphus*, *Nectactis*, and *Sideractis*; five genera in family Discosomatidae, *Discosoma*, *Actinotryx*, *Rhodactis*, *Metarhodactis*, and *Amplexidiscus*; and one genus, *Ricordea*, in family Ricordeidae.

CHAPTER II. MORPHOLOGY OF CORALLIMORPHARIANS

2-1. General morphology

Cnidarian polyps are characterized as being at the "tissue grade of construction" (Hyman, 1940), which means their specialized cells are grouped into tissues, but the tissues do not compose organs or organ systems. In spite of the simple structure, the anatomy of corallimorpharian polyps can be quite complex.

Between the outer layer, ectoderm, containing many cnidae, and the inner layer, endoderm, is a supporting layer of gelatinous substance termed mesoglea (Shick, 1991). The mesoglea, secreted by the cells of the epithelia, may be very thin, or thick. The polyp has the oral disc at the distal end (Figure 2-1) and the pedal disc at the proximal end. A mouth is located at the center of the oral disc and is connected to a tubular short actinopharynx, while tentacles encircle or cover the oral disc. Tentacles can be differentiated into discal and marginal tentacles depending on the position: discal tentacles are situated on the oral disc and marginal tentacles are situated at the margin of the oral disc. Tentacles may cover most of the area of the oral disc, or there may be a tentacle-free zone on the oral disc. A tentacle-free zone is either among the discal tentacles or between discal and marginal tentacles (Figure 2-2). The internal cavity, or coelenteron, is divided by mesenteries, longitudinal sheets of tissue that extend from the column wall. The mesenteries extending from column wall to the actinopharynx are complete, and incomplete mesenteries do not extend all the way to the actinopharynx (Carlgren, 1949). The free edge of the mesentery has unilobed mesenterial filaments that bear gland cells and cnidae. The musculature of corallimorpharians is very weakly developed or absent. The retractor musclem which runs longitudinally along the mesentery, is slightly convex on a transverse section, and consists of endodermal epitheliomuscular cells embedded in the mesoglea (Fautin and Mariscal, 1991). The marginal sphincter muscle, a circular muscle, is endodermal in corallimorpharians. The retractor and sphincter retractor muscles work together for contraction of a polyp: “the retractor effects rapid symmetrical depression of the oral disc” and “contraction of the sphincter acts as a drawstring and covers the retracted oral disc and tentacles” (Shick, 1991, p. 11).

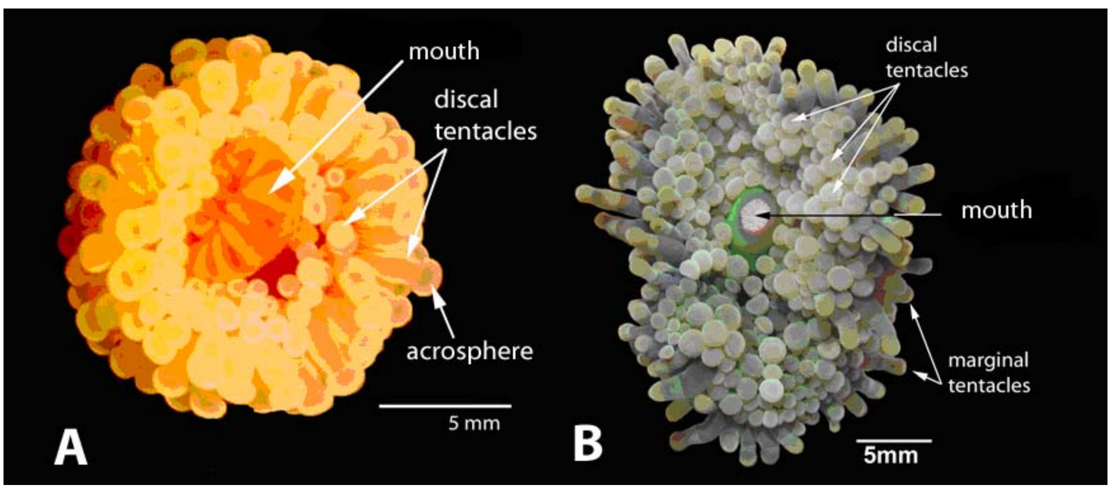


Figure 2-1. Oral view of corallimorpharians. A: *Corynactis californica* Carlgren, 1936; B: *Ricordea florida* Duchassing and Michelotti, 1860

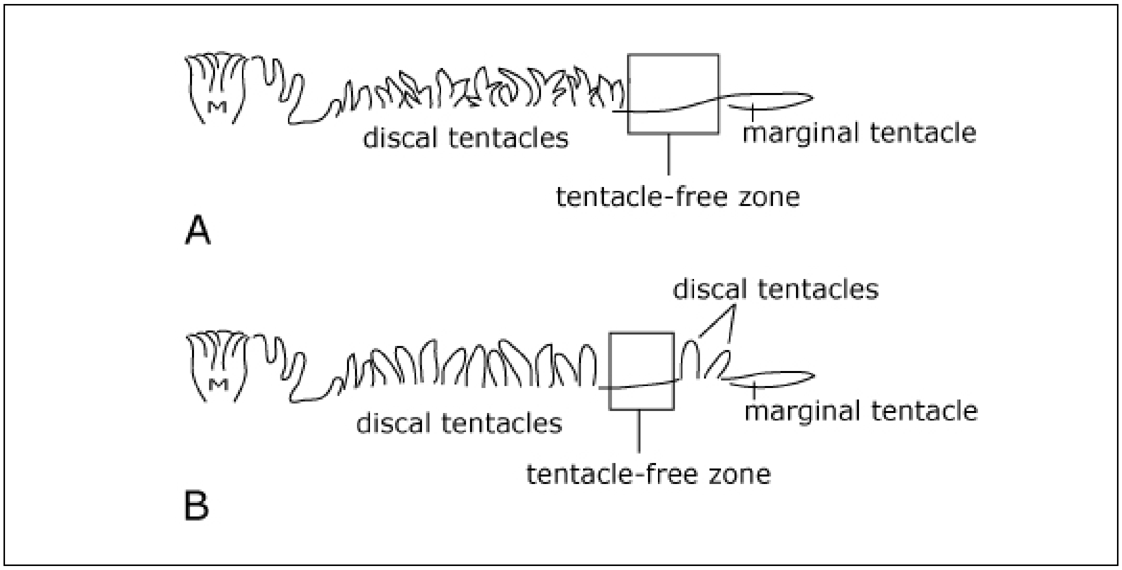


Figure 2-2. Types of tentacle-free zones on oral disc. A: between discal and marginal tentacles; B: among discal tentacles.

Cnidae are the defining characteristic of phylum Cnidaria, and are especially important characters in anthozoan taxonomy (Doumenc and Van Praët, 1987; Fautin, 1988; Fautin and Mariscal, 1991). The morphology, size, and distribution of cnidae are used to define groups within Corallimorpharia, and they are required for a description (Carlgren, 1900; Cutress, 1955; Mariscal, 1974; Fautin, 1988). Types of cnidae observed in corallimorpharians are described in section 2-3.

2-2. Tentacles

Tentacles are considered to be evaginations of all three layers of the oral disc (Fautin and Mariscal, 1974), or “any projection of the oral disc that occurs between one pair of mesenteries or between mesenteries of two adjacent pairs” (Ardelean, 2003, p. 36). In Anthozoa, at least five functions of tentacles are known: prey capture, defense, swimming, agonistic interactions, and harboring zooxanthellae (Fautin and Mariscal, 1974).

Tentacle shape is an important family- and genus-level character in corallimorpharian taxonomy. Comparison across corallimorpharian genera is complicated by non-standardized terminology concerning tentacles. In this study, I found four tentacle morphologies and standardized the terminology of each type.

Corallimorpharian tentacles can be either capitate or non-capitate. A capitate tentacle is well defined: a simple tentacle that possesses a globular end, called an acrosphere (Figure 2-3A). An acrosphere contains numerous nematocysts. A capitate tentacle is longer than other types of tentacles in corallimorpharians. Capitate tentacles are not associated with zooxanthellae. Capitate tentacles occur in family Corallimorphidae: they are retractile in *Corynactis* and *Pseudocorynactis*. In *Corallimorphus*, *Sideractis*, and *Nectactis* only non-retractile capitate tentacles have been reported from preserved specimens; retractability needs to be evaluated with live specimens.

Discoidal corallimorpharians have non-capitate tentacles. Non-capitate tentacles vary in morphology. Those tentacles have been described as small, bumpy, wart-like, or urn-like (e.g., Stephenson, 1922; Carlgren, 1900, 1949; den Hartog, 1980). Therefore, I elaborate on the terms for non-capitate tentacle shape.

The three types of non-capitate tentacles in Corallimorpharia are branched, digitiform, and papilliform. All three types of tentacles are non-retractile and harbor zooxanthellae. Branched tentacles (Figure 2-3B) vary morphologically among species in the number of branches and branching pattern, but they are short (length does not exceed 10 mm). Branched tentacles are common in family Discosomatidae. Digitiform tentacles (Figure 2-3C) are finger-shaped: each is simple and slender with a blunt tip. Digitiform tentacles are common in family Discosomatidae. Digitiform tentacles and branched tentacles exist together in some corallimorpharians. For example, in the genus *Rhodactis*, marginal tentacles are digitiform and discal tentacles are branched. Papilliform tentacles (Figure 2-3D) are very short with blunt tips; their length is too small to measure, but they project from the surface of the oral disc. They are common in families Discosomatidae and Ricordeidae.

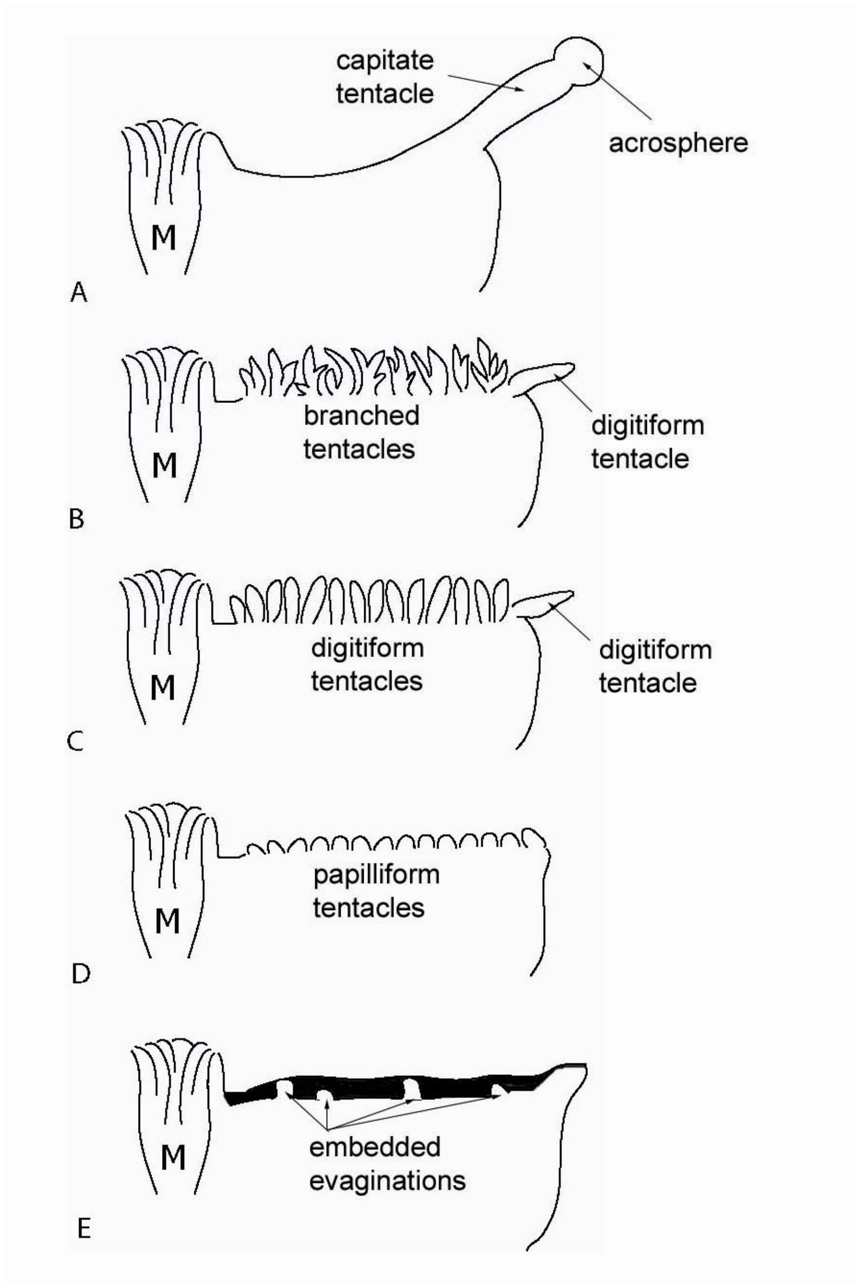


Figure 2-3. Tentacle shapes. A: a capitate tentacle; B: branched tentacles; C: digitiform tentacles: D: papilliform tentacles; E: embedded evaginations of endoderm of the oral disc (black layer indicates mesoglea). The thickness of mesoglea is not shown in A-D because it varies among species and among specimens.

I found evaginations of the endodermal layer of the oral disc that do not project from the surface of the oral disc: some of them can reach the surface of the oral disc, but they are embedded in thick mesoglea (represented as a black layer in figure 2-3E). These occurred in two small specimens of *Discosoma neglecta* (Carlgren, 1900). Based on histological sections of these specimens (Figure 2-4), it is clear that embedded evaginations 1) are hollow, 2) communicate with the coelenteric space like other types of tentacles, and 3) harbor zooxanthellae. I conclude that an embedded evagination is a developmental stage of a papilliform tentacle. In other similar-sized or larger specimens of the species, I observed papilliform discal tentacles covering the oral disc (Figure 4-10).

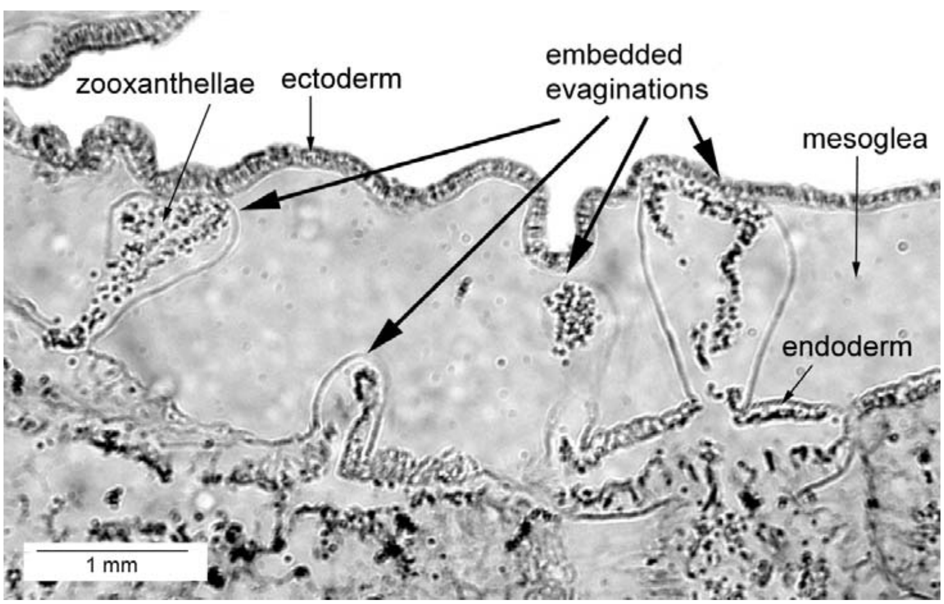


Figure 2-4. Longitudinal section of oral disc of *Discosoma neglecta* (Carlgren, 1900).

2-3. Cnidae

Cnidae are membrane-enclosed cellular secretions of the Golgi apparatus, consisting of a capsule and an eversible tubule (Slautterback and Fawcett, 1959; Slautterback, 1961; Skaer, 1973). Cnidarian systematists have considered types of types cnidae an important systematic character and have defined the cnidom as the census of cnidae present in a species (Weill, 1934). Cnidom and information on the size and distribution of cnidae are now considered as a requirement for the description of virtually any soft-bodied anthozoan (Carlgren, 1900; Cutress, 1955; Mariscal 1974; Fautin 1988). The presence or absence of any major type of cnidae is of particular importance in ordinal, familial, and generic definitions (Carlgren, 1949; Cutress, 1955; Fautin, 1988). The cnidom and distribution of cnidae of corallimorpharians are major features that show a similarity with the Scleractinia.

Cnidae are classified in three major categories, spirocysts, nematocysts, and ptychocysts. Spirocysts and ptychocysts each comprise a single type of cnida. Spirocysts are present only in Anthozoa and ptychocysts are found only in one order of Anthozoa, Ceriantharia. Nematocysts are diverse: Weill (1934) divided them into 16 categories based on observations made through the light microscope primarily of the discharged tubule. Additional nematocyst types were subsequently identified (Carlgren, 1940; Cutress, 1955; Schmidt, 1972; Mariscal, 1974, den Hartog, 1980). Various systems of nomenclature have been devised to cope with this diversity, including Stephenson’s (1929), which was also used by den Hartog (1980) and Schmidt (1969, 1972), although, generally nematocyst classification is based on that of Weill (1934) with modifications made by Carlgren (1940), Cuttress (1955), and Mariscal (1974).

Following the classification and the terminology of Mariscal (1974), I identified the cnidae of corallimorpharians. According to Carlgren (1949), corallimorpharians contain spirocysts, atrichs, holotrichs, and microbasic *b*- and *p*- mastigophores. However, the higher resolution achieved by modern light microscopes and the scanning electron microscope have revealed that atrichs are spined; thus atrichs and holotrichs are actually the same (Cutress, 1955; Westfall, 1965; Calder, 1974; Schmidt, 1974; Bigger, 1976; Marsical et al. 1977; Heeger et al., 1992; Östman et al. 1995; Östman, 2000). Therefore I identified four major types of cnidae in corallimorpharians: spirocysts, microbasic *b*- and *p*- mastigophores, and holotrichs. Within holotrichs, three types were distinguished that differed in capsule size and coiling patterns of the tubule.

Definition of types of cnidae of corallimorpharians:

Holotrich: type of cnida defined by a tubule with spines along the entire length.

Type I (Holotrichs I, Figure 2-5A): tubule coiled into three or four figure eights. Length of capsule up to 250 µm.

Type II (Holotrichs II, Figure 2-5B): tubule coiled into three to ten loops. Length of capsule around 100 µm.

Type III (Holotrichs III, Figure 2-5C): tubule densely coiled into numerous loops in capsule. Length of capsule around 100 µm.

Microbasic *b*-mastigophore (Figure 2-5E): type of cnida defined by a tubule with a barbed, basal shaft less than 3 times capsule length. No V-shaped notch at base of shaft in undischarged state; shaft tapers into tubule in discharged state.

Microbasic *p*-mastigophore (Figure 2-5F and 2-5G): type of cnida defined by a tubule with a barbed, basal shaft less than 3 times capsule length. Smooth tubule. V-shaped notch at base of shaft in undischarged state; shaft abruptly narrows into tubule in discharged state.

Hoplotelic microbasic *p*-mastigophore (Figure 2-5D): type of cnida defined by a tubule with a barbed, basal shaft less than 3 times capsule length. Tubule spined. V-shaped notch at base of shaft in undischarged state; shaft abruptly narrows into tubule in discharged state.

Spirocyst (Figure 2-5H): type of cnida defined by a thin, single walled capsule containing a long, spirally coiled, unarmed tubule of uniform diameter.

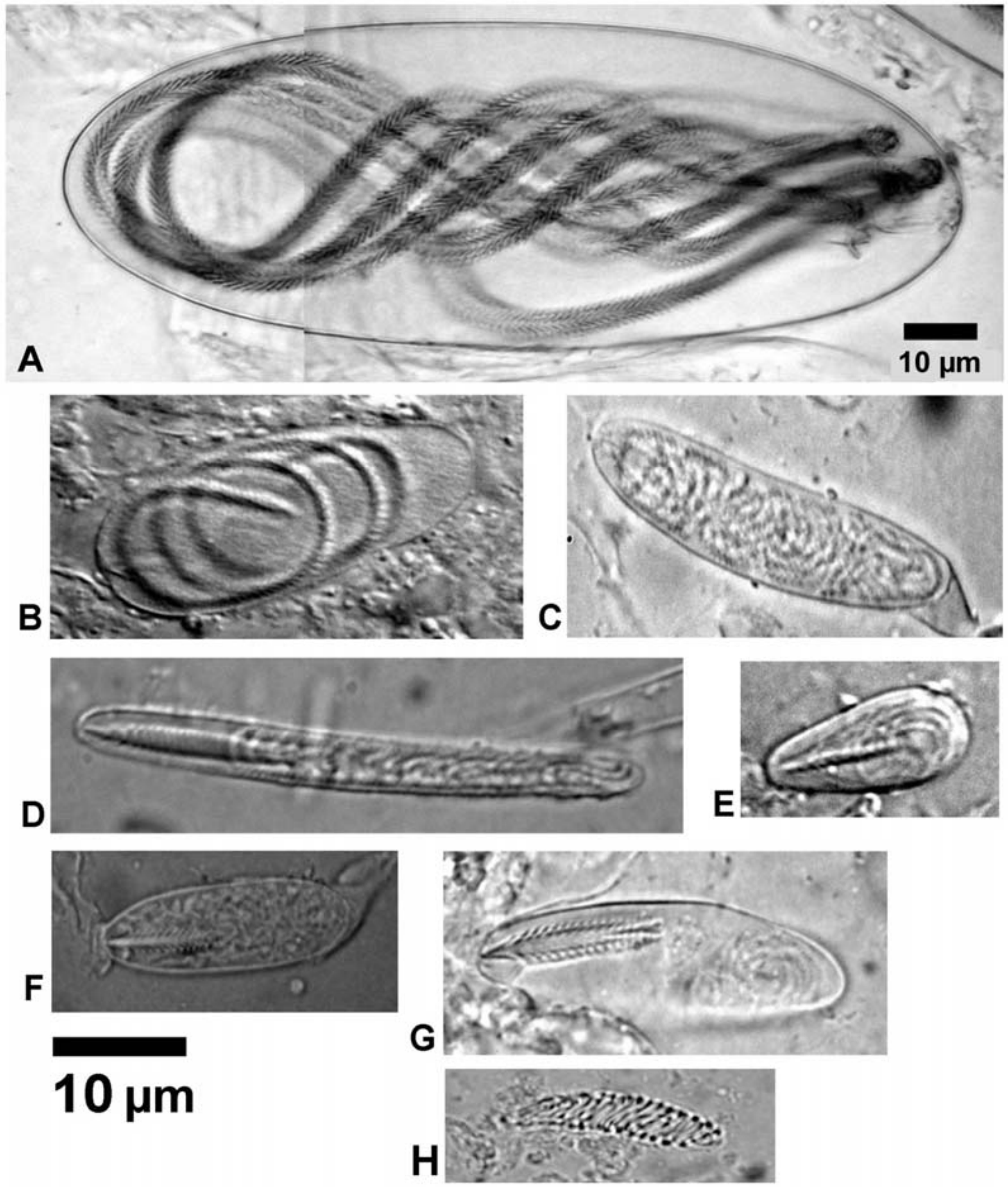


Figure 2-5. Types of cnidae in Corallimorpharia. A: Holotrich I; B: Holotrich II; C: Holotrich III; D: Hoplotelic microbasic *p*- mastigophore; E: Microbasic *b*-mastigophore; F-G: Microbasic *p*- mastigophore; H: spirocyst

CHAPTER III. GENERIC REVISION OF THE CORALLIMORPHARIA

3-1. Introduction

Although there are inventories of corallimorpharians (Andres, 1883; Stephenson, 1922; Carlgren, 1949; den Hartog, 1980; Fautin, 2006), there is no consensus about the number of valid genera and families. I investigated the validity of the 16 nominal genera based on five categories of morphological characters, body form, tentacle shape and arrangement, sphincter muscle development, nature of mesenteries, and cnidae composition, that have been used by other authors. Based on those characters, Stephenson (1922) recognized 10 genera in two families: three in Corallimorphidae, six in Discosomatidae, and *Nectactis*. He was uncertain about the proper family for *Nectactis* because the lack of discal tentacles prevented the genus being included in family Corallimorphidae. Carlgren (1949) recognized 10 genera in three families: two in Sideractidae, three in Corallimorphidae, and five in Actinodiscidae. den Hartog (1980) considered tentacle shape and arrangement to vary among members in a genus, and recognized seven genera in four families: one in family Discosomatidae, one in family Ricordeidae, three in family Corallimorphidae, and two in family Sideractidae (Table 3-1).

Table 3-1. Comparisons of classification schemes.

Genus \ Author	Stephenson (1922)	Carlgren (1949)	den Hartog (1980, 1993)	Cha (this study)
Sideractis Danielssen, 1890	n.a.	valid[3]	valid[6]	valid[6]
Nectactis Gravier, 1918	valid[1]	valid[3]	valid[6]	valid[6]
Corallimorphus Moseley, 1877	valid	valid	valid	valid
Isocorallion Carlgren, 1900	n.a.	invalid	invalid	invalid
Corynactis Allman, 1882	valid	valid	valid	valid
Sphincteractis Zamponi, 1976	n.a.	n.a.	invalid	invalid
Pseudocorynactis den Hartog, 1980	n.a.	n.a.	valid	valid
Actinotryx Duchassing and Michelotti, 1860	valid	invalid	invalid	valid
Discosoma Rüppell and Leuckart, 1828	valid	valid[4]	valid	valid
Orinia Duchassing and Michelotti, 1860	valid	valid	invalid	invalid
Phialactis Fowler, 1888	n.a.	invalid	invalid	invalid
Paradiscosoma Carlgren, 1900	valid	valid	invalid	invalid
Rhodactis Milne Edwards and Haime, 1851	valid	valid	invalid	valid
Metarhodacis Carlgren, 1943	n.a.	valid	invalid	valid
Amplexidiscus Dunn and Hamner, 1980	n.a	n.a	invalid	valid
Ricordea Duchassing and Michelotti, 1860	valid[2]	valid[5]	valid[7]	valid

1: Stephenson (1922) did not assign *Nectactis* to a family

2: classified in family Discosomatidae

3: classified in family Sideractidae

4: Carlgren (1949) used the name *Actinodiscus*

5: classified in family Corallimorphidae

6: classified in family Corallimorphidae

7: classified in family Ricordeidae

n.a.: the genus was not included for the study or not described at the time

The five morphological categories are recovered as phylogenetically informative (see chapter IV). Polyp shape, tentacle shape and arrangement, sphincter muscle development, and cnidae composition separated two clades in Corallimorpharia. Cnidae composition and nature of mesenteries supported the Corallimorpharia and Scleractinia clade, and were informative within the two clades in Corallimorpharia. For example, the genus *Pseudocorynactis* is separated from the other cylindrical body corallimorpharians by having directive mesenteries and lacking incomplete mesenteries. The major morphological characters of each nominal genus are summarized in Table 4-2.

Body form has been the primary character used to assign corallimorpharians to a family. Cylindrial body corallimorpharians are represented by *Corynactis*, *Corallimorphus*, *Pseudocorynactis*, *Sideractis*, and *Nectactis.* They do not have zooxanthellae, and have a wide vertical range of distribution from shallow to deep water. Discoidal body corallimorpharians are represented by *Actinotryx*, *Discosoma*, *Metarhodactis*, *Orinia*, *Paradiscosoma*, *Phialactis, Rhodactis*, and *Amplexidiscus.* They have zooxanthellae, and therefore their vertical distribution range is limited to shallow water. The sphincter muscle is treated as a genus-level character: *Corallimorphus* does not have a marginal sphincter muscle, *Corynactis* and *Pseudocorynactis* have a strongly developed marginal sphincter muscle. Nature of mesenteries is treated as a genus-level character: *Pseudocorynactis* was described by den Hartog (1980) as differing from *Corynactis* because members of

Pseudocorynactis have only complete mesenteries. Cnidae composition has been used as a character used as a family- and genus-level character. *Ricordea* was assigned to the family Corallimorphidae by Carlgren (1949) mainly because of spirocysts in the tentacles.

The shape and arrangement of tentacles are the most distinctive characters in live animals. The morphology of tentacles changes with preservation, but type of tentacles in a genus is constant; den Hartog (1980) considered tentacle shape and arrangement to vary at the species-level. All cylindrical-bodied corallimorpharians have capitate tentacles, and all discoidal-bodied corallimorpharians have non-capitate tentacles. Various types of non-capitate tentacles are a genus-level character. Two genera of cylindrical body corallimorpharians, *Sideractis* and *Nectactis*, are distinguished from *Corynactis*, *Corallimorphus*, and *Pseudocorynactis* based having one tentacle per inter-mesenterial space.

Based on morphological characters, seven of the 16 genera (*Corynactis*, *Corallimorphus*, *Pseudocorynactis*, *Sideractis*, *Nectactis*, *Ricordea* and *Amplexidiscus*) have been considered valid by many authors (e.g., Stephenson, 1922; Carlgren, 1949; den Hartog, 1980, 1993, 1997; Fautin, 2006) and two (*Sphincteractis* and *Isocorallion*) are considered junior synonyms of *Corynactis* and *Corallimorphus* respectively (Carlgren, 1949; den Hartog, 1980; Dunn, 1984).

The validity of the remaining seven genera (*Actinotryx*, *Discosoma*, *Metarhodactis*, *Orinia*, *Paradiscosoma*, *Phialactis,* and *Rhodactis*) was investigated based on the five categories of morphological character. Members of those genera are discoidal body corallimorpharians. Based on tentacle shape, *Actinotryx*, *Orinia*, and *Rhodactis* are distinguished from *Discosoma*, *Paradiscosoma*, *Phialactis*, and *Metarhodactis*. *Actinotryx* and *Orinia* differ from *Rhodactis* in having a tentacle-free zone on the oral disc and marginal sphincter muscle. Based on examination of the type species, I did not find differences between *Actinotryx sanctithomae*, the type species of *Actinotryx*, and *Orinia torpida*, the type species of *Orinia* by monotypy; therefore I synonymized *Orinia* with *Actinotryx*. The type species of three genera, *Discosoma*, *Paradiscosoma*, and *Philactis,* are very similar in five major morphological characters; therefore I synonymized *Paradiscosoma* and *Phialactis* with *Discosoma*. *Metarhodactis* resembles species of *Discosoma* in overall morphology, but *Metarhodactis* differs from *Discosoma* in having numerous hoplotelic microbasic *p*-mastigophores in mesenterial filaments. Based on my examination, I synonymized three of the seven genera, and recognized four genera, *Actinotryx*, *Discosoma*, *Metarhodactis*, and *Rhodactis*.

Conclusively, I recognize five genera in family Corallimorphidae, *Corynactis*, *Pseudocorynactis*, *Corallimorphus*, *Nectactis*, and *Sideractis*; five genera in family Discosomatidae, *Discosoma*, *Actinotryx*, *Rhodactis*, *Metarhodactis*, and *Amplexidiscus*; and one genus, *Ricordea*, in family Ricordeidae.

Table 3-2. Comparisons of type species of nominal genera.

Characters \ Type species	*Corynactis viridis*	*Corallimorphus profundus*	*Pseudocorynactis caribbeorum*	*Sideractis glacialis*	*Nectactis sigularis*	*Ricordea florida*
Shape of marginal tentacles	capitate	capitate	capitate	capitate	capitate	capitate or digitiform
Shape of discal tentacles	capitate	capitate	capitate	n/a (no discal tentacles)	n/a (no discal tentacles)	papilliform
Tentacle/coelenteron relationship	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per endocoel and per exocoel	one tentacle per endocoel and per exocoel	one tentacle per exocoel, multiple per endocoel
Tentacle-free zone on oral disc	No	No	No	Yes	Yes	No
Nematocyst composition	• Holotrichs up to 80 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 250 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore • Hoplotelic microbasic *p*-mastigophore	• Holotrichs up to 200 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore • Hoplotelic microbasic *p*-mastigophore	• Holotrichs up to 200 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 100 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 100 µm • Spirocysts numerous • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore • Hoplotelic microbasic *p*-mastigophore
Nature of mesentery	complete and incomplete	complete and incomplete	complete only	complete and incomplete	complete only	complete and incomplete
Sphincter muscle development	Distinctive – diffuse	Absent	Distinctive - diffuse	Absent	Absent	Absent
Endosymbionts	No	No	No	No	No	Yes

Table 3-2. Comparisons of type species of nominal genera.

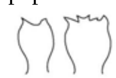
Characters \ Type species	*Actinotryx sanctithomae*	*Orinia torpida*	*Rhodactis rhodostoma*	*Metarhodactis boninensis*
Shape of marginal tentacle	digitiform (length: 3-4 mm in preservative)	digitiform (length: 2-3 mm in preservative)	digitiform (length: 4-5 mm in preservative)	absent
Shape of discal tentacles	papilliform or branched 	papilliform 	branched 	reduced papilliform or branched 
Tentacle/coelenter on relationship	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per endocoel multiple per exocoel
Tentacle-free zone on oral disc	Yes: Between marginal and discal tentacles	Yes: Between marginal and discal tentacles	No	No
Nematocyst composition	• Holotrichs up to 250 µm • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	Type specimen has been damaged: impossible to measure nematocysts.	• Holotrichs up to 160 µm • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 180 µm • Microbasic *p*-mastigophore • Hoplotelic microbasic *p*-mastigophore • Microbasic *b*-mastigophore
Nature of mesentery	complete and incomplete	unknown	complete and incomplete	complete and incomplete
Sphincter muscle development	Weak – diffuse	Unknown	Absent	Absent
Endosymbionts	Yes	Unknown	Yes	Yes

Table 3-2. Comparisons of type species of nominal genera.

Characters / Type species	*Discosoma nummiforme*	*Paradiscosoma neglecta*	*Phialactis neglecta*	*Amplexidiscus fenestrafer*
Shape of marginal tentacle	reduced digitiform (length: very short)	absent or reduced digitiform (length: very short)	reduced digitiform (length: very short)	digitiform
Shape of discal tentacles	reduced papilliform or branched	reduced papilliform or branched	reduced papilliform or branched	digitiform
Tentacle/coelenteron relationship	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per exocoel, multiple per endocoel	one tentacle per endocoel multiple per exocoel
Tentacle-free zone on oral disc	No	No	No	Yes: Within a field of discal tentacles
Nematocyst composition	• Holotrichs up to 160 µm • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 160 µm • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 160 µm • Microbasic *p*-mastigophore • Microbasic *b*-mastigophore	• Holotrichs up to 220 µm • Microbasic *p*-mastigophore • Hoplotelic microbasic *p*-mastigophore • Microbasic *b*-mastigophore
Nature of mesentery	complete only	complete and incomplete	complete and incomplete	complete and incomplete
Sphincter muscle development	Absent	Weak - diffuse	Weak – diffuse	Absent
Endosymbionts	Yes	Yes	Yes	Yes

3-2. Material

Material examined is listed in the description of each species.

Museum abbreviations:

MLP - Museo de La Plata (Argentina)

MOM - Musée Océanographique, Monaco (Monaco)

UBMZ - Museum of Zoology, University of Bergen (Norway)

RMNH - Nationaal Natuurhistorisch Museum, Leiden (The Netherlands)

SMNH - Naturhistoriska Riksmuseet, Stockholm (Sweden)

UUZM - Evolutionsmuseet, Uppsala Universitet (Sweden)

BMNH - British Museum Natural History, London (United Kingdom)

CAS – California Academy of Sciences, San Francisco, California (USA)

KUNHM – Kansas University Natural History Museum, Lawrence, Kansas (USA)

NMNH – National Museum of Natural History (Smithsonian Institution), Washington, D. C. (USA)

I examined the type specimens of the type species of each nominal genus. Examination of type specimens allowed me to identify new characters to distinguish each genus, to emend diagnosis of genera of uncertain validity, and to gather morphological characters for phylogenetic analyses. Information on type specimens is available from the "Hexacorallians of the World" (Fautin, 2006) (Table 3-3). In case no type specimens were designated or the type material is damaged, I examined non-type specimens of type species that I borrowed and collected. I collected specimens of *Actinotryx sanctithomae*

Duchassing and Michelotti, 1860, *Ricordea florida* Duchassing and Michelotti, 1860, and *Rhodactis rhodostoma* (Ehrenberg, 1834), all type species. Collecting specimens from the field provided much information such as color, habitat, and symbiotic associations.

Table 3-3. Type species for each nominal genus. Data from the database "Hexacorallians of the World" (Fautin, 2006).

Type species	Type specimens	Museum and Catalog number	Type locality
Discosoma nummiformis	Syntype	Naturhistoriska Riksmuseet, Stockholm; Cat. 1156	Tor, Red Sea
Actinotryx sanctithomae	?	Not known	St. Thomas, Jamaica
Orinia torpida	Syntype	Naturhistoriska Riksmuseet, Stockholm; Cat. 71	St. Thomas, Jamaica
Phialactis neglecta	Syntype	British Museum Natural History; Cat. 1894.2.7.1.	Papeete, Tahiti, French Polynesia
Paradiscosoma neglecta	?	Not known	St. Thomas, Jamaica
Rhodactis rhodostoma	?	Not known	Tor, Red Sea
Metarhodactis boninensis	Syntype	Evolutionsmuseet, Uppsala Universitet; Cat. 632	Port Lloyd, Bonin Islands (Ogasawara), Japan
Amplexidiscus fenestrafer	Holotype	California Academy of Sciences; Cat. 015553	Lizard Island, Great Barrier Reef, Australia

Table 3-3. Type species for each nominal genus. Data from the database “Hexacorallians of the World” (Fautin, 2006).

Type species	Type specimens	Museum and Catalog number	Type locality
Sideractis glacialis	Holotype	Museum of Zoology, University of Bergen; Cat. 9796	Norwegian North Atlantic Expedition 1876-1878 station 237 (70.68°N, 10.17°W)
Nectactis singularis	Syntype	Musée Océanographique, Monaco; Cat. 130023	Prince Albert I of Monaco 1895: Princesse-Alice et l'Hirondelle station 749 (38.91°N, 21.21°W)
Sphincteractis sanmatiensis	Holotype	Museo de La Plata; Cat. 8.504	San Matias Gulf, Rio Negro, Argentina
Corallimorphus profundus	Syntype	The Natural History Museum, London; Cat. 1889.11.25.4	Challenger Expedition, station 300 (32.30°S, 77.70°W)
Corynactis viridis	?	Not known	Cook Haven and coast of Cornwell, United Kingdom
Pseudocorynactis caribbeorum	Holotype	Nationaal Natuurhistorisch Museum, Leiden; Cat. 11481	Between Piscadera Bay and Blauw Bay, Curaçao
Ricordea florida	?	Not known	Port of St. Thomas, Jamaica

3-3. Methods

1) Collecting

Specimens of Corallimorpharia were collected by hand (California in May 2002), and by snorkeling and scuba diving (Oman in May 2004, Panama in August 2004, and St. Thomas, US Virgin Islands in August 2004). Most tropical shallow-water corallimorpharians attach to dead coral skeletons or rocks. To avoid damage to specimens, the substratum to which the specimen was attached was taken.

2) Geographic coordinates

Geographic coordinates of collected specimens were obtained with an Eagle 12-channel GPS receiver at the point of specimen collection. For specimens preserved in museum collections, and the geographic coordinates, if not given, were inferred from the place of collection.

3) Preservation

For morphological study, specimens were preserved in 10% formalin and some of them were transferred to 70% ethanol. For molecular study, specimens or part of a specimen were preserved in absolute or 95% ethanol. The specimens were cataloged and deposited in the Division of Invertebrate Zoology, Natural History Museum and Biodiversity Research Center, University of Kansas (KUNHM).

4) Histology

Specimens were prepared for embedding with an American Optical T/P 8000 tissue processor. Tissue was embedded in Paraplast®, and sectioned at 8-10 µm. Hematoxylin and eosin were used for staining (Humanson, 1979), and stained slides were mounted using Canada balsam.

5) Cnidae

Undischarged cnidae from preserved specimens were examined at 400x and 1000x in squash preparations using a light microscope equipped with differential interference optics. Squash preparations were made from the tip of discal and marginal tentacles, the column, and the mesenterial filaments of each specimen. Sigma Scan Pro version 4.01.003 measurement software was used to measure the length and the width of undischarged capsuled projected onto a Summa Sketch digitizing tablet (Summagraphics).

The number of capsules measured is indicated as “n” in the results for cnidae of each species; the ratio between the number of specimens in which that type of cnida was found to the number of specimens examined for that tissue is indicated as “N.”

6) Photography

Photographs of whole specimens, cnidae, and histological slides were made using Nikon Coolpix 950 digital camera. Photos were manipulated in Adobe Photoshop (version 5.5 and 7.0) to enhance contrast.

3-4. Results

Suborder CORALLIMORPHARIA Carlgren, 1940

Diagnosis (modified from Carlgren, 1949)

Solitary or clonal polyps without calcareous skeleton. Shallow water corallimorpharians solitary, or often clonal; deep water ones mainly solitary. Body cylindrical or discoidal. Width of oral disc from 10 mm to 450 mm. Mouth oval. Tentacles retractile or non-retractile. Tentacle shape: capitate, digitiform, papilliform, or branched. One or more tentacles communicate with each endocoel and exocoel. Column smooth with weak longitudinal muscles. Actinopharynx short. No siphonoglyphs. Mesenteries numerous and often irregularly arranged. Mesenterial filaments unilobed and often containing numerous holotrichs. Sphincter muscle present or absent. Retractor muscles weak. Basilar muscles absent or weak. Cnidom: holotrichs, microbasic *p*- and *b*- mastigophores, spirocysts.

Distribution

Corallimorpharians are distributed widely from shallow to deep water and from tropical to polar areas. The localities of corallimorpharians species published are shown in Figure 3-1.

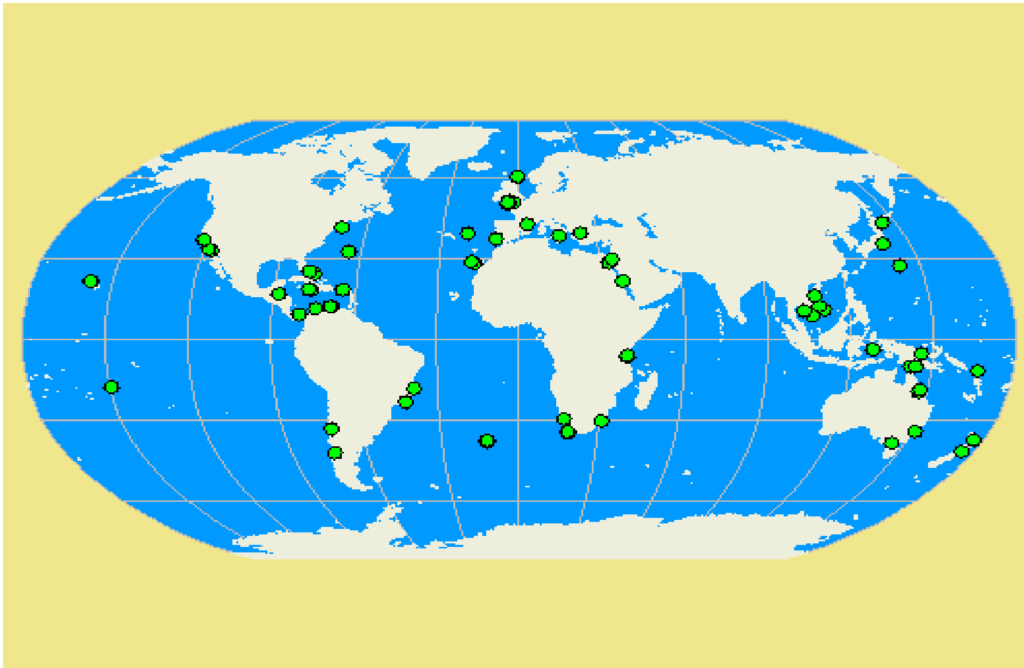


Figure 3-1. Distribution of corallimorpharians (Fautin, 2006). Green dots indicate known distribution of corallimorpharians.

Key to families of suborder Corallimorpharia

1.	Every tentacle capitate ---------------------------------------	Corallimorphidae
	Not every tentacle capitate ----------------------------------	2
2.	Spirocysts very rare or absent in tentacles ----------------	Discosomatidae
	Spirocysts common in tentacles ---------------------------	Ricordeidae

Family CORALLIMORPHIDAE Hertwig, 1882

Synonymy

Sideractiidae Danielssen, 1890

Diagnosis

Cylindrical: oral disc as wide as or slightly wider than pedal disc. All tentacles capitate, retractile or not. Tentacle-free zone absent or present. One or more tentacles communicate with each endocoel and exocoel. Column smooth, mesoglea thin or thick. Mesenteries numerous and often irregularly arranged. Marginal sphincter muscle endodermal or absent. Retractor muscles weak. Basilar muscles absent. Spirocysts numerous in tentacles. Solitary or clonal. Not associated with zooxanthellae.

Nomenclatural/ Taxonomic notes

I consider the family Sideractidae Danielssen, 1890, a junior synonym of Corallimorphidae Hertwig, 1882. Monotypic genera *Sideractis* Danielssen, 1890, and *Nectactis* Gravier, 1918, were assigned by Carlgren (1949), den Hartog (1980), and Dunn (1982) to family Sideractidae Danielssen, 1890, because they lack discal tentacles. Riemann-Zürneck (1979) and den Hartog (1993) discussed the resemblances between *Nectactis singularis* Gravier, 1918, type species of *Nectactis*, and *Corallimorphus*: all members of both genera share the absence of discal tentacles communicating with the exocoels. *Sideractis glacialis*, the type species of *Sideractis*, is similar to species of Corallimorphidae: in polyp size, capitate tentacles, and cylindrical body. It is similar to *Corynactis* and *Pseudocorynactis*; and the absence of discal tentacles is shared with *Nectactis singularis*. I therefore reject placing *Sideractis* and *Nectactis* in a family of their own. I agree with den Hartog (1993) in synonymizing Sideractidae Danielssen, 1890, with Corallimorphidae Hertwig, 1882. Phylogenetic analysis using morphological characters supports the inclusion of *Sideractis* and *Nectactis* in the Corallimorphidae (see Chapter III, Figure 3-1).

Key to genera of family Corallimorphidae

1.	No more than one tentacle per endocoel and exocoel -------	2
	More than one tentacle arise from an endocoel ---------------	3
2.	All mesenteries complete --	*Nectactis*
	Not all mesenteries complete ----------------------------------	*Sideractis*
3.	Polyps solitary ---	4
	Polyps clonal --	*Corynactis*
4.	All mesenteries complete --	*Pseudocorynactis*
	Not all mesenteries complete ----------------------------------	*Corallimorphus*

Genus *Corynactis* Allman, 1846

Synonymy

Draytonia Duchassaing and Michelotti, 1860

Sphincteractis Zamponi, 1976

Diagnosis (modified from den Hartog et al., 1993)

Column long when fully expanded, subglobular when retracted. Tentacles retractile (Figure 3-1, B and C). 2-6 endocoelic tentacles arranged in radial rows; one tentacle per exocoel. Exocoelic tentacles longer than endocoelic tentacles. Mesenteries complete and incomplete. No directive mesenteries. Sphincter muscle endodermal, diffuse. Asexual reproduction by longitudinal fission usual. Often gregarious. Cnidom: spirocysts, holotrichs, microbasic *b*- and *p*- mastigophores.

Nomenclatural/ Taxonomic notes

Corynactis Allman, 1846, is one of the most distictive genera in Corallimorpharia. *Draytonia* was erected for the species *D. myrcia* by Duchassaing and Michellotti, 1864, based on the difference in presence of "glandulae chromatophrae virides" along the margin of the oral disc. Andres (1883) and den Hartog (1980) considered this difference as a variation and synonymized *D. myrcia* with *Corynactis parvula*. Duchassaing and Michellotti (1864) did not designate any type material and type specimens are no longer extant. I agree that *D. myrcia* is a species in *Corynactis* based on the original description.

Sphincteractis was erected for *S. sanmatiensis* by Zamponi, 1976, based on its distinct endodermal marginal sphincter muscle. Zamponi (1976) considered

Corynactis to lack a sphincter muscle, but *Corynactis* is characterized by a distinct endodermal sphincter muscle. The synonymization of *Sphincteractis* with *Corynactis* was discussed in den Hartog (1993) and Genzano et al. (1996). The type species of *Sphincteractis*, *S. sanmatiensis,* was synonymized with *Corynactis carnea* by Genzano et al. (1996). Both species were described from San Matias Gulf, Argentina. Zamponi (1976) stated that the type material, Museo de La Plata, Argentina; catalog number 8.504, contained a holotype, but the type lot contains four specimens. Therefore, they are syntypes. The specimens are damaged. However, based on similarities in polyp size, capitate tentacles, clonal polyps, and endodermal sphincter muscle, I agree with den Hartog (1993) and Genzano et al. (1996) in synonymizing *Sphincteractis* with *Corynactis*.

Type species: *Corynactis viridis* Allman, 1846

Other species examined: *Corynactis californica* Carlgren, 1936

Corynactis viridis **Allman, 1846**

Synonymy

Corynactis viridis Allman, 1846: Gosse, 1860; Andres, 1883; Weill, 1934; Manuel, 1981; Ates, 1987; Manuel, 1988; den Hartog, 1993

Corynactis Allmani Thompson, 1847

Corynactis allmani (Thompson, 1847): Cocks, 1851

Body shape, size and color

Column diameter 5-9 mm, oral disc diameter 7-9 mm, pedal disc diameter 8-15 mm; column length 8-15 mm; tentacle length 4-8 mm. Color: brown in alcohol to pale yellow in formalin. According to Allman (1846), in life color of species various: column whitish, yellowish, green, orange, purple, brownish, pinkish; margin of oral disc often with bright green line; usually tentacle stalks same with column coloration; acrosphere white, creamy, pink, red, purple.

Oral disc and tentacles

Oral disc circular or oval-shape (Figure 3-2A). Tentacles capitate (Figure 3-2, A and C); 24-28 endocoelic radial rows of 2-5 tentacles in each radial row; 1 tentacle in each exocoelic space; total number of tentacles 112-128.

Internal anatomy

24-30 pairs of mesenteries in two or three cycles: first cycle of complete and fertile or sterile mesenteries with well-developed filaments, second cycle of incomplete and sterile mesenteries with filaments, third cycle of very short and sterile mesenteries without filaments (Figure 3-2E); often mesoglea of mesenteries thickened parietally. Sphincter muscle distinct, endodermal, diffuse (Figure 3-2D). Retractor muscles weak, diffuse (Figure 3-2E).

Cnidae: measured from three specimens, each of KUNHM 001882, RMNH 17743, and RMNH17776.

Acrospheres:

Spirocysts	22.33-73.02 x 2.34-5.30 µm	n= 35, N=3/3
Holotrichs III	53.45-84.52 x 27.70-25.34 µm	n= 21, N=3/3

Microbasic *b*-mastigophores	31.26-53.04 x 3.32-6.25 µm	n= 31, N=3/3
Microbasic *p*-mastigophores	24.37-35.10x 5.02-6.32 µm	n= 29, N=3/3
Microbasic *p*-mastigophores	43.82-72.33 x 5.60-6.88 µm	n= 24, N=3/3
Tentacle stalks:		
Spirocysts	24.84-36.77 x 2.35-5.20 µm	n= 47, N=3/3
Mesenterial filaments:		
Holotrichs II	40.57-55.45 x 14.73-17.55 µm	n= 25, N=3/3
Holotrichs III	65.32-80.45 x 30.21-43.08 µm	n= 25, N=3/3
Microbasic *b*-mastigophores	8.35-11.26 x 2.87-3.46 µm	n= 12, N=2/3
Microbasic *p*-mastigophores	20.37-50.05 x 5.41-6.35 µm	n= 24, N=3/3
Column		
Spirocysts	20.13-36.44 x 2.52-4.64 µm	n= 30, N=3/3
Holotrichs III	32.5-57.82 x 8.26-16.49 µm	n= 23, N=3/3
Microbasic *b*-mastigophores	16.12-25.54 x 3.68-6.47 µm	n= 34, N=3/3
Microbasic *p*-mastigophores	15.23-28.46 x 5.11-8.03 µm	n= 35, N=3/3
Microbasic *p*-mastigophores	32.66-53.56 x 6.20-11.09 µm	n= 21, N=3/3

Type specimens and locality

No type specimen designated.

Type locality: British Isles

Other material examined

England

KUNHM 001882: Plymouth; Oct-5-2003; 3 specimens

RMNH 17743: Plymouth, breakwater; 50°20’N, 4°10’W; Aug-1969; 2 specimens

Ireland

RMNH 17776: Southwest coast, County Cork, near Skibberdeen; 51°30’N, 9°20’W; Aug-10-1978; 2 specimens

France

RMNH 11426: Brittany, Roscoff, north of Ile de Batz; 48°40’N, 4°W; depth 80 m; Jul-28-1976; 2 specimens

Nomenclatural/ Taxonomic Notes

Because type material is not available, I examined the specimens used in den Hartog (1993) to redescribe *Corynactis viridis* Allman, 1846. I selected three specimens to measure cnidae; a specimen of KUNHM 001843 and two specimens of RMNH 17743 and 17776 were collected from near the type locality. The cnidae measurements provided in this study correspond well to the data in den Hartog (1993).

Geographical distribution

Corynactis viridis is known from around Ireland, on the south and west coast of Britain, to extreme northern Scotland (Manuel, 1981). The known distribution in continental coast of Europe is from northern France southward along the coast of Spain (Ramil and Pulpeiro, 1990). den Hartog et al. (1993) reported the species in the Mediterranean and in the Macronesian Islands: Madeira Archipelago, Azores, Canary Islands, and Selvagens Islands. It is reported from shallow water to 80 m deep.

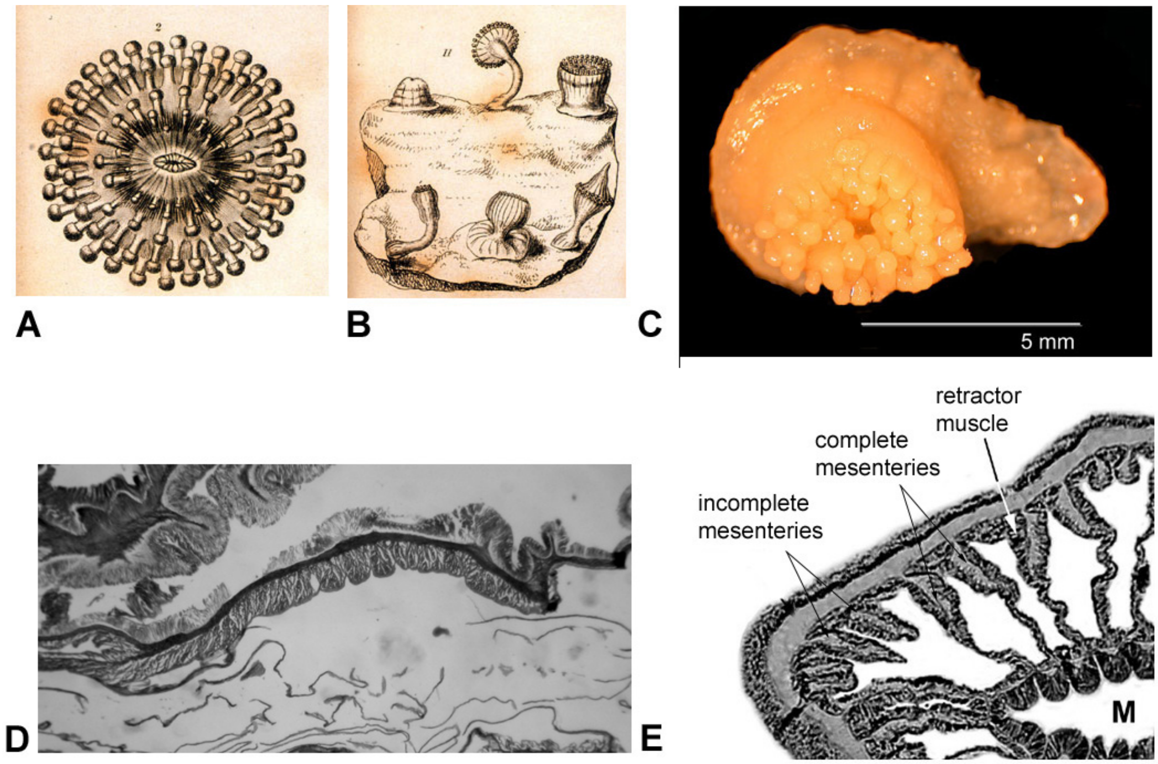


Figure 3-2. *Corynactis viridis* Allman, 1846. A : oral disc (Allman, 1846, Plate XI , fig. 2); B: various body forms (Allman, 1846, Plate XI , fig. 1); C: whole specimen (RMNH 11734); D: longitudinal section of endodermal sphincter muscle (KUNHM 001843); E: mesenteries and retractor muscle (KUNHM 001843).

Genus *Corallimorphus* Moseley, 1877

Synonymy

Isocorallion Carlgren, 1900

Diagnosis (modified from Carlgren, 1949)

Tentacles non-retractile. 2 endocoelic tentacles arranged in radial rows; one exocoelic tentacle. Tentacle-free zone between mouth and discal tentacles. Column with thick mesoglea. Mesenteries complete and incomplete. Sphincter muscle absent. Gonochoric. Cnidom: spirocysts, holotrichs, microbasic *b*-mastigophores, Hoplotelic microbasic *p*-mastigophores.

Nomenclatural/ Taxonomic notes

Corallimorphus Moseley, 1877, was established based on descriptions of *C. profundus* and *C. rigidus*. Carlgren (1949) recognized *C. profundus* as the type species because of page priority. *Isocorallion hertwigi* Carlgren, 1900, the type species of *Isocorallion*, was synonymized with *Corallimorphus rigidus* by Carlgren (1943), who is the author of *Isocorallion hertwigi*. Carlgren (1900) erected the new genus *Isocorallion* for a Hertwig's specimen, but in 1943, when he had the chance to examine additional material, he concluded that *I. hertwigi* belongs in *Corallimorphus*. Therefore, *Isocorallion* is a junior synonym of *Corallimorphus*.

Type species: *Corallimorphus profundus* Moseley, 1877

Corallimorphus profundus **Moseley, 1877**

Synonymy

Corallimorphus profundus: Hertwig, 1882; Andres, 1883; Stephenson, 1920, 1922; Carlgren, 1928; Carlgren and Stephenson, 1929; Carlgren, 1949; Dunn, 1984

Body shape, size and color

Column diameter 25-48 mm, oral disc diameter 28-50 mm, pedal disc diameter 24-45 mm; column length 15-25 mm; tentacle length up to 8 mm. Color yellow in preservation.

Oral disc and tentacles

Oral disc circular. Discal tentacles in cycles; marginal tentacles alternately long and short; endocoelic tentacles longer than exocoelic tentacles. Total number of tentacles 66 in BMNH 1889.11.25.4.

Internal anatomy

I was not allowed to make histological sections of the type specimens. Therefore, the description of internal anatomy is based on the original description and Dunn (1984). 24-30 pairs of mesenteries in two or three cycles: first cycle of complete and fertile or sterile mesenteries with well-developed filaments, second cycle of incomplete and sterile mesenteries with filaments, third cycle of very short and sterile mesenteries without filaments; often mesoglea of mesenteries thickened parietally. Sphincter muscle absent.

Cnidae: measured from two syntypes, BMNH 1889.11.25.4., and 1889.11.25.5.

Acrospheres:

Spirocysts	32.18-67.35 x 3.45-5.25 µm	n= 18, N=2/2
Holotrichs I	193.3-252.3 x 15.3-18.7 µm	n= 11, N=2/2
Microbasic *b*-mastigophores	42.36-67.69 x 3.59-4.90 µm	n= 19, N=2/2
Hoplotelic microbasic *p*-mastigophores	113.2-203.98x 3.78-4.83 µm	n= 20, N=2/2
Tentacle stalks:		
Spirocysts	30.84-49.16 x 3.94-7.50 µm	n= 24, N=2/2
Mesenterial filaments:		
Holotrichs III	80.46-103.35 x 16.86-22.57 µm	n= 20, N=2/2
Microbasic *b*-mastigophores	16.70-19.73 x 4.52-5.60 µm	n= 11, N=1/2
Hoplotelic microbasic *p*-mastigophores	53.46-70.90 x 8.34-11.05 µm	n= 20, N=2/2
Column		
Hoplotelic microbasic *p*-mastigophores	100.55-118.50 x 18.06-21.46 µm	n= 6, N=1/2

Type specimens and locality

Syntypes:

BMNH 1889.11.25.4: Challenger Expedition, station 300; 32.30°S, 77.70°W; depth 2514 m; 1 specimen

BMNH 1889.11.25.5: Challenger Expedition, station 293; 38.93°S, 104.92°W; depth 3702 m; 1 specimen

Nomenclatural/ Taxonomic notes

The cnidae data are compared with those of Dunn (1984), which is the first redescription of *Corallimorphus profundus*. Hoplotelic microbasic *p*-mastigophores are very rare in column tissue, but Dunn (1984) also found the type of nematocysts in the column.

Geographical distribution

Corallimorphus profundus is known from the Antarctic. The vertical distribution ranges from 132 to 3660 meters (Dunn, 1984).

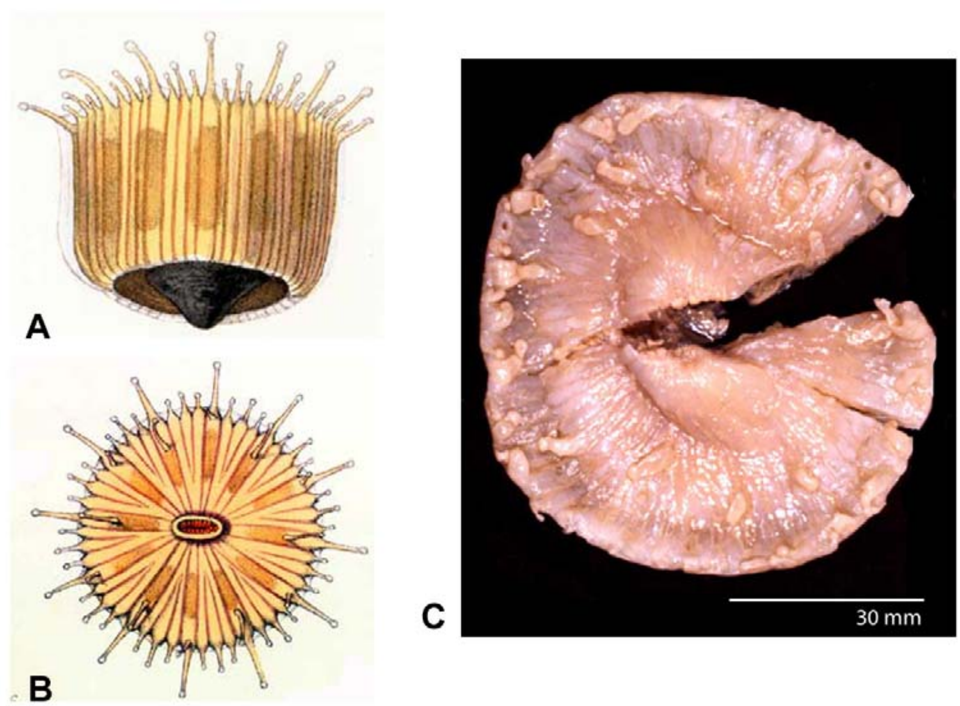


Figure 3-3. *Corallimorphus profundus* Moseley, 1877. A: side view (Mosley, 1877, Plate XLV, fig. 7); B: oral disc (Mosley, 1877, Plate XLV, fig. 7, fig. 8); C: oral disc of syntype (BMNH 1889.11.25.4.)

Genus Pseudocorynactis den Hartog, 1980

Diagnosis (modified from den Hartog, 1980)

Column long when fully expanded, subglobular form when retracted. Tentacles retractile (Figure 3-4, B and C). 3-5 endocoelic tentacles arranged in radial rows; one tentacle per exocoel. Exocoelic tentacles longer than endocoelic tentacles. Tentacle-free zone between mouth and discal tentacles. Mesenteries complete. Two directive mesenteries. Sphincter muscle endodermal, diffuse. Solitary. Cnidom: spirocysts, holotrichs, microbasic *b*- and *p*- mastigophores, hoplotelic microbasic *p*-mastigophores.

Nomenclature/Taxonomic Notes

There are two known species in *Pseudocorynactis*: *P. caribbeorum* and *P. caboverdensis*. Both species differ from *Corynactis* by large size, solitary habit, and the absence of asexual reproduction. Long spirocysts (Figure 3-4C) and slender holotrichs II (Figure 3-4D) are distinctive. Another character likely to be generic importance is the mesenteries: in *P. caribbeorum* all mesenteries are complete and able to gametogenesis, whereas in species of *Corynactis*, at least some mesenteries are incomplete.

Type species: *Pseudocorynactis caribbeorum* den Hartog, 1980

***Pseudocorynactis caribbeorum* den Hartog, 1980**

Body shape, size and color

Occasionally oral disc exceeds diameter of pedal disc; polyps connected by basal expansion; contracted specimens mammiform. Column diameter 26-32 mm, oral disc diameter 32-35 mm, pedal disc diameter 26-30 mm; column length 25-35 mm; tentacle length 10-16 mm in preserved expanded specimens. Pale yellow in formalin. According to den Hartog (1980) in life color of species various: upper column pale to vivid orange, lilac, orange-brown, yellowish brown, purplish brown, with or without opaque, whitish, greenish, or blackish streaks or specks; lower column often less intensely colored than upper column, 6 dark longitudinal bands; oral disc semi-transparent; mouth opaque white; tentacles colorless with vivid orange-red acrospheres.

Oral disc and tentacles

Oral disc circular; 25-30 endocoelic radial rows of 3-5 tentacles in each radial row; 1 tentacle in each exocoel; total number of tentacles 125-180.

Column

Mesenterial insertions clearly visible through column in some specimens preserved in formalin (Figure 3-4, A and B).

Internal anatomy

I was not allowed to make histological sections of the type specimens. Therefore, the description of internal anatomy is based on the original description, den Hartog

(1980). 23, 25 pairs of complete, fertile mesenteries: 2 pairs of directives (Figure 3-3E). Sphincter muscle distinct, endodermal, diffuse (Figure 3-4F).

Cnidae: measured from holotype (RMNH 11481) and paratype (RMNH 11479)

Acrospheres:		
Spirocysts	53.23-183.21 x 3.75-7.45 µm	n= 35, N=2/2
Holotrichs II	92.33-106.4 x 5.42-6.88 µm	n= 11, N=2/2
Holotrichs III	146.2-193.34 x 14.56-17.44 µm	n= 20, N=2/2
Microbasic *b*-mastigophores	35.26-50.24 x 4.71-6.34 µm	n= 30, N=2/2
Hoplotelic microbasic *p*-mastigophores	111.3-136.3x 5.32-6.84 µm	n= 31, N=2/2
Tentacle stalks:		
Spirocysts	21.33-40.01 x 2.33-4.50 µm	n= 18, N=2/2
Mesenterial filaments:		
Holotrichs III	62.40-82.35 x 24.31-31.84 µm	n= 22, N=2/2
Microbasic *b*-mastigophores	12.50-13.43 x 3.22-4.26 µm	n= 7, N=1/2
Microbasic *p*-mastigophores	18.62-24.59 x 6.01-7.35 µm	n= 20, N=2/2
Column		
Holotrichs III	33.39-41.06 x 10.35-12.30 µm	n= 20, N=2/2
Microbasic *b*-mastigophores	10.32-22.30 x 3.88-6.59 µm	n= 18, N=2/2
Microbasic *p*-mastigophores	17.41-29.08 x 6.43-8.31 µm	n= 19, N=3/3

Type specimens and locality

Holotype:

RMNH 11481; Curaçao, southcoast, between the entrance of Piscadera Bay and Blauw Bay; depth 6-15 m; Oct-30-1972

Paratype:

RMNH 11479; Curaçao, southcoast, between the entrance of Piscadera Bay and Blauw Bay; depth 6-15 m; Apr-1971

Distribution

Pseudocorynactis caribbeorum occurrs in the southern and eastern Caribbean. The vertical distribution is 6-50 m deep (den Hartog, 1980).

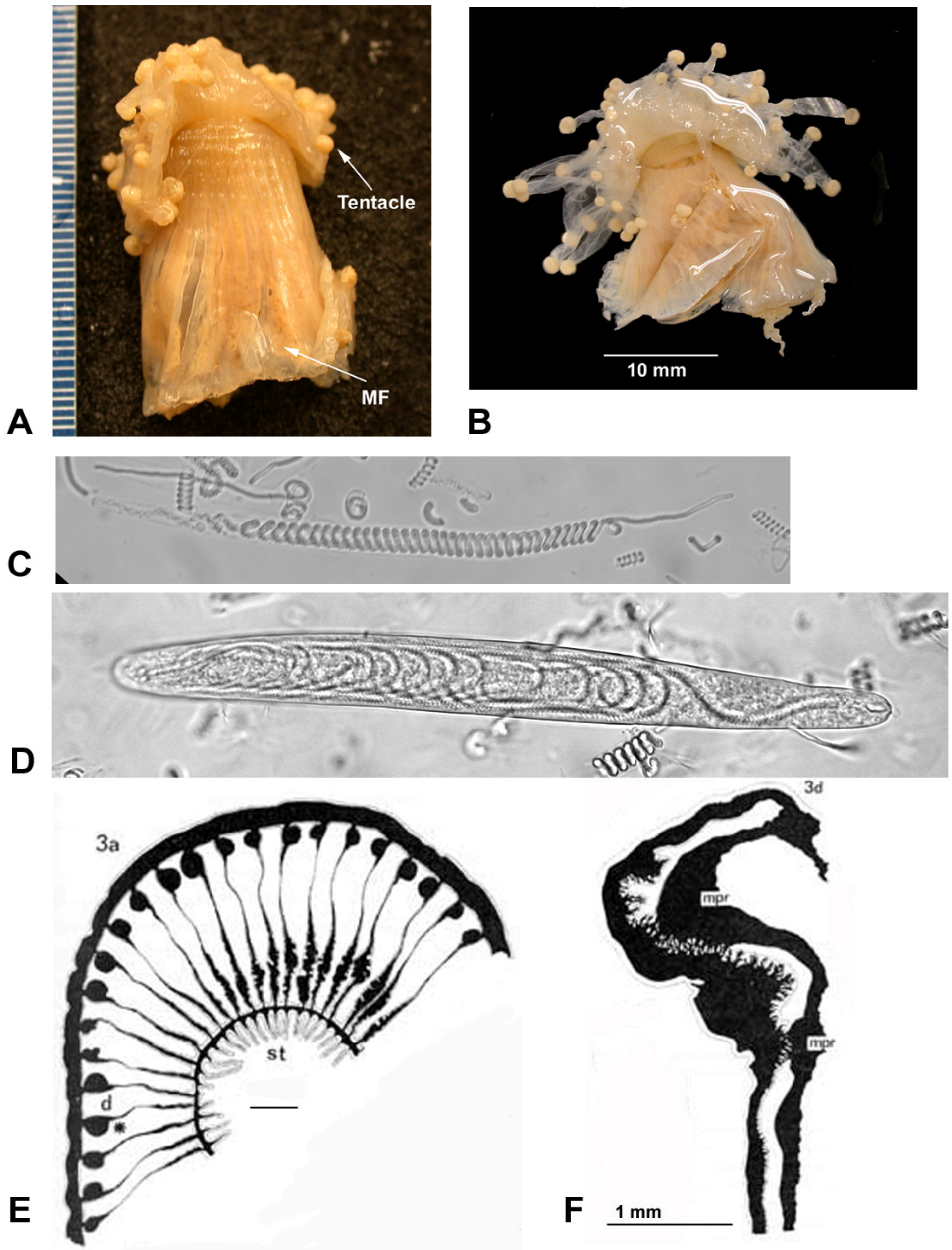


Figure 3-4. *Pseudocorynactis caribbeorum* den Hartog, 1980. A-B: whole body of holotype, note visible mesenterial insertion and acrospheres; C: long spirocysts in an acrosphere (RMNH 11481); D: slender holotrichs II in an acrosphere (RMNH 11481); E: a pair of directive (den Hartog, 1980, p. 21, Fig. 3); F: weak endodermal sphincter muscle (den Hartog, 1980, p. 21, Fig. 3). MF: mesenterial filaments.

Genus *Sideractis* Danielssen, 1890

Diagnosis (modified from Danielssen, 1890)

Tentacles non-retractile. Tentacles arranged in radial rows; one endocoelic, one exocoelic tentacle. Tentacle-free zone on oral disc. Mesenteries complete and incomplete. Sphincter muscle absent. Solitary. Cnidom: spirocysts, holotrichs, microbasic *b*- and *p*- mastigophores.

Nomenclature/ Taxonomic notes

Sideractis was established by Danielsson in 1890 based on monotypy, *S. singularis* Danielssen, 1890. Danielsson's original description is too simple and the illustration does not represent diagnostic features to identify the species. The type specimen of the species is damaged, so it was limited to examine anatomy of the species in detail. Therefore the description of the anatomy of the species is based on published descriptions (Carlgren 1921, 1940; den Hartog et al., 1993) and my own observation. Cnidae data collected from a syntype specimen.

Type species: *Sideractis glacialis* Danielssen, 1890

Sideractis glacialis Danielssen, 1890

Body shape, size and color

Oral disc width not exceeds 15 mm, pedal disc width not exceeds 12 mm, column length not exceeds 12 mm, tentacle length up to 8 mm. According to Danielssen (1890), in life pedal disc width not exceeds 20 mm.

Oral disc and tentacles

Oral disc circular; tentacle-free zone on oral disc. The number of tentacles 26 in type specimen, UBMZ 9796.

Internal anatomy

I was not allowed to make histological sections of the type specimens. Therefore, the description of internal anatomy is based on the original description, Danielssen (1890). 6 pairs of complete, fertile mesenteries; various number of incomplete, sterile mesenteries.

Cnidae: measured from holotype (UBMZ 9796)

Acrospheres:		
Spirocysts	26.30-76.47 x 2.85-5.25 µm	n= 12, N=1/1
Holotrichs I	106.7-194.3 x 17.8-24.3 µm	n= 8, N=1/1
Microbasic *b*-mastigophores	14.37-22.34 x 4.56-5.43 µm	n= 4, N=1/1
Microbasic *p*-mastigophores	76.4-94.45x 6.57-7.34 µm	n= 10, N=1/1
Tentacle stalks:		
Spirocysts	34.45-48.58 x 3.84-5.60 µm	n= 18, N=1/1
Mesenterial filaments:		
Holotrichs II	68.44-85.27 x 24.34-26.85 µm	n= 20, N=1/1
Microbasic *b*-mastigophores	14.56-16.21 x 4.56-4.70 µm	n= 2, N=1/1
Microbasic *p*-mastigophores	27.46-32.46 x 5.64-6.95 µm	n= 10, N=1/1
Column		
Microbasic *b*-mastigophores	13.67-15.81 x 4.21-4.86 µm	n= 7, N=1/1

Microbasic *p*-mastigophores	34.56-38.48 x 6.52-8.43 µm	n= 5, N=1/1

Type specimens and locality

Syntype:

UBMZ 9796: Norwegian North Atlantic Expedition 1876-1878 station 237, 70.68°N, 10.17°W

Geographical distribution

The species was known from Jan Mayen and the Trondheim, Vest, and Hardanger fiords in Norway. The type specimen from Jan Mayen was found on a stone (Danielssen, 1890). The depth the species reported from 220-500 m.

Nomenclature/ Taxonomic notes

The illustration in the original description is not accurate and confusing compare to actual type specimen (Figure 3-5).

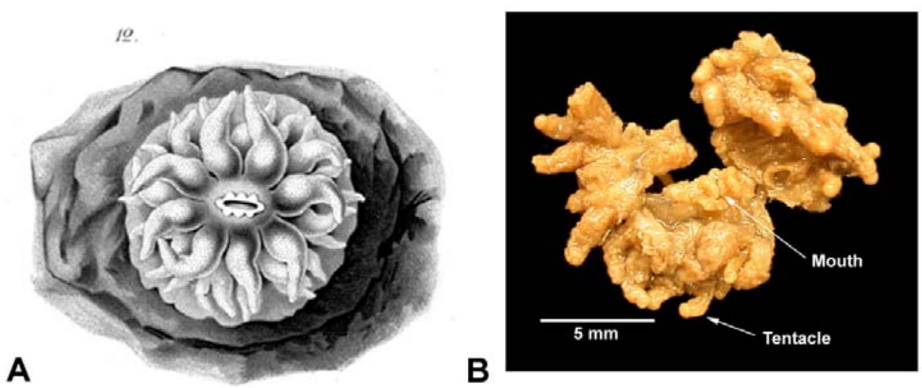


Figure 3-5. *Sideractis glacialis* Danielssen, 1890. A: illustration in the original description (Danielssen, 1890, pl. 1, fig. 1); B: whole specimen of holotype (UBMZ 9796).

Genus *Nectactis* Gravier, 1918

Diagnosis (modified from Gravier, 1918)

Tentacles non-retractile. Tentacles arranged near the margin in 2 cycles, one endocoelic, one exocoelic tentacle. Tentacle-free zone on oral disc. Mesenteries complete. No directive mesenteries. Sphincter muscle absent. Retractor muscles weak. Solitary. Cnidom: spirocysts, holotrichs, microbasic *b*- and *p*- mastigophores.

Type species: *Nectactis singularis* Gravier, 1918

Nectactis singularis **Gravier, 1918**

Body shape, size and color

Oral disc width not exceeds 25 mm, pedal disc width not exceeds 20 mm, column length not exceeds 10 mm.

Oral disc and tentacles

Oral disc circular or oval-shape. Tentacles length up to 5 mm (most tentacles macerated). Tentacles arranged in two cycles; one endocoelic cycle with up to 30 tentacles, one exocoelic cycle with up to 30 tentacles. Endocoelic tentacles longer than exocoelic tentacles. The number of tentacles up to 60.

Internal anatomy

I was not allowed to make histological sections of the type material. Therefore, the description of internal anatomy is based on the original description. 30 pairs of mesenteries all complete, fertile or sterile.

Cnidae: measured from two specimens, each of MOM 130023 and MNHM 1224

Acrospheres:		
Spirocysts	28.20-34.57 x 4.23-5.56 µm	n= 10, N=2/2
Holotrichs II	78.8-95.5 x 22.4-24.4 µm	n= 10, N=2/2
Microbasic *b*-mastigophores	16.47-21.59 x 4.35-5.21 µm	n= 6, N=2/2
Microbasic *p*-mastigophores	81.49-89.06x 6.32-7.54 µm	n= 11, N=2/2
Mesenterial filaments:		
Holotrichs II	72.48-80.40 x 22.43-28.45 µm	n= 9, N=2/2
Microbasic *b*-mastigophores	13.08-14.31 x 4.20-4.35 µm	n= 3, N=2/2
Microbasic *p*-mastigophores	26.37-30.23 x 6.12-6.39 µm	n= 4, N=2/2
Column		
Microbasic *b*-mastigophores	11.24-14.81 x 3.78-4.46 µm	n= 6, N=2/2

Type specimens and locality

Syntypes:

MOM 130023: S. A. Le Prince de Monaco, station 753, 39°50-54'N 17°57'-18°06'W; depth 4360 m, Sep-18-1896; 11 specimens

MOM 130135: S. A. Le Prince de Monaco, station 749, 38°54-55'N 21°06'45"-18°45'W; depth 5005 m; Sep-16,17-1896; 5 specimens

Other materials examined

MNHM 1215: Golfe de Gascogne N/O "Jean Charcot" BIOGAS 6, station no. CP20, 44°23'N 04°51'W; depth 4459 m; Oct-29-1974; 5 specimens

MNHM 1224: Golfe de Gascogne N/O “Cryos” BIOGAS 5, station no. CP05, 46°29’N 10°20’W; depth 3850 m; Jun-19-1974; 4 specimens

Geographical distribution

The species is known from Iberian deep sea basin east of Azores and Bay of Biscay. The known vertical distribution ranges from 3850-5005 m.

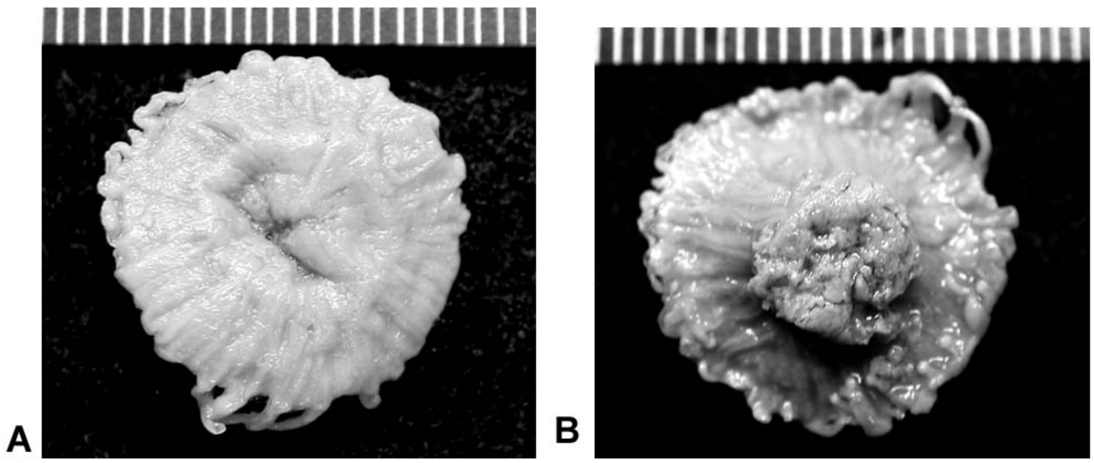


Figure 3-6. *Nectactis singularis* Gravier, 1918. A: oral disc of syntype (MOM 130023); B: pedal disc of syntype (MOM 130023).

Family RICORDEIDAE Watzl, 1922

Diagnosis (modified from Watzl, 1922)

Discoidal body: Oral disc wider than pedal disc; in some specimens pedal disc irregular. One, or often, more mouths. Two types of tentacles: capitate or digitiform discal tentacles, some branched; digitiform or capitate marginal tentacles. Tentacles arranged in radial rows over the endocoels; non-retractile. No tentacle-free zone. Mesenteries complete and incomplete, often irregularly arranged. Sphincter muscle absent. Basilar muscle absent. Spirocysts in tentacles. Solitary, often gregarious. Associated with zooxanthellae.

Nomenclatural/ Taxonomic notes

Ricordea is the single genus in Recordeidae, and has intermediate morphology between Corallimorphidae and Discosomatidae (den Hartog, 1980). *Ricordea* resembles Corallimorphidae in cnidae composition based on the presence of spirocysts, and in tentacle shape that some marginal tentacles are capitate as in Corallimorphidae. However, tentacle arrangement is similar to that of Discosomatidae, and marginal tentacles are very short and non-retractile despite some of them are capitate. Species of *Ricordea* have discoidal body and are unable to withdraw oral disc and tentacles. Because member of *Ricordea* have both attributes of Discosomatidae and Corallimorphidae, Stephenson (1922) placed the genus in Discosomatidae and Carlgren (1949) assigned *Ricordea* to the Corallimorphidae. In this study, I concluded to accommodate the genus in a family its own, Ricordeidae

Watzl, 1922, as proposed by Watzl (1922) and den Hartog (1980) based on the distinctive morphological characters of *Ricordea* from members of Discosomatidae. According to phylogeny of Corallimorpharia, *Ricordea* is more closely related to genera of Discosomatidae than those of Corallimorphidae (see chapter IV). To reflect the phylogeny to the classification, *Ricordea* needs to be placed in family Discosomatidae. However, as discussed in chapter III, the relationships among genera are not conclusive at this moment due to the lack of comprehensive taxon sampling in Corallimorphidae and the limitation of genetic markers used in molecular analyses. Indeed the systematic position of *Ricordea* in Corallimorpharia is not consistent in molecular analyses: 28S rDNA data support *Ricordea* in Corallimorphidae, while 16S rDNA data support *Ricordea* in Discosomatidae. The question about the systematic position of *Ricordea* needs to be addressed in further studies.

Genus *Ricordea* Duchassaing and Michelotti, 1860

Diagnosis: Same as in the family.

Type species: *Ricordea florida* Duchassaing and Michelotti, 1860

Ricordea florida Duchassaing and Michelotti, 1860

Synonymy

Heteranthus floridus (Duchassaing and Michelotti, 1860): McMurrich, 1889

Corynactis bahamensis Watzl, 1922

Body shape, size and color

Oral disc diameter 10-36 mm, pedal disc diameter 8-25 mm, column length up to 5 mm. Color: beige to pale yellow in formalin, in life mouth red or bright green, tip of tentacles bright green, stalk of tentacles brown, column brown or green to dull green (Figure 3-7, B-D).

Oral disc and tentacles

Oral disc circular; four mouths observed from one specimen (KUNHM 002373). Tentacles numerous; at least ten tentacles on each endocoel and more than one tentacles on each exocoel. Tentalces arranged radially (Figure 3-7B); often difficult to recognize arrangement in clonal specimens due to irregularities from asexual reproduction. The number of endocoelic rows 46 to 92.

Internal anatomy

The number of mesenteries numerous, often arranged irregularly. Sphincter muscle absent.

Cnidae: measured from four specimens; each from KUNHM 002373, KUNHM 002392, USNM 56603, and USNM 19043

Marginal tentacles:

Holotrichs III	67.11-76.61 x 11.94-14.45 µm	n=25, N=4/4
Hoplotelic *p*-mastigophores	93.87-121.59 x 7.17-8.83 µm	n=34, N=4/4
Spirocysts	42.17-75.65 x 2.14-3.67 µm	n=36, N=4/4
Microbasic *b*-mastigophores	50.25-75.74 x 4.98-7.30 µm	n=38, N=4/4
Microbasic *b*-mastigophores	21.40-38.58 x 3.20-9.18 µm	n=24, N=4/4

Discal tentacles:

Holotrichs III	59.77-75.97 x 11.91-15.12 µm	n=65, N=4/4
Hoplotelic *p*-mastigophores	76.50-83.21 x 6.84-8.90 µm	n=46, N=4/4
Spirocysts	34.52-55.21 x 2.63-3.79 µm	n=36, N=4/4
Microbasic *b*-mastigophores	18.93-26.47 x 3.15-4.52 µm	n=27, N=4/4
Mesenterial filaments		
Holotrichs II	41.74-49.68 x 12.82-15.19 µm	n= 25, N=4/4
Holotrichs III	50.81-61.79 x 22.56-26.38 µm	n= 37, N=4/4
Microbasic *p*-mastigophores	35.31-55.99 x 7.39-13.95 µm	n= 57, N=4/4
Column		
Holotrichs II	41.74-49.68 x 12.82-15.19 µm	n= 25, N=4/4
Holotrichs III	50.81-61.79 x 22.56-26.38 µm	n= 37, N=4/4
Microbasic *p*-mastigophores	35.31-55.99 x 7.39-13.95 µm	n= 57, N=4/4

Type specimens and locality

No type specimens designated.

Type locality: St. Thomas, US Virgin Islands

Other material examined

<u>Belize, British Honduras</u>

USNM 56576: Carrie Bow Cay; May-5-1974; 1 specimen

USNM 56582: Carrie Bow Cay; May-5-1974; 5 specimens

USNM 56602: Carrie Bow Cay; May-23-1974; 1 specimen

USNM 56903: Carrie Bow Cay, Outer Fore Reef Slope; depth 18 m; Mar-23-1978; 4 specimens

St. Thomas, US Virgin Islands

KUNHM 002373: Water Is. Sprat point, 18°81’N 64°54’W; depth 10 m; Aug-19-2004; 5 specimens

KUNHM 002375: Hull Bay, 18°29’N 64°55’W; depth 0.3-0.5 m; Aug-20-2004; 4 specimens

KUNHM 002376: Coki Bay, 18°35’N 64°86’W; depth 5 m; Aug-21-2004; 5 specimens

KUNHM 002377: N. Saba Is., 18°21’N 64°58’W; depth 5 m; Aug-18-2004; 5 specimens

St. John, US Virgin Islands

USNM 52014: Reef Bay; depth 19 m; Jan-5-1961; 5 specimens

Bocas del Toro, Panama

KUNHM 002392: Isla Colon, Boca del Drago, 09°15’N 82°19’W ; depth 2 m; Aug-10-2004; 2 specimens

KUNHM 002393: Crawl Cay, 09°15’N 92°07’W; depth 2 m; Aug-6-2004; 4 specimens

Bonaire

RMNH 11499: South-west coast, 2 miles north of Kralendijk; 3-5 m deep; Apr-9-1922; 2 specimens

Curaçao

RMNH 11495: South-coast, between Piscadera Bay and Blauw Bay; depth 36 m; Jul-9-1973; 1 specimen

RMNH 11496: South-coast, between Piscadera Bay and Blauw Bay; depth 45 m; Apr-21-1973; 1 specimen

<u>Jamaica</u>

USNM 19043: Port Royal Cays; 1 specimen

USNM 51540: Kingston, South East Cay; depth 1 m; Sep-5-1959; 7 specimens

<u>Puerto Rico</u>

USNM 51082: La Parguera, Majimo Reef; Jan-1959; 30 specimens

USNM 94777: La Parguera, Media Luna Reef; Oct-1-1984; 1 specimen

Geographical distribution

Ricordea florida is a common Caribbean species, not reported from the Gulf of Mexico and so far also not from Brazilian reefs. The known vertical distribution ranges 1 to 45 meters.

Nomenclatural/ Taxonomic notes

McMurrich (1889) considered *Ricordea florida* is a species of the actiniarian genus *Heteranthus* Klunzinger, 1877, and made a new combination, *Heteranthus floridus* (Duchassaing and Michelotti, 1860). However, he realized that *Heteranthus* was a junior synonym of *Ricordea*, and he corrected this misinterpretation himself in McMurrich (1896). *Corynactis bahamensis* Watzl, 1922, was described from a single, preserved specimen. Watzl stated that the specimen is 1 cm in diameter with 200 to 300 tentacles associated with zooxanthellae. However, *Corynactis* is a nonzooxanthellae genus and the illustration in the original description of *C. bahamensis* (Figure 3-7E) does not resemble a *Corynactis* species at all. Based on Watzl's observation, in my view, *C. bahamensis* is a small specimen of *Ricordea florida*. Cnidae data gathered in this study is relatively well corresponding to the data in den Hartog (1980), but the length of hoplotelic microbasic *p*-mastigophores in marginal tentacles measured in this study is longer than the one in den Hartog (1980).

Biological notes

The symbiotic association between *Ricordea florida* and a shrimp, *Periclimenes rathbunae*, is reported from Belize (Ritson-Williams and Paul, 2007).

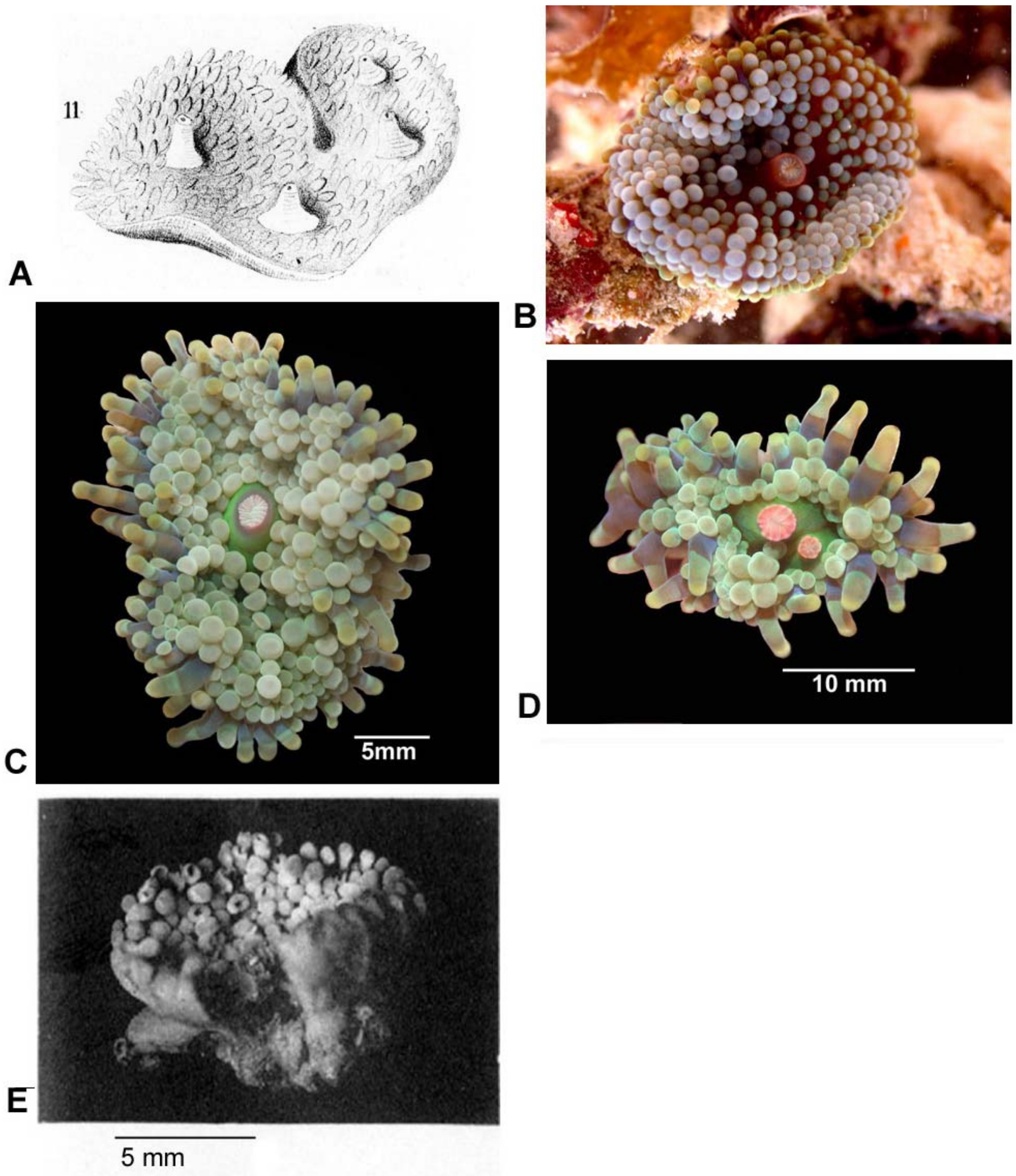


Figure 3-7. *Ricordea florida* Duchassing and Michelotti, 1860. A: illustration in the original description (Duchassaing and Michelotti, 1860, Plate VI, fig. 11); B: radial tentacle arrangement (KUNHM 002377); C: oral disc with irregular tentacle arrangemet (KUNHM 002375); D: two mouths on oral disc (KUNHM 002373); E: illustration of the original description of *Corynactis bahamensis* Watzl, 1922.

Family DISCOMATIDAE Duchassaing and Michelotti, 1864

Synonymy

Discosomae Duchassing and Michelotti, 1864

Discostominae Verrill, 1869

Rhodactidae Andres, 1883

Phialactidae Fowler, 1888

Actinodiscidae Carlgren, 1949

Diagnosis (modified from Carlgren, 1949)

Discoidal body: oral disc wider than pedal disc. Two types of tentacles: branched or papilliform discal tentacles, reduced digitiform marginal tentacles, sometimes marginal tentacles absent. Tentacles non-retractile; arranged in radial rows, often discal tentacles densely arranged in central field, sparsely arranged in area near margin and mouth. Tentacle-free zone absent or present. Mesenteries complete and incomplete, numerous and often irregularly arranged. Sphincter muscle very weak or absent. Retractor muscles weak. Basilar muscle weak or absent. Spirocysts very rare or usually absent. Often gregarious. Associated with zooxanthellae.

Nomenclatural/ Taxonomic notes

The family Discosomatidae is established based on *Discosoma* Rüppell and Leuckart, 1828. Duchassaing and Michelotti (1864) introduced the family name Discosomae. Verrill (1869) accepted Ehrenberg's incorrect change of the genus name *Discosoma* into *Discostoma* (Ehrenberg, 1834), and proposed a sub-family Discostominae of the family Thalassianthidae in Actiniaria. However, these taxa are objective synonyms because they are based on genus *Discosoma* Rüppell and Leuckart, 1828. Therefore, Discosomae Duchassaing and Michelottis, 1864 has priority over Discostominae Verrill, 1869. Because the proper suffix of a family name is -idae, the correct family name is Discosomatidae Duchassaing and Michelotti, 1864. Unfortunately Carlgren (1949) did not use valid names, *Discosoma* and Discosomatidae, because he followed de Blainville (1830, 1834) in replacing the name *Discosoma* by the junior name *Actinodiscus*. Accordingly he used the family name Actinodiscidae for Discosomatidae, adding another junior synonym. Phialactidae Fowler, 1888 is subjective junior synonym because of the subjective synonymy of *Phialactis* and *Discosoma*. Andres (1883) introduced family name Rhodactidae for genus *Rhodactis*. However, based on morphology, *Rhodactis* differs in tentacle shape and length. In my view it is not realistic to assign a family for *Rhodactis* itself, therefore Rhodactidae Andres, 1883 is a subjective junior synonym of Discosomatidae.

Key to genera of family Discosomatidae

1.	Digitiform marginal tentacles ---------------------------------------	2
	Reduced marginal tentacles or none at all -------------------------	3
2.	No tentacle-free zone on oral disc, branched discal tentacles --	*Rhodactis*
	Tentacle-free zone on oral disc ------------------------------------	4
3.	Hoplotelic *p*-mastigophores absent in mesenterial filaments ---	*Discosoma*
	Hoplotelic *p*-mastigophores present in mesenterial filaments --	*Metarhodactis*
4.	Branched discal tentacles --	*Actinotryx*
	Digitiform discal tentacles ---	*Amplexidiscus*

Genus *Discosoma* Rüppell and Leuckart, 1828

Synonymy

Actinodiscus de Blainville, 1830

Discostoma Ehrenberg, 1834

Phialactis Flower, 1888

Paradiscosoma Carlgren, 1900

Diagnosis (moidified from den Hartog, 1980)

Tentacles extremely short, shorter than 1 mm. Two types of tentacles: none or reduced ditigiform marginal tentacles, papilliform discal tentacles. No tentacle-free zone. Mesenteries complete and/or imcomplete. Sphincter muscle absent or very weak. Basilar muscle absent. Cnidom: holotrichs, microbasic *b*- and *p*- mastigophores.

Nomenclatural/ Taxonomic notes

The nomenclatural issues of the name *Discosoma* are discussed in den Hartog (1980). De Blainville (1830) replaced the name *Discosoma* by *Actinodiscus*, clearly stating the genus name is based on *Discosoma nummiforme* Rüppel and Leuckart, 1828. Ehrenberg (1834) stated *Discosoma* is a junior homonym of a genus of lizards, *Discosomus* Oken, 1816, and proposed to change the name into *Discostoma*. However, according to International Commission on Zoological Nomenclature (ICZN) Art. 58d, *Discosomus* Oken is not a homonym. In fact, *Discosomus* Oken was published as the name rejected for nomenclatural purposes (ICZN, 1956), and listed in the Official Index of Rejected and Invalid names in Zoology (ICZN, 1963) (den Hartog, 1980). Based on my examination, the type species of *Phialactis*, *Ph. neglecta* Fowler, 1888, and the type species of *Paradiscosoma*, *Pa. neglecta* Carlgren, 1900, are well accommodated in *Discosoma* based on diagnostic characters of the two species described below.

Type species: *Discosoma nummiforme* Rüppell and Leuckart, 1828

Other species examined: *Discosoma neglecta* (Duchassing and Michelotti, 1860)

Discosoma fowleri (Fowler, 1889)

Discosoma carlgreni (Watzl, 1922)

***Discosoma nummiforme* Rüppell and Leuckart, 1828**

Synonymy

Actinodiscus nummiforme (Rüppell and Leuckart, 1828): Carlgren, 1949

Body shape, size and color

Oral disc diameter 18 mm, pedal disc diameter 12 mm; column length 5 mm. In life oral disc diameter 16-32 mm, pedal disc diameter 14-22 mm; column length up to 7 mm. Color: pale yellow in formalin. In life color of species various: column brown; tentacles same with column coloration (Figure 3-8C).

Oral disc and tentacles

Discal tentacles papilliform, marginal tentacles reduced digitiform; arranged in radial rows, arrangement of each row varies: tentacles too numerous to count the number of endocoelic and exocoelic tentacles.

Internal anatomy

All mesenteries complete (Figure 3-8E); number of mesenteries varies: approximately 32 pairs in a small specimen, 48 pairs in a large specimen. Sphincter muscle absent.

Cnidae: measured from the syntype specimen, SMNH 1156, and three non-type specimens, each of KUNHM 002080, 002081, and 002094

Marginal tentacles:

Holotrichs I	68.42-93.48 x 23.03-38.42 µm	n= 18, N=3/4
Holotrichs II	28.33-31.02 x 6.33-11.43 µm	n= 26, N=4/4
Microbasic *b*-mastigophores	17.32-24.32 x 3.44-5.21 µm	n= 24, N=3/4
Microbasic *p*-mastigophores	17.83-29.35 x 4.33-7.58 µm	n= 21, N=3/4

Discal tentacles:

Holotrichs I	68.33-102.35 x 28.37-43.44 µm	n= 18, N=2/4
Holotrichs II	31.93-46.75 x 9.36-12.05 µm	n= 28, N=3/4
Microbasic *p*-mastigophores	16.93-26.46 x 4.96-10.34 µm	n= 35, N=4/4

Mesenterial filaments:

Holotrichs I	86.29-154.85 x 53.26-73.44 µm	n= 29, N=4/4
Holotrichs II	30.48-63.42 x 16.42-22.63 µm	n= 32, N=3/4
Holotrichs III	36.45-58.03 x 10.88-18.34 µm	n= 24, N=3/4
Microbasic *p*-mastigophores	33.40-42.38 x 6.33-8.42 µm	n= 32, N=4/4
Microbasic *p*-mastigophores	17.68-26.08 x 4.53-6.49 µm	n= 21, N=2/4

Column

Microbasic *b*-mastigophores	18.92-24.33 x 4.68-9.32 µm	n= 20, N=2/4
Microbasic *p*-mastigophores	25.37-36.49 x 5.93-11.23 µm	n= 21, N=3/4

Type specimens and locality

Syntype: SMNH 1156: Red Sea, Tor; 28.23°N, 33.61°W; 1 specimen

Other material examined

Oman

KUNHM 002079: Bandar Khayran near aquaculture weirs, 23º30'27"N, 58º45'37"W; depth 5 m; May-17-2004; 1 specimen

KUNHM 002080: Bander Jissah, 23º33'26"N, 58º39'04"W; depth 6 m; May-18-2004; 1 specimen

KUNHM 002081: Bander Jissah, 23º33'26"N, 58º39'04"W; depth 6 m; May-18-2004; 1 specimen

KUNHM 002089: Between Bander Kharyan and Bander Jissah, 23º32'01"N, 58º41'57"W; depth 9 m; May-20-2004; 1 specimen

KUNHM 002090: Bander Jissah, 23º33'26"N, 58º39'04"W; depth 7.6 m; May-20-2004; 2 specimens

KUNHM 002092: Fahal Island, 23º32'01"N, 58º41'57"W; depth 6 m; May-21-2004; 2 specimens

KUNHM 002094: Cemetery Bay (Bandar Sidab), 23º36'41"N, 58º36'02"W; depth 12 m; May-21-2004; 1 specimen

Geographical distribution

D. nummiforme is known from Red Sea, East Africa, and the Gulf of Oman. This species lives in shallow water: the depth does not exceed 12 m.

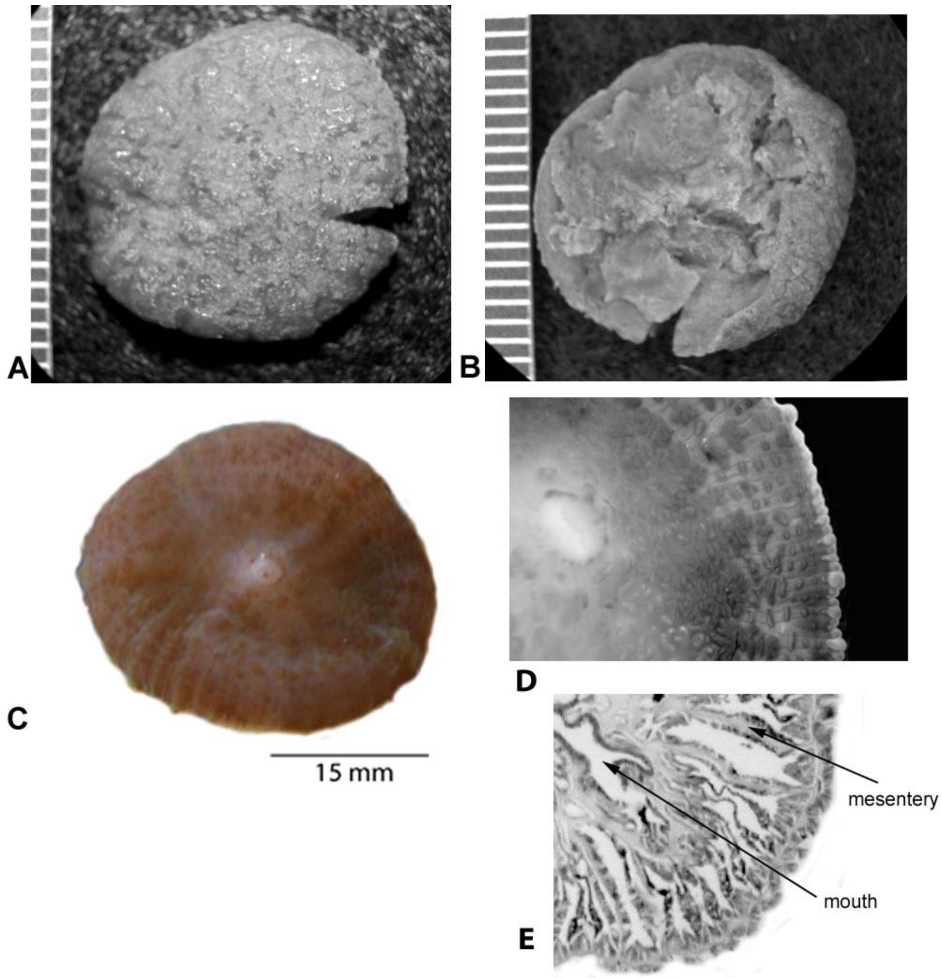


Figure 3-8. *Discosoma nummiforme* Rüppell and Leuckart, 1828. A: oral disc of syntype specimen (SMNH 1156); B: pedal disc of syntype specimen (SMNH 1156); C: oral disc of live material (KUNHM 002092); D: reduced marginal tentacles (KUNHM 002092); E: transverse section (KUNHM 002090), note complete mesenteries.

***Discosoma fowleri* (Fowler, 1889)**

Synonymy

Phialactis neglecta Fowler, 1889

Ricordea neglecta (Fowler, 1889): Haddon, 1898

Rhodactis neglecta (Fowler, 1889): Carlgren, 1900; Carlgren, 1949

Actinodiscus neglecta (Fowler, 1889): Cutress, 1979

Discosoma fowleri (Fowler, 1889): den Hartog, 1980

Body shape, size and color

Oral disc diameter 21-40 mm, pedal disc diameter 15-20 mm; column length up to 20 mm. Color: yellow in 70% alcohol.

Oral disc and tentacles

Oral disc circular; margin creculated in large specimens. Discal tentacles papilliform, marginal tentacle reduced digitiform arranged in radial rows: 3-14 in an endocoelic row, no tentacles in an exocoelic row (Figure 3-9, B and C).

Internal anatomy

Mesenteries complete or incomplete; at least three cycles (Figure 3 -9D), number of mesenteries varies: approximately 72 pairs (12 complete, 60 incomplete) in a small specimen, 86 pairs (18 complete, 68 incomplete) in a large specimen. Sphincter muscle weak, diffuse.

Cnidae: measured from the holotype (BMNH 194.2.7.1) and two specimens, each of USNM 50485 and 52492

Marginal tentacles:

Holotrichs II	32.45-41.33 x 6.45-7.41 µm	n= 13, N=3/3
Holotrichs III	35.57-37.46 x 10.59-12.32 µm	n= 13, N=3/3
Microbasic *b*-mastigophores	13.45-16.46 x 4.57-5.80 µm	n= 16, N=3/3
Microbasic *p*-mastigophores	12.33-16.66 x 4.32-6.08 µm	n= 21, N=3/3
Discal tentacles:		
Holotrichs III	37.30-43.06 x 9.84-15.55 µm	n= 14, N=3/3
Microbasic *b*-mastigophores	13.22-15.32 x 4.55-5.70 µm	n= 9, N=2/3
Microbasic *p*-mastigophores	16.97-29.35 x 3.08-6.74 µm	n= 21, N=3/3
Mesenterial filaments:		
Holotrichs I	162.47-220.65 x 64.32-82.16 µm	n= 28, N=3/3
Holotrichs II	34.93-58.34 x 16.13-22.58 µm	n= 33, N=3/3
Microbasic *p*-mastigophores	36.49-43.72 x 7.02-10.83 µm	n= 41, N=3/3
Microbasic *p*-mastigophores	13.44-20.75 x 3.96-5.84 µm	n= 22, N=3/3
Column		
Holotrichs III	15.89-17.44 x 4.90-6.72 µm	n= 8, N=2/3
Microbasic *b*-mastigophores	12.97-18.43 x 5.40-6.32 µm	n= 12, N=2/3
Microbasic *p*-mastigophores	13.05-18.29 x 4.08-7.29 µm	n= 30, N=3/3

Type specimens and locality

Syntype:

BMNH1894.2.7.1: French Polynesia, Tahiti, Papeete, 17.52°S 149.58°E; depth 0-10 m; 1 specimen (cut in two pieces)

Other material examined

<u>French Polynesia</u>

USNM 50485: Society Islands, Tahiti, Papeete, Motu Uta Reef, Quarantine Island; depth 2 m; Mar-17-1956; 1 specimen

USNM 52492: Society Islands, Tahiti, Papeete, Motu Uta Reef, Quarantine Island; depth 1 m; Apr-10-1957; 87 specimens

USNM 52494: Society Islands, Bora Bora, Tereia Point, Fanui Bay; depth 1 m; Apr-25-1957; 30 specimens

Nomenclatural/Taxonomic notes

Discosoma neglecta (Fowler, 1888) is a junior homonym of *Discosoma neglecta* (Duchassaing and Michelotti, 1860). Therefore, *Discosoma fowleri* was proposed as a substitute name for *Phialactis neglecta* Fowler by den Hartog (1980).

The type specimen of *Discosoma fowleri* (Fowler, 1888) was small (the width of oral disc is approximately 12 mm), but the specimen was cut in pieces, thus the size may not be an accurate measurement. The anatomy and cnidae of *D. fowleri* have been documented in Fowler (1888) and Cutress (1979), and there are a few points need to be discussed. Fowler (1888) stated that the tentacles do not have nematocysts, but I found several types of nematocysts from both discal and marginal tentacles. The number of nematocysts found is relatively small to the ones of other tissues such as mesenterial filaments, and it is not surprising that Fowler did not find nematocysts with considerations in technical limitations, and in the number of specimens examined: Fowler (1888) examined only one specimen. The “large cnidocil” (Figure

3-9E) found by Fowler (1888) is holotrichs I. The size of the capsule and coiling pattern of tubule fit well in the definition of holotrichs I (Figure 3-9E, see chapter II). Cutress (1979) documented that the species has spirocysts, but he found only one spirocyst from marginal tentacle. From my examinations, I did not find any spirocysts from three specimens, thus I assume that Cutress's tissue squash was contaminated.

Geographical distribution

The species is known from Tahiti.

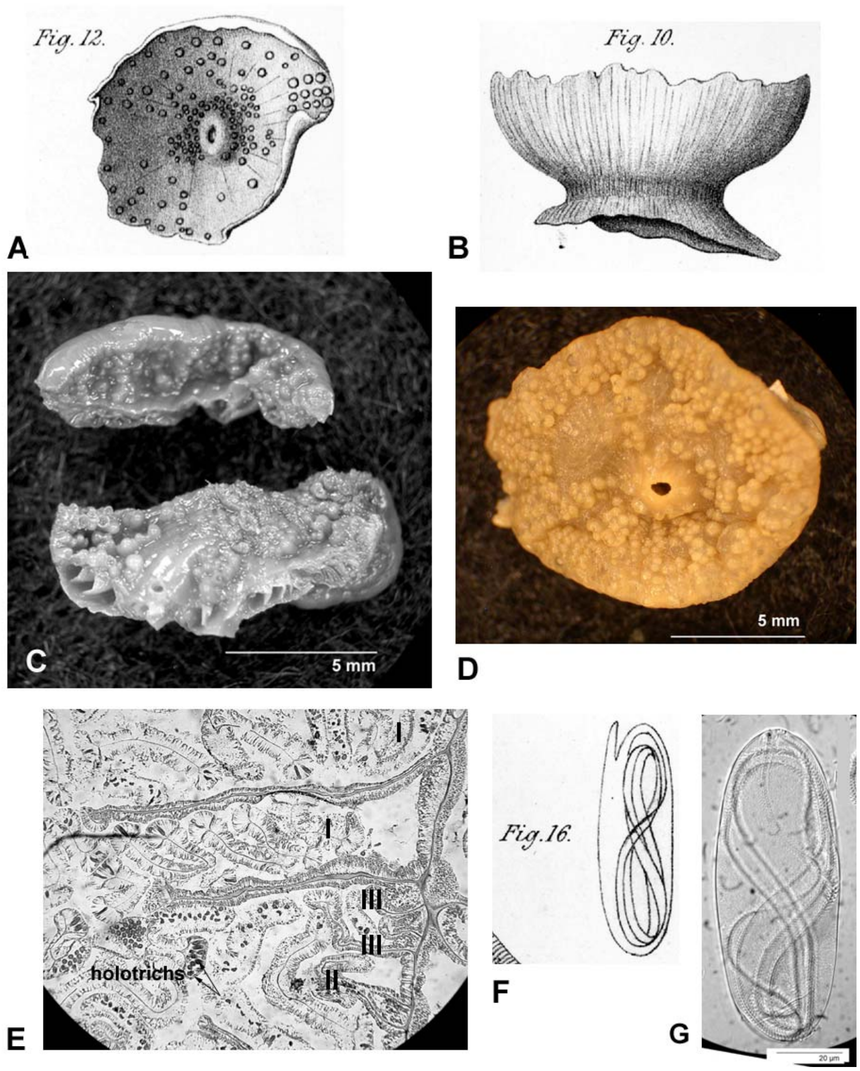


Figure 3-9. *Discosoma fowleri* (Fowler, 1889). A: oral disc view from the original description (Fowler, 1888, Plate XV, fig. 12); B: side view from the original description (Fowler, 1888, Plate XV, fig. 10); C: syntype specimen (BMNH 1894.2.7.1); D: whole specimen (USNM 52494); E: transverse section (USNM 52494), note three cycles of mesenteries (I, II, and III) and holotrichs in mesenterial filaments; F: “large cnidocil” (Fowler, 1888, Plate XV, fig. 16); G: holotrichs I from mesenterial filaments.

***Discosoma neglecta* (Duchassaing and Michelotti, 1860)**

Synonymy

Isaura neglecta Duchassaing and Michelotti, 1860

Paradiscosoma neglecta (Duchassaing and Michelotti, 1860): Carlgren, 1900; Carlgren, 1943: Carlgren, 1949

Discosoma neglecta (Duchassaing and Michelotti, 1860): den Hartog, 1980

Body shape, size and color

Oral disc diameter 15-60 mm, pedal disc diameter 12-35 mm; column length up to 30 mm. Color: yellow in formalin.

Oral disc and tentacles

Oral disc circular; margin drawn out into a variable number of distinct outgrowths, large marginal outgrowths often alternate with smaller ones, tips of outgrowths often trifid (Figure 3-10, A and B). Discal tentacles arranged in radial rows papilliform, immature discal tentacles embedded in mesoglea (Figure 3-10), irregular arrangement in an endocoelic row. Marginal tentacles absent.

Internal anatomy

Mesenteries complete and incomplete; number of mesenteries varies. Sphincter muscle very weak, diffuse (Figure 3-10E).

Cnidae: measured from three specimens, two of USNM 51674 and one of USNM 51674

Discal tentacles:

Holotrichs III	32.45-53.86 x 8.29-12.89 µm	n= 20, N=2/3

Microbasic *b*-mastigophores	12.06-18.33 x 4.67-5.32 µm	n= 12, N=2/3
Microbasic *p*-mastigophores	17.20-36.35 x 4.90-6.59 µm	n= 28, N=3/3
Mesenterial filaments:		
Holotrichs I	134.85-161.39 x 52.90-77.26 µm	n= 18, N=2/3
Holotrichs II	32.98-61.50 x 14.33-20.48 µm	n= 32, N=3/3
Microbasic *p*-mastigophores	30.80-44.02 x 5.90-11.23 µm	n= 21, N=2/3
Microbasic *p*-mastigophores	16.84-27.80 x 4.10-6.25 µm	n= 24, N=3/3
Column		
Holotrichs III	22.90-25.49 x 5.33-5.90 µm	n= 6, N=2/3
Microbasic *b*-mastigophores	14.50-21.30 x 4.32-5.97 µm	n= 18, N=2/3
Microbasic *p*-mastigophores	12.89-30.97 x 4.68-6.30 µm	n= 32, N=3/3

Type specimens and locality

No type specimens designated.

Type locality: Caribbean Sea, Antilles; 16.26°N 62.52°W

Other material examined

Curaçao

RMNH 12006: south coast; depth 15 m; Jul-18-1973; 5 specimens

RMNH 12007: south coast; depth 5-10 m; Aug-25-1972; 6 specimens

RMNH 12008: south coast; Nov-1971; 1 specimen

Jamaica

USNM 52505: Port Royal, Biddlecomb shoal; depth 20 m; Dec-3-1961; 2 specimens

St. John, US Virgin Islands

USNM 51674: Cabritt Horn Point; depth 22.5 m, Mar-24-1960; 1 specimen

Nomenclatural/ Taxonomic notes

Isaura neglecta was originally described as by Duchassing and Michelotti, 1860. The genus *Isaura* belongs to the order Zoanthidea and authors unfortunately did not provide clear reasons for their placement of the species in *Isaura*. Calgren (1900) reexamined the species and he established a new genus *Paradiscosoma.* Therefore, *Paradiscosoma neglecta* (Duchassaing and Michelotti, 1860) is the new combination for *I. neglecta* Duchassing and Michelotti, 1860. Carlgren (1900) reasoned that the genus *Paradiscosoma* is distinctive in having marginal lobes instead of marginal tentacles in other species in *Discosoma*. Stephenson (1922) accepted Carlgren's perspective and stated that "*Paradiscosoma* differs from *Discosoma* with margin of disc thrown into small lobes. Otherwise like *Discosoma*." I recognized that the marginal lobes of *P. neglecta* are histologically identical to the rest of the margin (Figure 3-10C), thus the presence of marginal lobes of *P. neglecta* is unique character of the species. However, except the marginal lobes, the species is well accommodated in *Discosoma* based on major diagnostic characters (see Table 3-2). Therefore, I treated the presence of marginal lobes of *P. neglecta* as a species-level character, and synonymized *Paradiscosoma* with *Discosoma* in this study. The size of holotrichs I in mesenterial filaments measured in this study is slightly smaller than the one in den Hartog (1980). Holotrichs III in column is very rare.

Geographical distribution

The species in known from Caribbean Sea: Bahamas, St. Thomas, Jamaica, and Haiti.

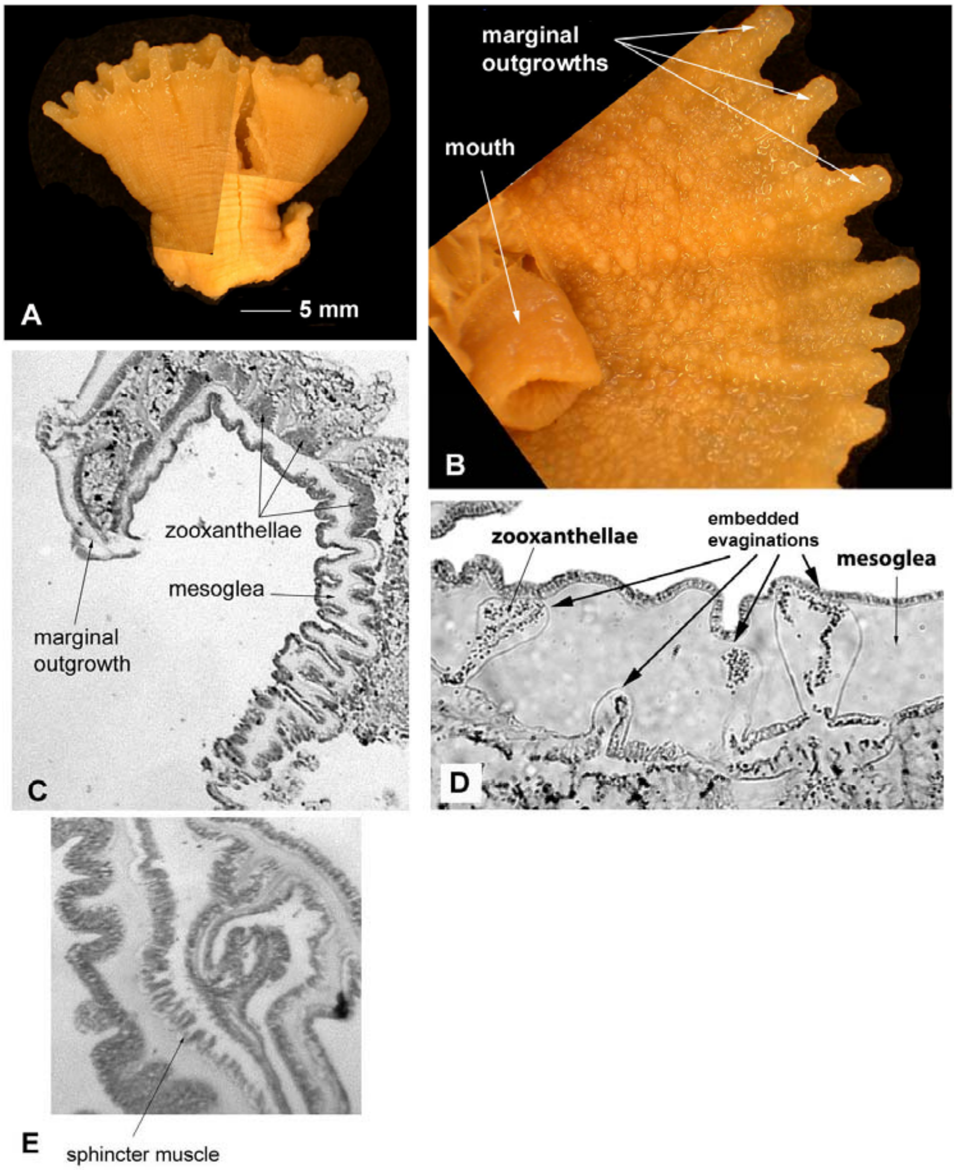


Figure 3-10. *Discosoma neglecta* (Duchassaing and Michelotti, 1860). A: whole body (USNM 52505); B: oral disc and marginal outgrowths (USNM 52505); C: longitudinal section of a small specimen (RMNH 12007); D: embedded oral disc evaginations of a small specimen (RMNH 12007); E: longitudinal section (USNM 52505), note weak marginal sphincter muscle.

Genus *Actinotryx* Duchassaing and Michelotti, 1860

Synonymy

Orinia Duchassaing and Michelotti, 1864

Diagnosis

Two types of tentacles: papilliform, often branched discal tentacles, digitiform marginal tentacles. Tentacle-free zone between discal tentacles and marginal tentacles. Mesenteries complete and incomplete. Sphincter muscle endodermal, weak, diffuse. Asexual reproduction by longitudinal fission usual. Often gregarious. Cnidom: holotrichs, microbasic *b*- and *p*- mastigophores.

Nomenclatural/ Taxonomic notes

The synonymy of *Actinotryx* is discussed at nomenclatural/ taxonomic notes of the type species.

Type species: *Actinotryx sanctithomae* Duchassaing and Michelotti, 1860

Actinotryx sanctithomae Duchassaing and Michelotti, 1860

Synonymy

Actinotryx Sancti Thomae Duchassaing and Michelotti, 1860

Orinia torpida Duchassaing and Michelotti, 1860

Rhodactis Sancti Thomae (Duchassing and Michelotti, 1860): McMurrich, 1889

Actinotryx Sancti-Thomæ Duchassing and Michelotti, 1860: Haddon, 1898

Actinotryx macropapillata Weill, 1929

Rhodactis sancti thomae (Duchassing and Michelotti, 1860): Carlgren, 1949

Discosoma sanctithomae (Duchassing and Michelotti, 1860): den Hartog, 1980

Body shape, size and color

Oral disc diameter 15-35 mm, pedal disc diameter 7-24 mm (pedal disc expansion excluded); column length to 5 mm. Color: brown in alcohol to pale yellow in formalin. In life color of species various: column brown, purple, green; tentacles same with column coloration, often brighter than column color (Figure 3-12B).

Oral disc and tentacles

Oral disc circular; small tentacles around mouth (Figure 3-12B). Discal tentacles papilliform, often branched in larger specimens, arranged in radial rows: 3 to 8 discal tentacles in endocoelic row in small specimens, arrangement irregular in larger specimens (Figure 3-12, C and D). Marginal tentacles digitiform.

Internal anatomy

The number of mesenteries varies: approximately 80 pairs (24 complete, 56 incomplete) is a small specimen, 168 pairs (44 complete, 124 incomplete) in a large specimen. Sphincter muscle endodermal, very weak, diffuse (Figure 3-12E).

Cnidae: measured from four specimens, each of USNM 56548, KUNHM 002369, 002391, and 002395

Marginal tentacles:

Holotrichs I	72.42-121.53 x 35.07-51.19 µm	n= 33, N=4/4
Holotrichs II	33.05-42.93 x 7.46-13.77 µm	n= 18, N=4/4
Holotrichs III	31.76-48.52 x 6.03-9.96 µm	n= 32, N=4/4

Microbasic *b*-mastigophores	18.44-29.08 x 4.21-5.63 µm	n= 22, N=4/4
Microbasic *p*-mastigophores	16.97-30.37 x 4.51-8.60 µm	n= 25, N=4/4
Discal tentacles:		
Holotrichs I	73.90-120.08 x 37.40-50.78 µm	n= 33, N=4/4
Holotrichs II	35.32-49.65 x 13.08-18.44 µm	n= 46, N=4/4
Microbasic *p*-mastigophores	18.44-23.96 x 5.11-9.24 µm	n= 26, N=4/4
Mesenterial filaments:		
Holotrichs I	162.47-250.65 x 64.32-82.16 µm	n= 28, N=4/4
Holotrichs II	34.93-58.34 x 16.13-22.58 µm	n= 33, N=4/4
Microbasic *p*-mastigophores	36.49-43.72 x 7.02-10.83 µm	n= 41, N=4/4
Microbasic *p*-mastigophores	13.44-20.75 x 3.96-5.84 µm	n= 22, N=4/4
Column		
Microbasic *b*-mastigophores	16.30-20.18 x 5.36-8.72 µm	n= 36, N=4/4
Microbasic *p*-mastigophores	21.48-35.50 x 6.94-10.31 µm	n= 30, N=4/4

Type specimens and locality

No type specimens designated.

Type locality: St. Thomas, Virgin Islands

Other material examined

<u>British Honduras</u>

USNM 56548: Carrie Bow Cay, sand through on outer fore reef; depth 15-18 m; Mar-25-1978; 1 specimen

St. Thomas, US Virgin Islands

KUNHM 002369: Brewers Bay; 18º20.0'N, 64º58.8'W; depth 0.7 m; Aug-15-2004; 6 specimens

KUNHM 002371: N. Saba Is.; depth 3-6 m; Aug-18-2004; 10 specimens

KUNHM 002372: Water Is., Sprat Point; 18º18'09.1"N, 64º54'19.4"W; depth 6-7.5 m; 10 specimens

Bocas del Toro, Panama

KUNHM 002391: Cayo Adriana; 09º14'45.6"N, 82º 10'41.3"W; depth 12 m; Aug-9-2004; 1 specimen

KUNHM 002395: Crawl Cay; 09º15'261"N, 82º 7'787"W; depth 2-4 m; Aug-6-2004; 2 specimens

KUNHM 002396: Crawl Cay; 09º15'261"N, 82º 7'787"W; depth 2-4 m; Aug-6-2004; 2 specimens

Jamaica

USNM 19042: Port Royal Cay; 3 specimens

USNM 51641: Port Royal Cay, on reef flat; Dec-1-1959; 10 specimens

Puerto Rico

USNM 53260: Parquera, Cayo Enrique, on dead coral; depth 1 m; Aug-18-1964; 22 specimens

Geographical distribution

Actinotryx santithomae is known from all around the Caribbean Sea.

Nomenclatural/ Taxonomic notes

The brief original description provides only limited criteria for delimitating the species. Fortunately, the original description contains an illustration including several critical morphological features for recognition of *Actinotryx sanctithomae* (Figure 3-12A): branched discal tentacles, digitiform marginal tentacles, and tentacle-free zone on the oral disc. The synonymy of *A. sanctithomae* and *Orinia torpida* has been discussed in McMurrich (1905), Stephenson (1922), Carlgren (1934), and den Hartog (1980). Both species are described from St. Thomas, US Virgin Islands by Duchassing and Michelotti (1864). In the original description, authors stated that *Orinia torpida* is characterized by tubular openings ("orifices tubuleux") (Figure 3-12A). Later Carlgren (1900, 1934), McMurrich (1905), and Stephenson (1922) re-examined the single specimen deposited in the Duchassaing and Michelotti collection in the Zoological Museum of Turin. McMurrich (1905) stated not every tentacle has a terminal opening, and Stephenson (1922) concluded that the tubular opening is actually the collapsed vesicular tentacles. Although Carlgren (1900) recognized the similarities of the two species in two types of tentacles and tentacle-free zone on the oral disc, in his later paper (Carlgren, 1934), he concluded *O. torpida* differs from *A. sanctithomae* based on the shape and the arrangement of these tentacles. den Hartog (1980) examined the type specimen of *O. torpida* and he concluded that *O. torpida* is an abnormal specimen of *A. sanctithomae*. I agree on the synonymy of den Hartog (1980) based on my own examination of syntype specimen of *O. torpida* (SMNH Cat. 71). Even though the syntype specimen of *O. torpida* has been damaged and only a wedge left (Figure 3-11B), a few critical morphological characters of the specimen have left: shape of discal tentacles is palmate and presence of tentacle-free zone on oral disc. The comparisons between two type species are shown in Table 3-2. In my view, tubular openings of discal tentacles may be caused by the common behavior of many species in Discosomatidae: they extrude mesenterial filaments through tentacle tips and mouth when they disturbed.

The *Actinotryx* has been confused with genera *Discosoma* and *Rhodactis*. The name of genus *Discosoma*, represented by the type species *D. nummiforme,* was introduced by Rüppel and Leuckart in 1828. *Rhodactis rhodostoma* (Hemprich and Ehrenberg in Ehrenberg, 1834) known from Red Sea is the type species of *Rhodactis*. McMurrich (1889) and Carlgren (1949) considered *Actinotryx* is a synonym of *Rhodactis* based on branched discal tentacles and absence of sphincter muscle. However, I found weak sphincter muscle (Figure 3-12D) from the specimen collected from St. Thomas, US Virgin Islands, which separate *Actinotryx* from *Rhodactis*. I also found papilliform discal tentacles (Figure 3-12C) as well as branched ones (Figure 3-12D) from the specimens of *Actinotryx sanctithomae*. den Hartog (1980) synonymized *Actinotryx* with *Discosoma* because he considered traditional genus-level diagnostic characters – tentacle-free zone and shape of discal tentacles -- with very little diagnostic value. However, *Actinotryx sanctithomae,* the type species of genus *Actinotryx,* differs from *Discosoma nummiforme* in external morphology and the measurement of nematocysts (Table 3-2). The distinctions between two type species strongly support the separation of genus *Actinotryx* from genus *Discosoma*, and resuscitation of *Actinotryx*. *Discosoma* has been applied to species that has features like extremely reduced papilliform discal tentacles, no naked zone on oral disc, and absence or presence of reduced marginal tentacles. While based on observations and original description and illustration of the type species, *Actinotryx* has features such as branched discal tentacles, digitiform marginal tentacles, and presence of naked zone on oral disc between marginal and discal tentacles. *A. sanctithomae* is easily distinguished from *Discosoma* and *Rhodactis* in field based on diagnostic keys provided in this study.

Weill (1929) incorrectly identified *Actinotryx sanctithomae* and proposed a new name *Actinotryx macropapillata* for *A. santithomae*. In 1934, he corrected his misidentification himself based on the original description (Duchassing and Michelotti, 1864) and subsequent description (Duerden, 1900). Therefore, *Actinotryx macropapillata* is a junior synonym.

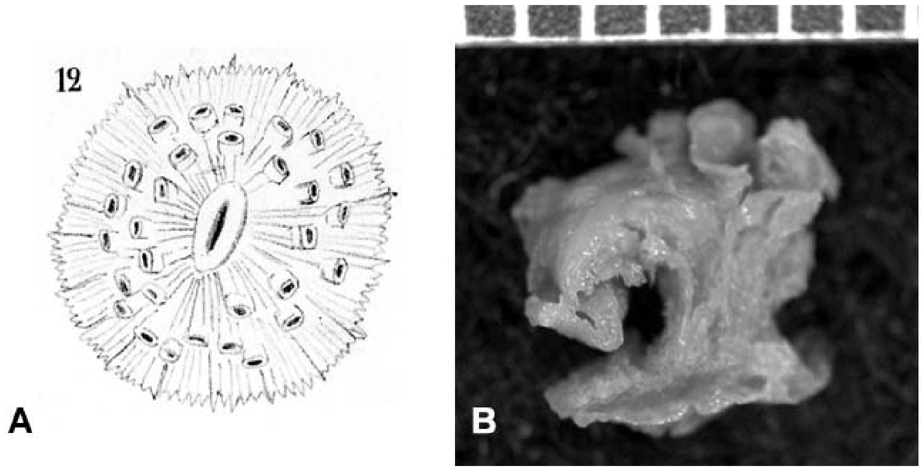


Figure 3-11. *Orinia torpida* Duchassaing and Michellotti, 1860. A: illustration from the original description (Duchassaing and Michelotti, 1860, Plate VII, fig. 12); B: Syntype specimen (SMNH 71).

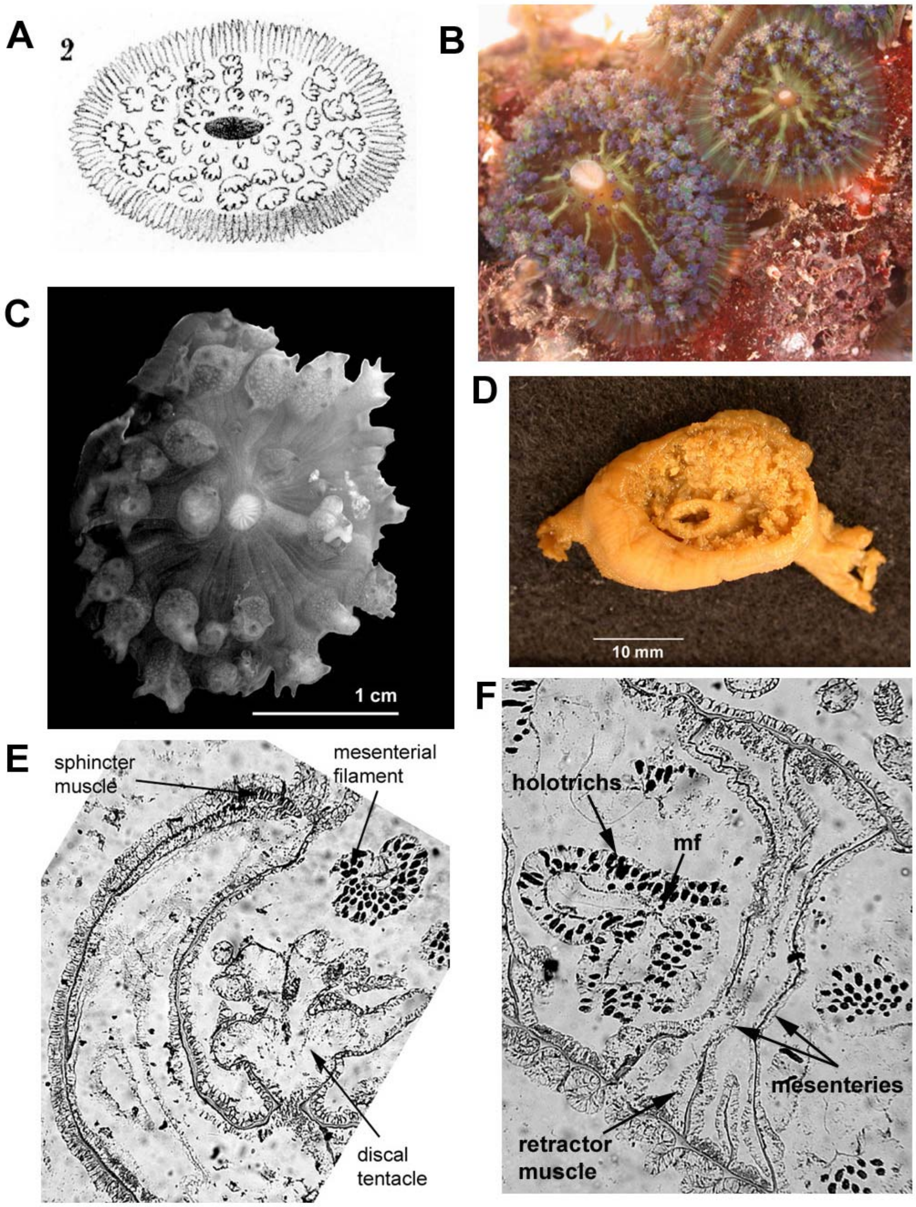


Figure 3-12. *Actinotryx sanctithomae* Duchassaing and Michelotti, 1860. A: illustration in the original description (Duchassaing and Michelotti, 1860, Plate VII, fig. 2); B: species in life; C: oral disc (KUNHM 002371); D: whole body (UNSM 19042); E: longitudinal section of oral disc (KUNHM 002371); F: transverse section (KUNHM 002371).

Biological notes

The aggressive behavior of *Actinotryx santithomae* is reported. Miles (1991) observed that the tropical corallimorpharian *A.sanctithomae* uses both marginal tentacles and mesenterial filaments to damage adjacent scleractinian corals. He found that in 75% of cases where *A. sanctithomae* was adjacent to a scleractinian there were areas of dead coral associated with the area of contact.

A symbiotic association with shrimp species, *Periclimenes yucatanicus*, is reported from St. Croix, US Virgin Islands and from Martinique (Williams and Williams, 1982; Spotte et al., 1991; Ritson-Williams and Paul, 2007).

Genus *Amplexidiscus* Dunn and Hammer, 1980

Diagnosis (modified from Dunn and Hamner, 1980):

Tentacles digitiform. Tentacle-free zone between outermost and inner discal tentacles. Mesenteries complete. Sphincter muscle absent. Basilar muscles weak. Solitary or gregarious. Cnidom: holotrichs, microbasic *b*- and *p*- mastigophores, spirocysts (rare).

Type species: *Amplexidiscus fenestrafer* Dunn and Hamner, 1980

Amplexidiscus fenestrafer Dunn and Hamner, 1980

Synonymy

Discosoma fenestrafer (Dunn and Hamner, 1980): den Hartog, 1997; Uchida and Soyama, 2001

Body shape, size and color

Oral disc diameter up to 450 mm, pedal disc diameter up to 180 mm; column length up to 50 mm. Color: pale yellow in formalin. According to Dunn and Hamner (1980) in life oral disc dull grey-greenish brown, lighting toward margin; column similar to that of oral disc distally, fading basally to color of pedal disc.

Oral disc and tentacles

Tentacles digitiform, endocoelic, discal tentacles longer than marginal tentacles. Marginal tentacles sparse, little shorter when oral disc expanded, digitiform when oral disc enfolded. Area immediately around mouth may lack tentacles. Several tentacles may occur in tentacle-free zone occasionally.

Internal anatomy

I was not allowed to make histological sections of the type specimens. Therefore, the description of internal anatomy is based on the original description, Dunn and Hamner (1980). Mesenteries very narrow, most or all complete, approximately 500 pairs in average-sized animal. Sphincter muscle absent.

Cnidae: measured from the holotype (CASIZ 15553) and the paratype (CASIZ 15554)

Marginal tentacles:

Holotrichs I	86.32-139.43 x 30.45-52.48 µm	n= 20, N=2/2
Holotrichs II	43.42-53.80 x 13.36-21.45 µm	n= 12, N=2/2
Holotrichs III	34.66-68.20 x 5.63-10.46 µm	n= 20, N=2/2
Microbasic *p*-mastigophores	16.97-30.25 x 3.46-7.49 µm	n= 18, N=2/2
Sprirocysts	19.35-22.35 x 3.06-3.93 µm	n= 2, N=1/2

Discal tentacles:

Holotrichs I	105.33-120.46 x 49.48-46.05 µm	n= 6, N=2/2
Holotrichs II	42.33-53.47 x 14.38-19.36 µm	n= 31, N=2/2
Microbasic *p*-mastigophores	17.44-21.84 x 3.98-8.12 µm	n= 13, N=2/2
Sprirocysts	18.64-26.52 x 4.38-5.86 µm	n= 3, N=1/2

Mesenterial filaments:

Holotrichs I	154.65-218.40 x 51.68-62.36 µm	n= 18, N=2/2
Holotrichs II	43.57-62.71 x 13.42-20.46 µm	n= 28, N=2/2

Hoplotelic microbasic *p*-mastigophores	24.57-48.46 x 6.42-10.33 µm	n= 30, N=2/2
Column		
Holotrichs II	48.33-60.35 x 13.06-21.38 µm	n= 16, N=2/2
Microbasic *p*-mastigophores	17.32-24.60 x 6.06-9.46 µm	n= 24, N=2/2
Microbasic *b*-mastigophores	16.42-26.33 x 5.59-8.37 µm	n= 18, N=2/2

Type specimens and locality

Holotype:

CASIZ 15553: Lizard Island, Great Barrier Reef, Queensland, Australia; 14°40'S, 145°30'E; depth 10 m; Jan-8-1977; 1 specimen

Paratype:

CASIZ 15554: Lizard Island, Great Barrier Reef, Queensland, Australia; 14°40'S, 145°30'E; depth 10 m; Jan-8-1977; 1 specimen

Geographical distribution

Amplexidiscus fenestrafer is known from Great Barrier Reef, Australia and Madang Province, Papua New Guinea.

Nomenclatural/ Taxonomic notes

Spirocysts in discal and marginal tentacles are very rare as discussed in Dunn and Hamner (1980).

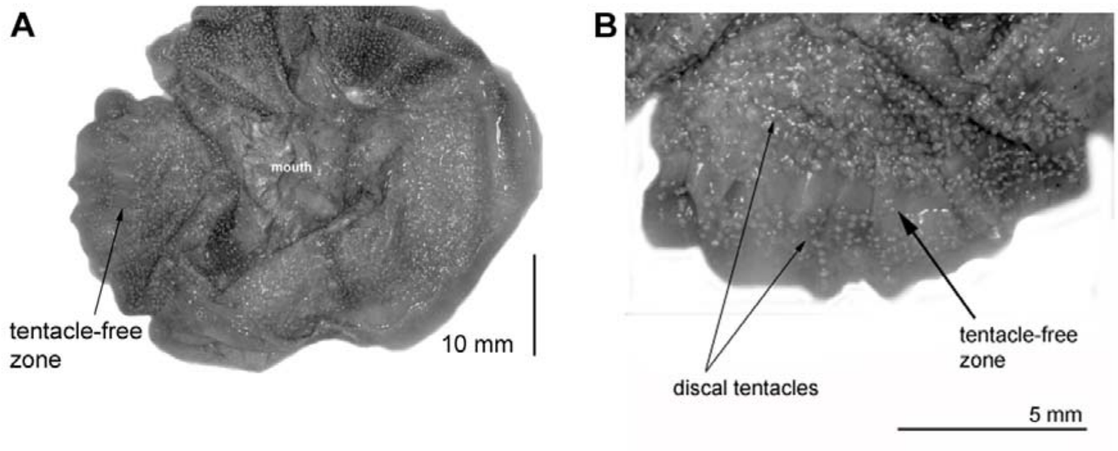


Figure 3-13. *Amplexidiscus fenestrafer* Dunn and Hamner, 1980. A: whole specimen of the holotype (CASIZ 15553); B: tentacle-free zone on the oral disc.

Genus *Rhodactis* Milne Edwards and Haime, 1851

Diagnosis

Two types of tentacles: branched discal tentacles and digitiform marginal tentacles, non-retractile. No tentacle-free zone. Mesenteries complete and incomplete. One directive mesentery. Sphincter muscle absent. Asexual reproduction by longitudinal fission usual. Often gregarious. Cnidom: holotrichs, microbasic *b*- and *p*-mastigophores.

Nomenclatural/ Taxonomic notes

The synonymy of *Rhodactis* is discussed at nomenclatural/ taxonomic notes of the type species.

Type species: *Rhodactis rhodostoma* (Hemprich and Ehrenberg in Ehrenberg, 1834)

Rhodactis rhodostoma (Hemprich and Ehrenberg in Ehrenberg, 1834)

Synonymy

Metridium rhodostoma Hemprich and Ehrenberg in Ehrenberg, 1834

Rhodactis rhodostoma (Ehrenberg, 1834): Milne Edwards and Haime, 1851

Discosoma rhodostoma (Ehrenberg, 1834): den Hartog, 1980

Body shape, size and color

Oral disc diameter 25-38 mm, pedal disc diameter 22-30 mm; column length up to 12 mm. In life oral disc diameter up to 45 mm, column length up to 15 mm.

Color: pale yellow in formalin. In life color of species various: column brown to purple; tentacles similar to column coloration; mouth bright purple or white (Figure 3-14A).

Oral disc and tentacles

Two types of tentacles: branched discal tentacles (Figure 3-14, B and C) and digitiform marginal tentacles. Tentacles arranged in radial rows: discal tentacles more branched, densely arranged distally; tentacles immediate near of mouth shorter; 5-12 distal tentacles in an endocoelic row.

Internal anatomy

The number of mesenteries varies: approximately 72 pairs (24 complete, 48 incomplete) is a small specimen, 124 pairs (36 complete, 68 incomplete) in a large specimen. One directive (Figure 3-14D). Sphincter muscle absent.

Cnidae: measured from three speciemens, each of KUNHM 002093, USNM 52016, and USNM 52478

Marginal tentacles:

Holotrichs I	97.61-97.60 x 44.52-49.96 µm	n= 11, N=2/3
Holotrichs II	39.13-49.66 x 12.48-20.19 µm	n= 24, N=3/3
Holotrichs III	31.17-49.67 x 4.74-9.23 µm	n= 31, N=3/3
Microbasic *b*-mastigophores	18.34-20.85 x 5.63-7.65 µm	n= 22, N=2/3
Microbasic *p*-mastigophores	23.16-26.68 x 8.11-10.52 µm	n= 24, N=3/3

Discal tentacles:

Holotrichs I	145.33-155.03 x 78.05-80.04 µm	n= 14, N=3/3

Holotrichs II	39.32-48.63 x 14.77-18.45 µm	n= 21, N=3/3
Microbasic *p*-mastigophores	21.86-26.29 x 6.45-10.82 µm	n= 24, N=3/3
Microbasic *b*-mastigophores	18.50-23.53 x 5.85-6.49 µm	n= 18, N=3/3
Mesenterial filaments:		
Holotrichs I	150.89-178.96 x 72.22-91.22 µm	n= 12, N=2/3
Microbasic *p*-mastigophores	35.23-41.91 x 9.86-12.98 µm	n= 32, N=3/3
Column		
Holotrichs III	25.42-42.33 x 8.56-16.55 µm	n= 20, N=3/3
Microbasic *p*-mastigophores	18.33-32.89 x 4.57-10.24 µm	n= 30, N=3/3
Microbasic *b*-mastigophores	14.86-19.35 x 4.35-6.47 µm	n= 16, N=2/3

Type specimens and locality

No type specimens designated.

Type locality: Red Sea, Tor

Other material examined

<u>Oman</u>

KUNHM 002093: Fahal Island, 23º32'01"N 58º41'57"W; depth 6 m; May-21-2004; 3 specimens

KUNHM 002099: Bander Khayran, 23º31'39"N 58º44'23"W; depth 7.5 m; May-27-2004; 4 specimens

KUNHM 002100: Bander Khayran, 23º31'39"N 58º44'23"W; depth 6 m; May-27-2004; 3 specimens

Madagascar

USNM 52016: Nosy Be, Nosy Komba, Point Ambarionaomby; depth 2 m; Aug-18-1960; 4 specimens

Red Sea, Gulf of Aqaba

USNM 52478: Israel, Eilat; depth 1 m; Apr-29-1962; 1 specimen

Nomenclatural/ Taxonomic notes

Rhodactis rhodostoma (Hemprich and Ehrenberg in Ehrenberg, 1834) was originally described as *Metridium rhodostoma*. The author neither designated type specimens nor provided reasons for placing the species in an actiniarian genus *Metridium* because there were only two genera of sea anemones at that time. Later Milne Edwards and Haime (1851) realized that the species is different from any members of *Metridium* in tentacle shape and arrangement, and established the genus *Rhodactis* based on *Metridium rhodostoma* Hemprich and Ehrenberg in Ehrenberg, 1834. den Hartog (1980) synonymized *Rhodactis* with *Discosoma.* den Hartog (1980) considered the supposed generic characters, the presence or absence of marginal tentacles, the presence or absence of a tentacle-free zone, and the shape of discal tentacles, as variations at species-level. He studied only three Caribbean species, *Discosoma sanctithomae* (*Actinotryx sanctithomae* in this study), *Rhodactis carlgreni* (*Discosoma carlgreni* in this study), and *Paradiscosoma neglecta* (*Discosoma neglecta* in this study), but he did not examine the type species of *Rhodactis* and *Discosoma*. Based on my examination of the type species of *Rhodactis* and *Discosoma*, there are distinctive characters that differentiate the genera (Table 4-3).

Rhodactis rhodostoma differs from *Discosoma nummiforme* in shape and length of discal tentacles, and length of marginal tentacles; therefore, I conclude that *Rhodactis* is a valid genus in Discosomatidae.

Biological notes

Langmead and Chadwick-Furman (1999) observed polyps of the corallimorpharian *Rhodactis rhodostoma* overgrowing encrusting macroalgae, sponges, scleractinian corals, and zoanthids at Eilat, in the northern Red Sea. Furthermore they were able to describe a competitive hierarchy within the stony corals with regard to the outcome of agonistic interactions between *R. rhodostoma* with members of the families Faviidae and Mussidae being observed in standoff interactions, whilst Acroporidae, Pocilloporidae and Poritidae were either damaged or overgrown. The terminal ends of the oral disk marginal tentacles of *R. rhodostoma* were bulbous or swollen during contact with other cnidarians, including having significantly thicker ectoderm and a higher proportion of holotrichous nematocytsts than did ‘normal’ filiform marginal tentacles of this species. Also polyps of *R. rhodostoma* were observed to overgrow zoanthids, hydrozoan corals, sponges and encrusting macroalgae on a fringing reef at Eilat in the northern Red Sea (Muhandro et al., 2002).

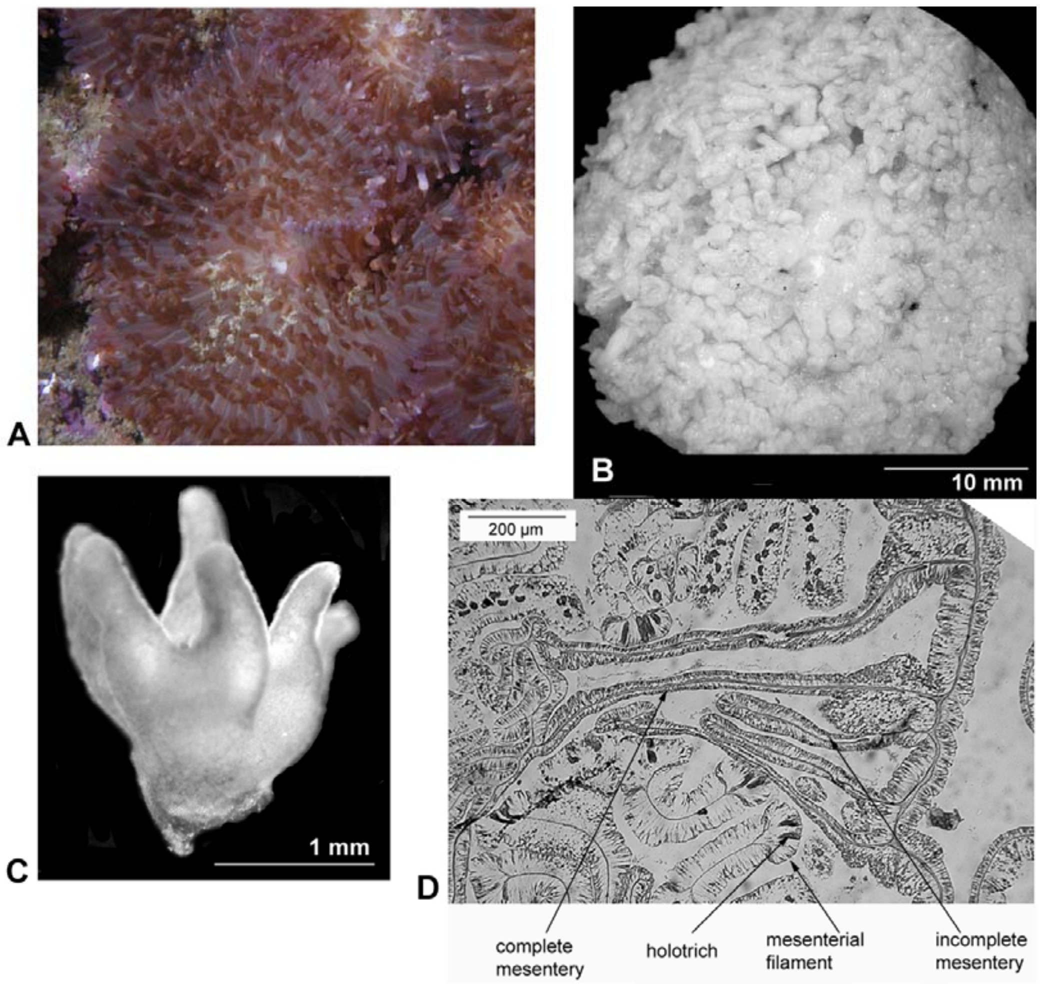


Figure 3-14. *Rhodactis rhodostoma* (Ehrenberg, 1834). A: species in life (KUNHM 002093); B: whole specimen (USNM 52016); C: branched discal tentacle; D: mesenterial arrangement (KUNHM 002100).

Genus *Metarhodactis* Carlgren, 1943

Diagnosis

Discal tentacles papilliform or branched, no marginal tentacles. No tentacle-free zone. Mesenteries complete and incomplete. Sphincter muscle absent. Cnidom: holotrichs, microbasic *b*- and *p*- mastigophores, hoplotelic microbasic *p*-mastigophores numerous in mesenterial filaments.

Nomenclatural/ Taxonomic notes

Metarhodactis Carlgren, 1943 was established based on the type species, *M. boninensis* Carlgren, 1943. den Hartog (1980) questionably synonymized *Metarhodactis* with *Discosoma* and stated the need of examining nematocysts composition of type species to verify his synonymization. Although external morphology is similar to members of *Discosoma*, *Metarhodactis* can be distinguished from most genera in Discosomatidae by possessing numerous hoplotelic microbasic *p*-mastigophores in mesenterial filaments (Figure 3-15C). Hoplotelic microbasic *p*-mastigophores are present in the family Corallimorphidae. Despite hoplotelic microbasic *p*-mastigophores are found in genus *Amplexidiscus*, they are much less numerous. Because the composition of nematocysts is generic character in hexacorallian taxonomy, in this study, I conclude that *Metarhodactis* is a valid genus in the family Discosomatidae.

Type species: *Metarhodactis boninensis* Carlgren, 1943

***Metarhodactis boninensis* Carlgren, 1943**

Synonymy

Metarhodactis boniensis Carlgren, 1943: Carlgren, 1949

? *Discosoma boninensis* (Carlgren, 1943): den Hartog, 1980

Body shape, size and color

Oral disc diameter up to 25 mm, pedal disc diameter up to 15 mm; column length 4-12 mm. Color: pale yellow in formalin.

Oral disc and tentacles

Oral disc circular or oval-shape; often slightly crenulated. No marginal tentacles. Discal tentales papilliform or branched; simpler toward margin of oral disc. Tentacles arranged in radial row (Figure 3-15A); branched discal tentacles arrange in endocoelic rows, papilliform tentacles arrange in exocoelic rows. The number of tentacles vary according to the size of specimens; more tentacles in larger specimens.

Internal anatomy

Mesenteries arranged irregularly: 24 complete mesenteries, numerous incomplete mesenteries sterile without well-developed filaments. Sphincter muscle absent.

Cnidae: measured from the syntype (UUZM 632) and two specimens of USNM 50099

Discal tentacles:

Holotrichs II	33.20-50.02 x 10.82-16.52 µm	n= 45, N=3/3
Microbasic *p*-mastigophores	13.88-18.55 x 4.33-7.57 µm	n= 21, N=3/3
Microbasic *b*-mastigophores	12.55-14.81x 1.78-2.31 µm	n= 22, N=3/3

Mesenterial filaments:

Holotrichs I	134.1-184.13 x 63.75-73.69 µm	n= 24, N=3/3
Holotrichs II	38.28-47.30 x 12.30-14.25 µm	n= 20, N=3/3
Hoplotelic microbasic *p*-mastigophores	42.23-79.12 x 3.09-5.41 µm	n= 19, N=3/3

Column

Holotrichs II	37.25-43.31 x 13.15-17.97 µm	n= 20, N=3/3
Microbasic *b*-mastigophores	14.50-17.60 x 4.79-6.46 µm	n= 22, N=3/3
Microbasic *p*-mastigophores	16.33-21.49 x 6.12-8.42 µm	n= 36, N=3/3

Type specimens and locality

Syntype:

UUZM 632: Port Lloyd, Bonin Islands, Japan; 27.14°N 142.20°W; depth 0-9 m; 2 specimens

Other material examined

<u>Northern Mariana Islands</u>

USNM 50099: Saipan Islands; May-3-1949; 5 specimens

Nomenclatural/ Taxonomic notes

Specimens of USNM 50099 were identified by O. Carlgren, who described the genus and the species. One specimen of USNM 50099 has a small polyp attached to the column of larger specimen (Figure 3-15B). This specimen provides evidence of asexual reproduction of the species.

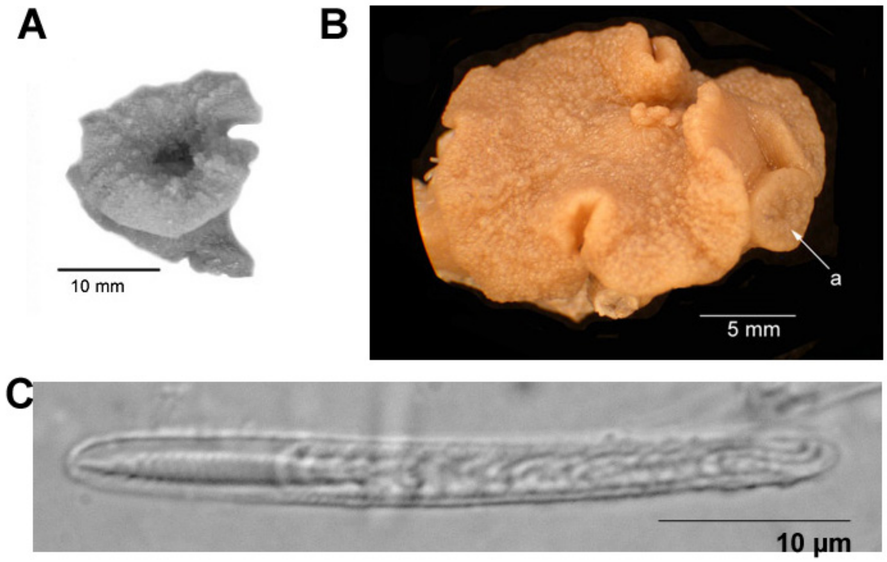


Figure 3-15. *Metarhodactis boninensis* Carlgren, 1943. A: whole specimen of the syntype; B: whole specimen (USNM 50099), note a polyp reproduced by asexual reproduction (a); C: hoplotelic microbasic *p*-mastigophore in mesenterial filaments (USNM 50099).

CHAPTER IV. PHYLOGENY

4-1. Taxon sampling and character selection

The primary goal was to include at least one species representing each of the 11 valid corallimorpharian genera in my analyses. The diagnostic features for the genera included are described in chapter IV. Corallimorpharian species included in the analyses are restricted to those treated in detail in the taxonomic section of this study. To investigate sister group relationships of Corallimorpharia, I included representatives of the both evolutionary lineages of Scleractinia, complex and robust (Romano and Cairns, 2000), and taxa representing three of the four tribes of Actiniaria, Acontiaria, Endomyaria, and Athenaria (Carlgren, 1949; Dunn, 1982). The genus *Cerianthus* of order Ceriantharia was used as an outgroup for analyses. Cerianthids are widely recognized as the sister group to the remaining orders Actiniaria, Corallimorpharia, and Scleractinia (Schmidt, 1974; Fautin and Lowenstein, 1992; Bernsten et al., 1999). Chen et al. (1995) found *Cerianthus* to be the deepest node within Anthozoa in a phylogeny derived from 28S rDNA data. Ceriantharia was the deepest node in the hexacorallian branch according to phylogenetic inference based on 16S rDNA by France et al. (1996).

Morphological analyses:

Characters were collected from specimens of type species rather than from the literature. If only one or two specimens were available, the original description or the redescriptions of the taxon were also used as a source of data. Seven species of Actiniaria, each from a different genus, were included. Two genera (*Anthopleura* and *Stichodactyla*) belong to tribe Endomyaria, three genera (*Aiptasia, Bathyphellia*, and *Metridium*) belong to tribe Acontiaria, and two genera (*Edwardsia* and *Nematostella*) belong to tribe Athenaria. Seven species of Scleractinia, each from a different genus, were included. Three genera (*Caryophyllia, Oculina*, and *Montastrea*) belong to the robust lineage, and four genera (*Balanophyllia, Goniopora, Porites*, and *Pavona*) belong to the complex lineage. The characters of polyp anatomy were taken from Doumenc et al. (1987) or from histological sections I made of the genera *Oculina*, *Montastrea*, *Porites*, and *Pavona*. A total of 33 characters was assembled (Appendix 1), one of calcareous exoskeleton, 10 of external morphology, nine of internal morphology, seven of cnidae, and six of polyp organization, reproduction, symbioses, and habitat. The methods for gathering morphological data are documented in chapter III. Of 33 characters, 29 were binary. Multiple states were generated for the remaining 4 characters and they were treated as unordered. Unknown characters, coded as "?", were used in case the character could not be obtained due to poor preservation condition, or other technical limitations. The list of taxa is shown in Table 4-1.

Molecular analyses:

Ten species of eight genera in Corallimorpharia, 11 species of seven genera in Actiniaria, and 18 species of 14 genera in Scleractinia were included. Sequences of

12 species are newly generated for this study, 10 of corallimorpharians, one of an actiniarian (*Bathyphellia australis*), and one of a scleractinian (*Fungiacyathus marenzelleri*). Three genera of corallimorpharians, *Pseudocorynactis, Sideractis*, and *Nectactis*, were not included in molecular analyses because of the lack of tissue samples (members of those genera are rare). Data sets were assembled with sequences from GenBank and the sequences I obtained. For the combined data set, in case all sequences were not available for a species, I integrated sequences for different genes from two or three species of a genus into a single row of data. Missing and inapplicable molecular data were coded as "?". The list of taxa is shown in Table 3-2.

I used three widely-used mitochondrial and ribosomal markers, 16S mtDNA, 18S rDNA, and 28S rDNA. The three markers were chosen because they are effective for resolving relationships at family- or order-level in Cnidaria (e. g. Chen et al., 1995; Romano and Palumbi, 1996; Chen et al., 1996; Bernston et al., 1999; Romano and Cairns, 2000; Shearer et al., 2002; Won et al., 2000; Daly et al., 2003; Medina et al., 2006; Bugler and France, 2007).

Table 4-1. Taxa included in morphological analysis.

Higher taxon	Tribe or Suborder	Family	Genus
Corallimorpharia	-	Discosomatidae	*Actinotryx*
	-	Discosomatidae	*Amplexidiscus*
	-	Corallimorphidae	*Corallimorphus*
	-	Corallimorphidae	*Corynactis*
	-	Discosomatidae	*Discosoma*
	-	Discosomatidae	*Metarhodactis*
	-	Corallimorphidae or Sideractidae	*Nectactis*
	-	Corallimorphidae	*Pseudocorynactis*
	-	Discosomatidae	*Rhodactis*
	-	Corallimorphidae or Ricordeidae	*Ricordea*
	-	Corallimorphidae or Sideractidae	*Sideractis*
Actiniaria	Acontiaria	Aiptasiidae	*Aiptasia*
	Endomyaria	Actiniidae	*Anthopleura*
	Acontiaria	Bathyphelliidae	*Bathyphellia*
	Athenaria	Edwardsiidae	*Edwardsia*
	Acontiaria	Metridiidae	*Metridium*
	Athenaria	Edwardsiidae	*Nematostella*
	Endomyaria	Stichodactylidae	*Stichodactyla*
Scleractinia	Dendrophylliinae	Dendrophylliidae	*Balanophyllia*[1]
	Caryophylliina	Caryophylliidae	*Caryophyllia*[2]
	Fungiina	Poritidae	*Goniopora*[1]
	Faviina	Faviidae	*Montastrea*[2]
	Faviina	Oculinidae	*Oculina*[2]
	Fungiina	Agaraciidae	*Pavona*[1]
	Fungiina	Poritidae	*Porites*[1]
Ceriantharia		Cerianthidae	*Cerianthus*

1: complex scleractinian lineage; 2: robust scleractinian lineage.

Table 4-2. Taxa included in molecular analyses, with GenBank accession numbers for sequence used. Bolded GenBank accession numbers indicate the sequences I obtained in this study. CO: Corallimorpharia; AC: Actinaria; SC: Scleractinia; CE: Cerianthatia.

Higher taxon	Tribe or suborder	Species	18S	28S	16S
CO	-	*Actinotryx sanctithomae*	**EF589070**	**EF589075**	**EF589056**
	-	*Amplexidiscus fenestrafer*	**EF589071**	**EF589076**	**EF589053**
	-	*Corallimorphus pilatus*	**EF589066**	**EF589084**	**EF589060**
	-	*Corynactis californica*	**EF589065**	**EF589083**	**EF589059**
	-	*Corynactis viridis*	**EF589064**	**EF589082**	**EF589058**
	-	*Discosoma nummiforme*	**EF589068**	**EF589078**	**EF589051**
	-	*Discosoma neglecta*	**EF589069**	**EF589077**	**EF589052**
	-	*Metarhodactis* sp.	**EF589073**	**EF589079**	**EF589055**
	-	*Rhodactis rhodostoma*	**EF589072**	**EF589080**	**EF589054**
	-	*Ricordea florida*	**EF589067**	**EF589081**	**EF589057**
AC	Acontiaria	*Aiptasia pulchella*	AY297437	U69684	AY345875
	Endomyaria	*Anthopleura kurogane*	Z21671	-	-
	Endomyaria	*Anthopleura dixoniana*	-	U69686	-
	Endomyaria	*Anthopleura elegantissima*	-	-	U40292
	Acontiaria	*Bathyphellia australis*	**EF589063**	**EF589086**	**EF589062**
	Athenaria	*Edwardsia elegans*	AF254376	AY345870	-
	Acontiaria	*Metridium senile*	U19550	-	AF000023
	Athenaria	*Nematostella vectensis*	AF254382	AY345871	AY169370
	Endomyaria	*Stichodactyla helianthus*	U52977	-	-
	Endomyaria	*Stichodactyla tapetum*	-	U69687	-
	Endomyaria	*Stichodactyla* sp.	-	-	AY345874

SC	Dendrophylliinae	*Balanophyllia elegans*[1]	U52973	-	-
	Dendrophylliinae	*Balanophyllia regia*[1]	-	AF265626	AF265587
	Caryophylliina	*Caryophyllia inornata* [2]	-	AF265642	AF265587
	Caryophylliina	*Catalaphyllia jardinei*[2]	AY372255	AF265637	L76000
	Dendrophylliinae	*Dendrophyllia gracilis*[1]	-	AF265627	AF265588
	Dendrophylliinae	*Enallopsammia rostrata*[1]	AF052885	AF265631	U40294
	Caryophylliina	*Flabellum impensum*[1]	-	AS265649	AF265582
	Fungiina	*Fungia scutaria*[2]	AF052884	AF265631	L76005
	Fungiina	*Fungiacyathus marenzelleri*[1]	**EF589074**	**EF589085**	**EF589061**
	Faviina	*Lobophyllia hataii*[2]	AY372252	-	-
	Faviina	*Lobophyllia hemprichii*[2]	-	AF265624	L76013
	Faviina	*Montastrea annularis*[2]	AF238267	AB126790	
	Faviina	*Montastrea cavernosa*	-	-	AY580333
	Faviina	*Oculina patagonica*[2]	-	AF265636	AF265601
	Fungiina	*Pavona varians*[1]	AF052883	AF263350	L76016
	Fungiina	*Porites compressa*[1]	-	AF265630	L76020
	Fungiina	*Porites lutea*[1]	AY722788	-	-
	Dendrophylliinae	*Tubastrea coccinea*[1]	Z92906	AF265625	L76022
CE	-	*Cerianthus borealis*	AF052897	-	U40288
		Cerianthus sp.	-	U69678	-

1: complex scleractinian lineage; 2: robust scleractinian lineage.

4-**2**. **DNA extraction and PCR amplification**

Molecular sequence data were collected from material preserved in 95% or absolute ethanol. DNA was extracted using the DNeasy^{TM} Tissue Kit from Qiagen (catalog no. 69504), following the procedure included with the DNeasy^{TM} Tissue kit.

The small subunit ribosomal RNA gene (18S rDNA) was amplified from whole genome preparations using a set of nested primers (Table 4-3) that generated three sequence fragments (Apakupakul et al., 1999; Daly et al., 2003) totaling 1800 base pairs. Partial fragments of 28S ribosomal DNA gene (300 base pairs) and 16S mitochondrial DNA (1200 base pairs) were amplified (Cunningham and Buss, 1993; Chen et al., 1995; Romano and Palumbi, 2000).

Each 25 µl polymerase chain reaction (PCR) mixture contained 9.5 µl RNase-free pure water, 12.5 µl *Taq* master mix (Qiagen catalog no. 201443), 1 µl forward primer (10 µM), 1 µl reverse primer (10 µM), and 1 µl DNA template. The PCR reaction was run on a Bio-Rad Thermo Cycler. For gel purification, 100 µl PCR reactions were run; each contained four times the amount of each reagent listed above. The PCR thermal profile for each gene is listed in Table 4-4. PCR products were purified using QIAquick PCR Purification kit (Qiagen catalog no. 28104) or QIAquick Gel Extraction Kit (Qiagen catalog no. 28704). The 100 µl PCR products were run out on a 1.0% or 1.5% agarose gel, removed from the gel, and purified.

Table 4-3. Primer sequences used

Locus	Primers	Primer sequence	Source
18S	18A	5’-AACCTGGTTGATCCTGCCAGT-3’	Apakupakul et al., 1999; Daly et al., 2003
	18L	5’-CCAACTACGAGCTTTTTAACTG-3’	Apakupakul et al., 1999; Daly et al., 2003
	18C	5’-CGGTAATTCCAGCTCCAATAG-3’	Apakupakul et al., 1999; Daly et al., 2003
	18Y	5’-CAGACAAATCGCTCCACCAAC-3’	Apakupakul et al., 1999; Daly et al., 2003
	18B	5’-TGATCCTTCCGCAGGTTCACCT-3’	Apakupakul et al., 1999; Daly et al., 2003
	18O	5’-AAGGGCACCACCAGGAGTGGAG-3’	Apakupakul et al., 1999; Daly et al., 2003
16S	16Sg-5’	5’-TCGACTGTTTACCAAAAACATAGC-3’	Cunningham and Buss, 1993
	16SI-3’	5’-TTTAAAGGTCGAACAGACC-3’	Cunningham and Buss, 1993
28S	28F	5’-GGCGACCCGCTGAATTCAAGCATAT-3’	Chen et al., 1995
	28R	5’-AACTTTCCCTCACGGTACTTGT-3’	Romano and Palumbi, 2000

Table 4-4. Thermoprofiles for PCR reactions.

Locus	Primers	Thermoprofiles
18S	18A, 18L, 18C, 18Y, 18B, 18O	1 cycle at 94°C (2 min), 50°C (1 min), and 72°C (2 min); 29 cycles at 94°C (30 sec), 52°C (1 min), and 72°C (1 min)
28S	28F, 28R	1 cycle at 94°C (2 min), 50°C (1 min), and 72°C (2 min); 25 cycles at 92°C (30 sec), 52°C (1 min), and 72°C (1 min)
16S	16Sg-5’, 16SI-3’	10 cycles at 94°C (30 sec), 45°C (30 sec), and 72°C (45 sec); 30 cycles at 94°C (30 sec), 50°C (30 sec), and 72°C (1 min)

4-3. Sequencing

Sequencing was done at the KUNHM DNA sequencing facility using ABI prism BigDye dye-terminator chemistry (Perkin-Elmer Applied Biosystems) and following ABI protocols.

4-4. Alignment

A Basic Local Alignment Search Tool (BLAST, http://www.ncbi.nlm.nih.gov/BLAST/) search was used to find regions of local similarity between sequences. BLAST compares nucleotide sequences to sequence databases, and calculates the statistical significance of matches. Sequence data were aligned using MUSCLE (http://www.drive5.com/muscle/), a multiple sequence alignment program. MUSCLE was used because the program provides faster and more accurate alignment than other alignment programs (Edgar, 2004). Alignments were refined using BioEdit (http://www.mbio.ncsu.edu/BioEdit/bioedit.html).

4-5. Phylogenetic analysis and molecular clock dating

Phylogenetic analyses were performed using PAUP 4.05 (http://paup.csit.fsu.edu/) in conjunction with MacClade (http://macclade.org/macclade.html). To reconstruct phylogeny, two commonly used methods, maximum parsimony (MP) and maximum likelihood (ML), were applied. MP infers a phylogenetic tree by minimizing the total number of evolutionary steps required to explain a given set of data (Felsenstein, 2004). MP is based on shared and derived characters; therefore, it tries to provide information on the ancestral states. But evolution may not have occurred following a minimum number of changes, because the same change may have happened independently along different branches, and some changes may have involved intermediate steps. ML evaluates a hypothesis about evolutionary history in the data set. The topology with the highest maximum probability is chosen (Felsenstein, 2004). Advantages of ML over MP are: 1) ML may have lower variance, so is less affected by sampling error, and 2) ML is statistically well founded, so it can statistically evaluate various tree topologies. The disadvantage of ML is that the result depends on the model of evolution.

The most parsimonious trees were searched using a heuristic search with 100 random additions of sequences. Bootstrap indices were calculated for 1000 replicate searches. The bootstrap is widely applied in the phylogenetic literature to indicate confidence level of the results (Felsenstein, 1985, 2004). For ML analysis, the best-fit model of DNA substitution and parameter estimates used for tree construction were chosen by performing hierarchical likelihood ratio tests (Huelsenbeck and Crandall, 1998; Harris and Crandall, 2000) using PAUP 4.05 (Swofford, 2001) and ModelTest 3.0 (Posada and Crandall, 1998). Heuristic ML searches were performed using fast stepwise-addition and 500 bootstrap replicates. To evaluate the degree of incongruence of data sets, the partition homogeneity test was performed. In case data sets were not incongruent, combined analyses were performed.

All characters were given equal weight, and were unordered; the character state optimization setting ACCTRAN was in effect. ACCTRAN optimization will interpret ambiguity as a synapomorphy, which may be appropriate for missing (but not inapplicable) data. For each analysis that produced more than one tree, I obtained a strict consensus tree with the method "Compute consensus" in PAUP. The morphological data matrix is shown in Appendix 1, and the molecular data matrix is shown in appendix 2.

For the molecular clock dating, I first performed the log likelihood ratio test (LRT; Felsenstein, 1981) between the clock enforced ML tree and the clock non-enforced ML tree that compared the likelihood scores with and without the clock assumption on the trees of combined molecular data. When the data rejected the clock with significant p value, I used cross-validated penalized likelihood method in r8s (Sanderson, 2004; http://ginger.ucdavis.edu/r8s/). The program r8s allows incorporating multiple calibration points rather than a single, fixed calibration point, and then calculates the most likely ages of nodes given the remaining constraints and substitutions in the data set (Sanderson, 2004). Penalized likelihood is a semi-parametric approach that allows different substitution rates between ancestral and descendent branches. This method reduces the number of arbitrary alternatives by assigning a penalty that increases with the abruptness of rate change between adjacent branches. The penalty (or ''smoothing'' parameter) is calculated by removing part of the data, reestimating the remaining model parameters, and using the fitted model parameters to predict the data that were removed. The cross validation option is useful to find the optimal level of smoothing (Sanderson, 2004).

Fossil data for three genera in Scleractinia, *Fungia, Pavona,* and *Oculina,* allowed calibration points: *Fungia* arose in the Miocene, 24 Mya, *Pavona* arose in the Early Oligocene, 34 Mya, and *Oculina* arose in the Middle Cretaceous, 100 Mya (Wells, 1956; Foster, 1986; Budd, 1991; Veron, 1995). I chose the three points because the clades of *Pavona-Fungiacyathus* and *Fungia-Cataphyllia,* and the node of *Oculina* are relatively well supported in my ML analysis. The origin of Scleractinia at 240 Mya in Mid-Triassic (Deng and Kong, 1984; Qi, 1984; Morycowa, 1988), was used as the calibration point of a basal node.

4-6. Results

1. Morphological data (Figure 4-1):

Parsimony analysis of the morphological data produced 12 trees of length = 96 with a consistency index (CI) of 0.55 and a retention index (RI) of 0.68. The strict consensus tree had two polytomies, neither basal. Morphological characters unambiguously supporting each node are indicated in Figure 4-1.

2. Molecular data

Likelihood-ratio tests determined that the General Time Reversible (GTR) model of evolution was the most appropriate for each gene individually, and for the combined data sets of all genes. The GTR model allows the four nucleotides to be present in different frequencies. The model assumes each pair of nucleotide substitutions has a different rate, and a symmetric substitution matrix. In other words, A changes into T at the same rate that T changes into A (Hillis et al., 1996; Li, 1997; Felsenstein, 2004). In all data sets, the MP and ML trees were not incongruent based on the partition homogeneity tests.

2-1. 18S rDNA data (Figure 4-2):

A total of 1871 characters was collected: 1258 characters were constant, 330 variable characters were parsimony-uninformative, and 283 characters were parsimony-informative. Parsimony analysis produced 18 trees of length = 1104 with a CI of 0.73 and a RI of 0.72. Maximum likelihood analysis produced a topology with –ln likelihood 8769.0938.

2-2. 28S rDNA data (Figure 4-3):

A total of 339 characters was collected: 191 characters were constant, 39 variable characters were parsimony-uninformative, and 109 characters were parsimony-informative. Parsimony analysis produced 2 trees of length = 371 with a CI of 0.55 and a RI of 0.72. Maximum likelihood analysis produced a topology with –ln likelihood 2462.7699.

2-3. 16S mtDNA data (Figure 4-4):

A total of 984 characters was collected: 466 characters were constant, 173 variable characters were parsimony-uninformative, and 345 characters were parsimony-informative. Parsimony analysis produced 11 trees of length = 1060 with a CI of 0.70 and a RI of 0.84. Maximum likelihood analysis produced a topology with –ln likelihood 6263.1777.

2-4. Combined molecular data (Figure 4-5):

For MP analysis, a total of 737 characters was collected: 283 18S rDNA parsimony-informative characters, 109 28S rDNA parsimony-informative characters, and 345 16S mtDNA parsimony-informative characters. According to the partition homogeneity test, data sets are not incongruent (p=0.996). The parsimony analysis of the combined molecular data set produced two equally the most parsimonious trees of length = 2062 with a CI of 0.57 and a RI of 0.76. For ML analysis, a total of 3194 characters were combined: 1871 of 18S rDNA, 339 of 28S rDNA, and 984 of 16S mtDNA. The combined data set produced a topology with –ln likelihood 17498.8625.

3. Phylogenetic relationships:

All data sets support the monophyly of each of the three orders, Actiniaria, Corallimorpharia, and Scleractinia; Corallimorpharia and Scleractinia are sister taxa. Actiniaria is sister taxon to Corallimorpharia-Scleractinia.

Monophyly of Actiniaria is supported by trilobed mesenterial filaments and the presence of siphonoglyphs, 5 substitutions in 18S rDNA, 7 substitutions in 28S rDNA, and 25 substitutions in 16S mtDNA. Within Actiniaria, three clades are recognized, each clade corresponding to the tribe of Carlgren (1949). Athenaria is the basal group and sister group to Endomyaria - Acontiaria clade. 16S mtDNA did not resolve the relationships among tribes.

The monophyly of Scleractinia is supported by calcareous exoskeleton, 5 substitutions in 18S rDNA, 6 substitutions in 28S rDNA, and 14 substitutions in 16S mtDNA. Within Scleractinia, two lineages, complex and robust, are supported by all molecular data sets.

The monophyly of Corallimorpharia is supported by 3 substitutions in 18S rDNA, 7 substitutions in 28S rDNA, and 13 subsitutions in 16S mtDNA. Although the monophyly is well supported by molecular data, two anatomical characters that define corallimorpharians are shared with scleractinians: unilobed mesenterial filaments and large holotrichs. Within Corallimorpharia, two clades, cylindrical body group (C1) and discoidal body group (C2), are recognized based on morphological data, 16S mtDNA, and the combined molecular data. 18S rDNA data did not support the two clades. Based on 28S rDNA data, *Ricordea*, a discoidal corallimorpharian genus, clusters with genera in C1.

4. Molecular clock dating

Molecular clock dating estimates the divergence time of Corallimorpharia from the ancestral lineage of the Corallimorpharia-Scleractinia clade at 262 Mya (Late Permian).

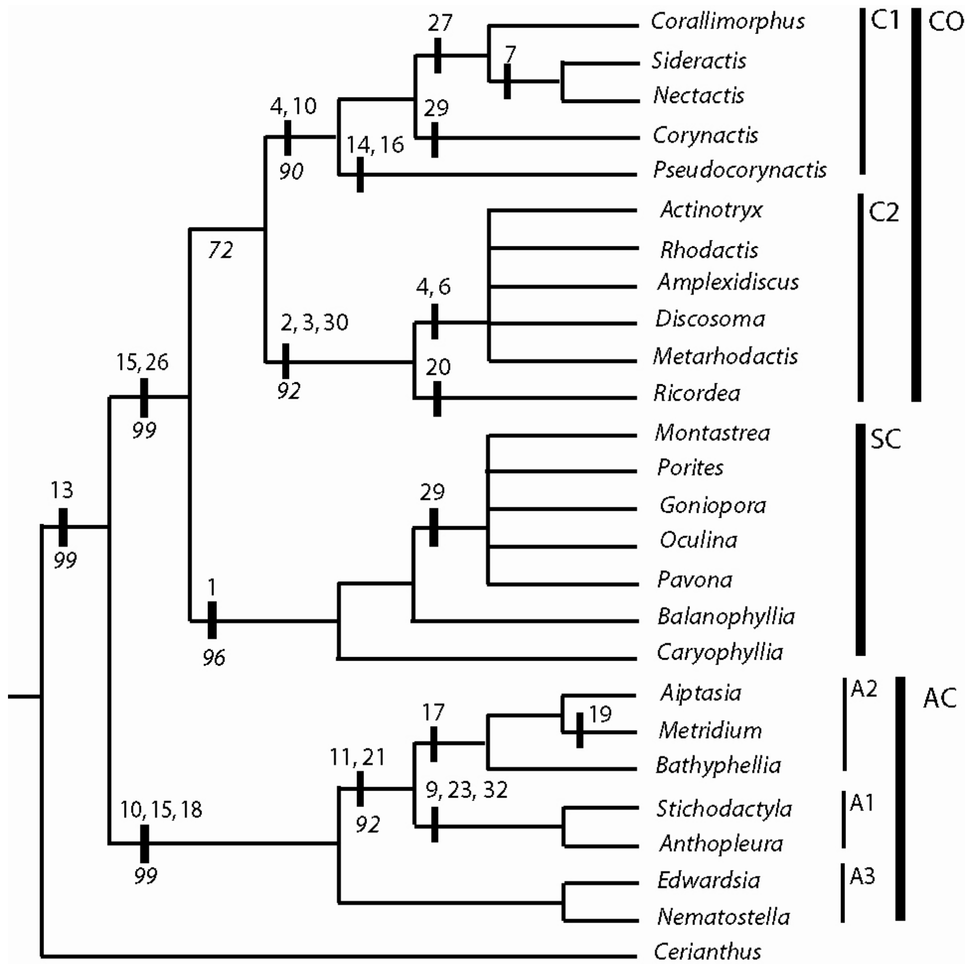


Figure 4-1. Strict consensus tree of 12 most parsimonious trees based on morphological characters (CI= 0.55; RI= 0.68) inferred using the heuristic method in PAUP. Numbers above the branches represent the characters unambiguously supporting the node. Numbers below the branches represent the percentage of 1000 non-parametric bootstrap replications. Branches without number are supported by bootstrap value of less than 70%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; C1: clade 1 in Corallimorpharia; C2: clade 2 in corallimorpharia; A1: Endomyaria in Actiniaria; A2: Acontiaria in Actiniaria; A3: Athenaria in Actiniaria.

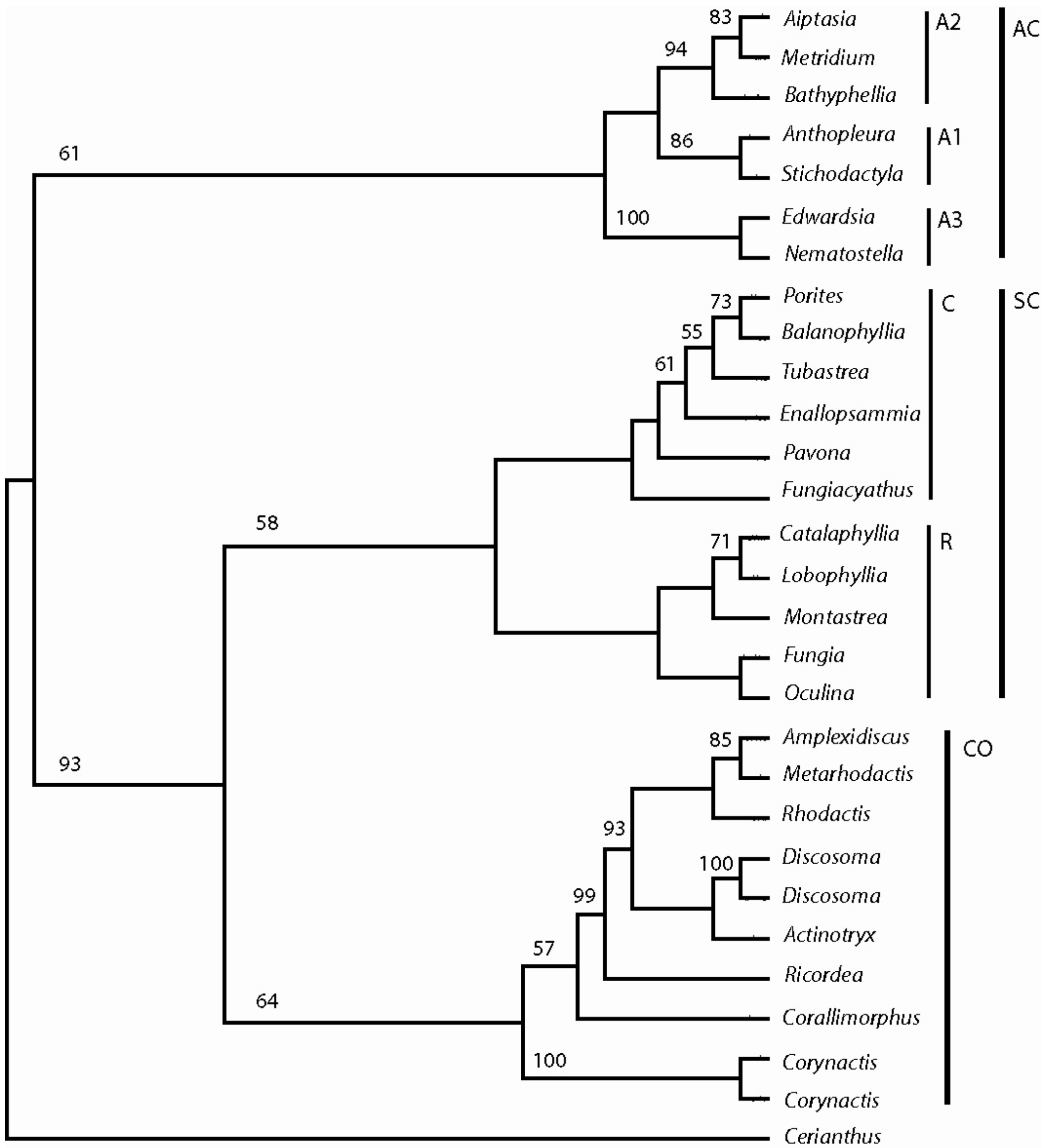


Figure 4-2. Maximum likelihood tree generated based on 18S rDNA data using GTR model, heuristic search, random stepwise addition with 500 repetitions. Numbers above the branches represent the percentage of 1000 non-parametric bootstrap replications. Branches without number are supported by bootstrap value of less than 50%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; R: robust scleractinian coral; C: complex scleractinian corals; A1: Endomyaria in Actiniaria; A2: Acontiaria in Actiniaria; A3: Athenaria in Actiniaria.

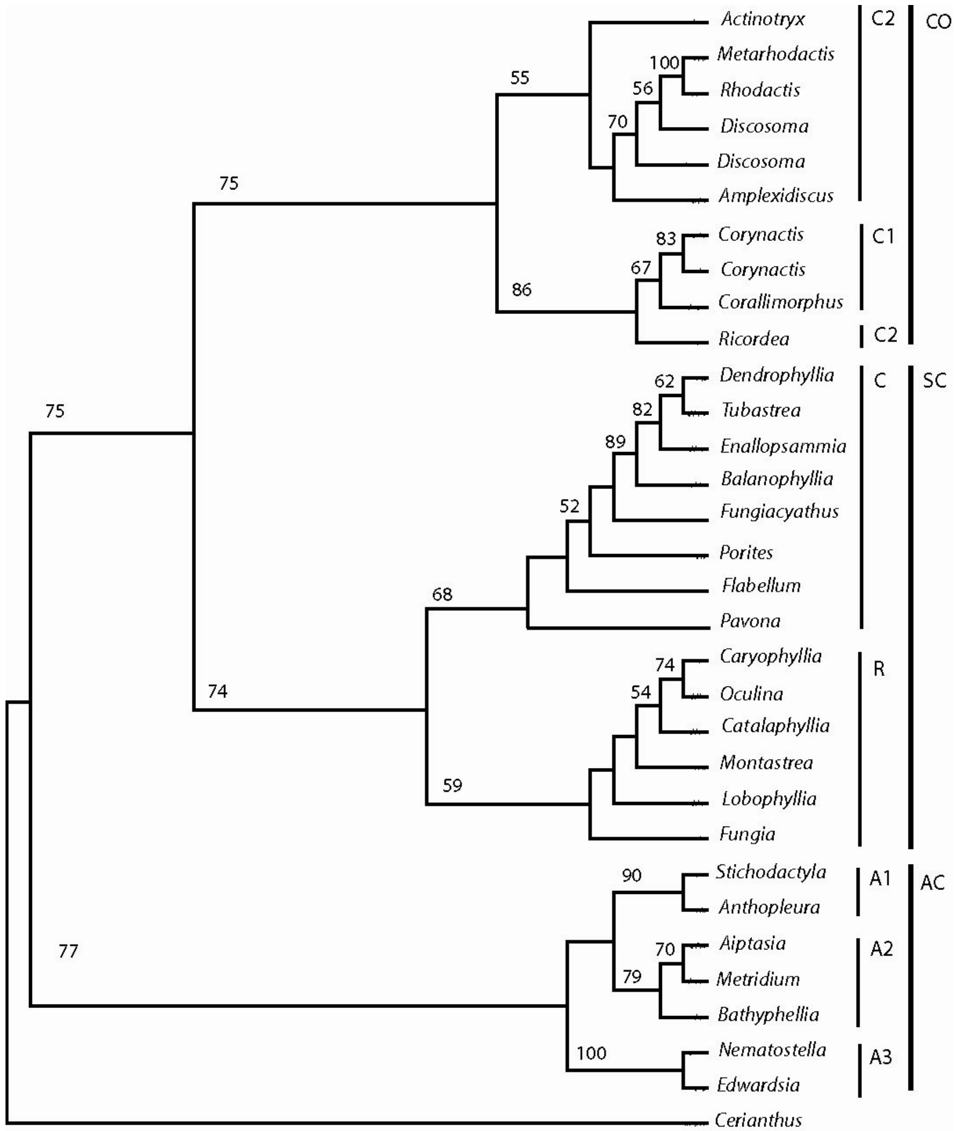


Figure 4-3. Maximum likelihood tree generated based on 28S rDNA data using GTR model, heuristic search, random stepwise addition with 500 repetitions. Numbers above the branches represent the percentage of 1000 non-parametric bootstrap replications. Branches without number are supported by bootstrap value of less than 50%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; R: robust scleractinian coral; C: complex scleractinian corals; C1: clade 1 in Corallimorpharia; C2: clade 2 in corallimorpharia; A1: Endomyaria in Actiniaria; A2: Acontiaria in Actiniaria; A3: Athenaria in Actiniaria.

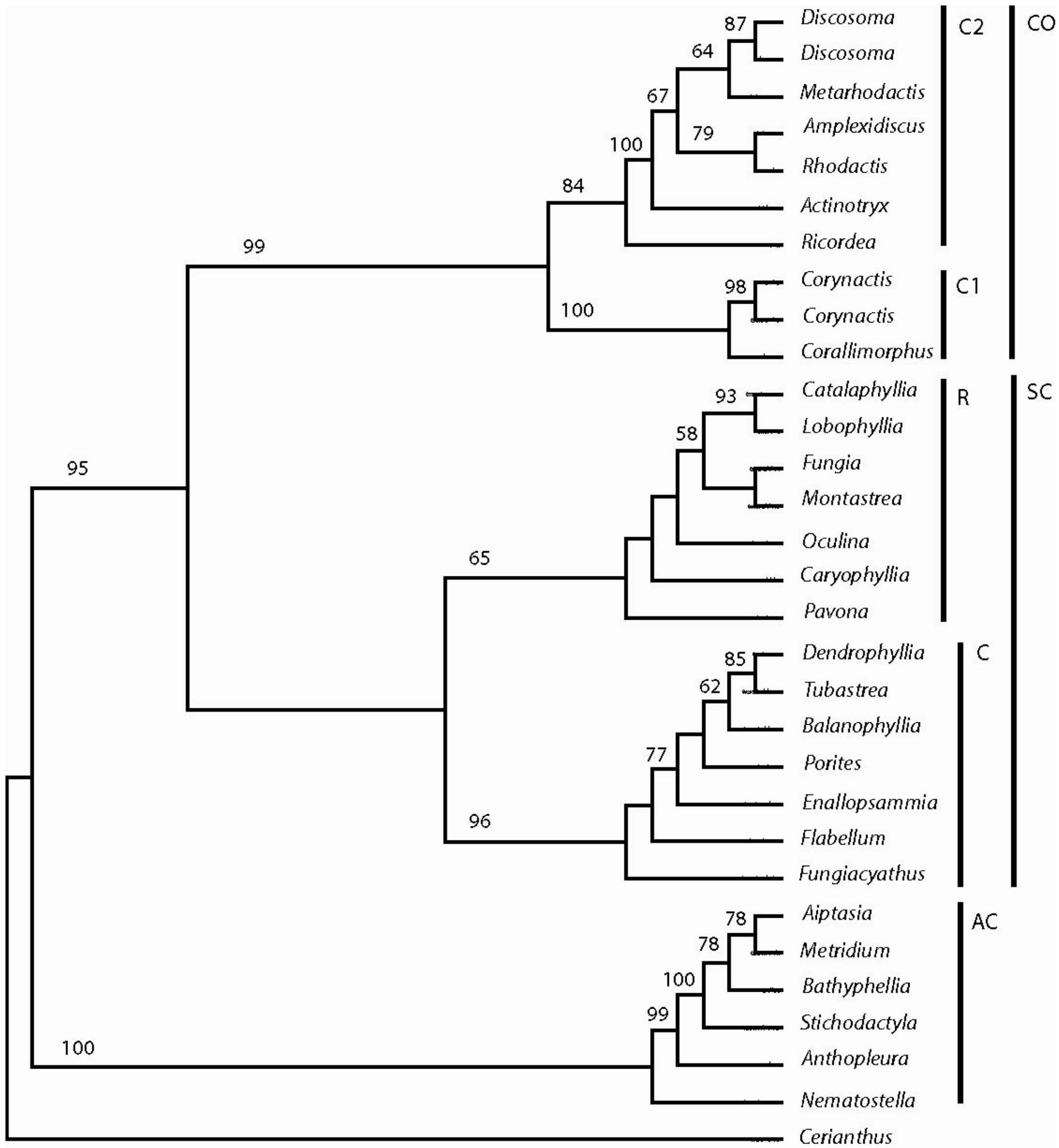


Figure 4-4. Maximum likelihood tree generated based on 16S mtDNA data using GTR model, heuristic search, random stepwise addition with 500 repetitions. Numbers above the branches represent the percentage of 1000 non-parametric bootstrap replications. Branches without number are supported by bootstrap value of less than 50%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; R: robust scleractinian coral; C: complex scleractinian corals; C1: clade 1 in Corallimorpharia; C2: clade 2 in corallimorpharia.

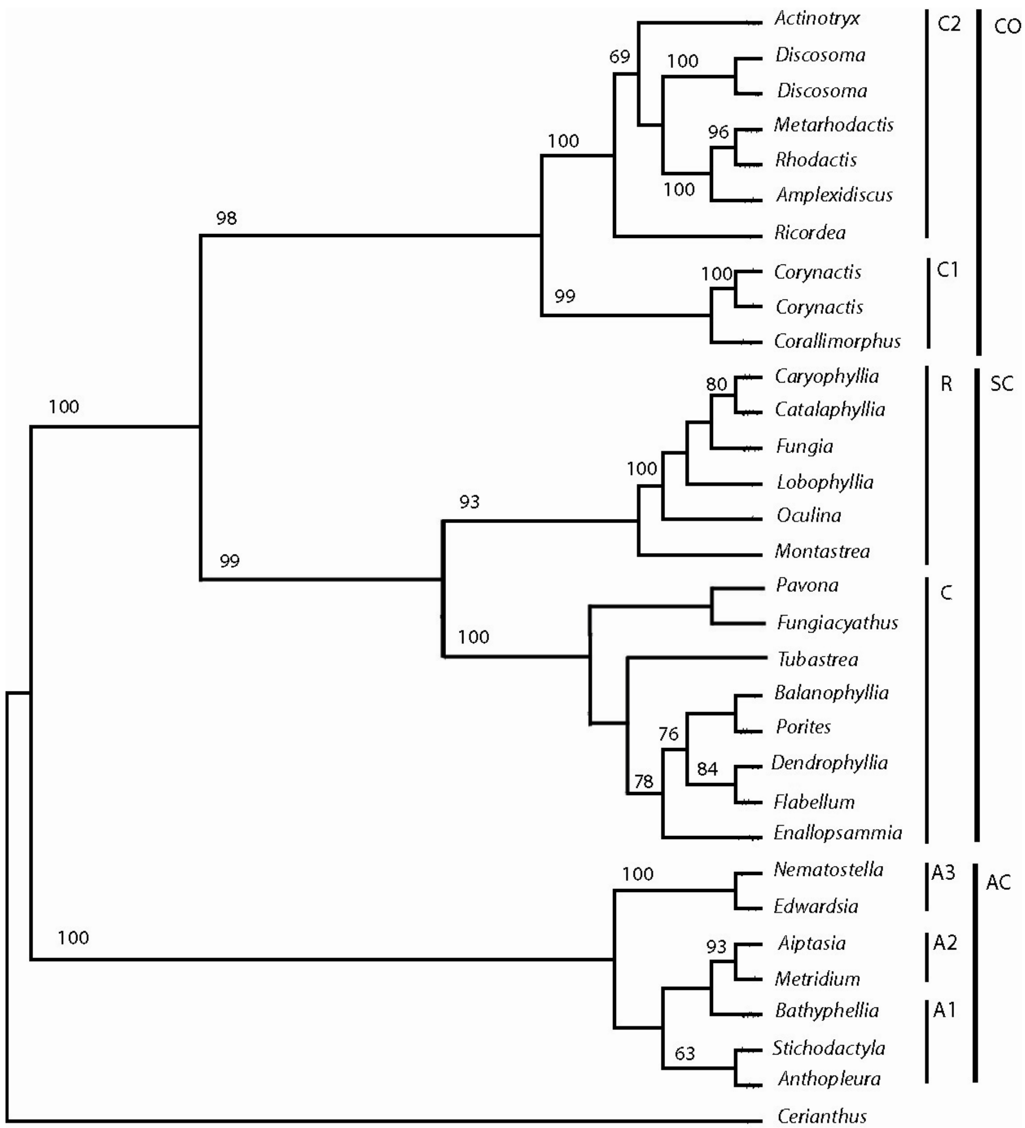


Figure 4-5. Strict consensus tree of two most parsimonious trees based on combined molecular data. Numbers above the branches represent the percentage of 1000 non-parametric bootstrap replications. Branches without number are supported by bootstrap value of less than 70%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; R: robust scleractinian coral; C: complex scleractinian corals; C1: clade 1 in Corallimorpharia; C2: clade 2 in corallimorpharia.

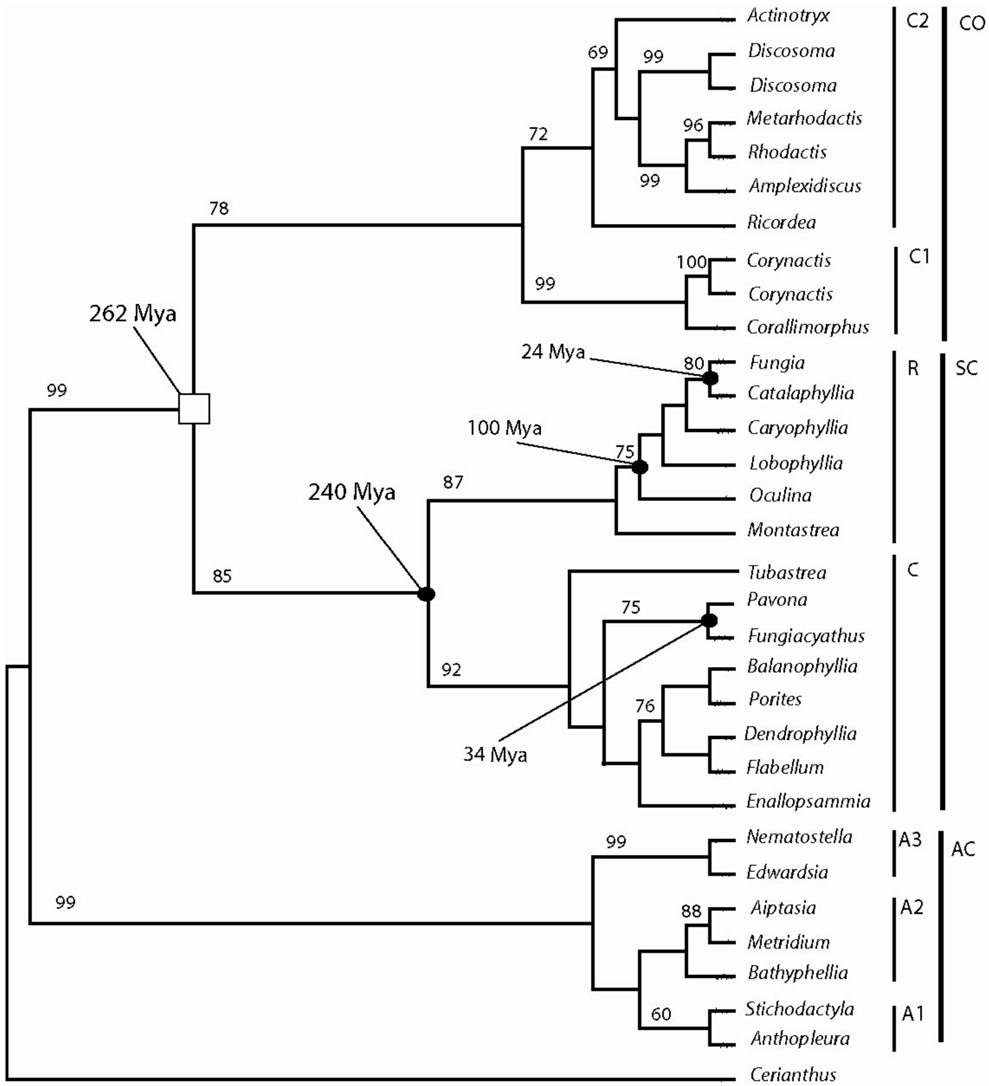


Figure 4-6. Maximum likelihood tree generated based on combined molecular data using GTR model, heuristic search, random stepwise addition with 500 repetitions. Numbers above the branches represent the percentage of 1000 non-parametric bootstrap replications (Felsenstein, 1985). Branches without number are supported by bootstrap value of less than 50%. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; R: robust scleractinian coral; C: complex scleractinian corals; A1: Endomyaria in Actiniaria; A2: Acontiaria in Actiniaria; A3: Athenaria in Actiniaria. Filled circles are the calibrations points for molecular clock dating, and empty squares are estimated divergence time.

4-7. Discussion

Monophyly and interordinal relationships of Corallimorpharia

Both morphological and molecular data sets suggest that Corallimorpharia is a monophyletic group. The monophyly of Corallimorpharia contradicts the inferences in Fautin and Lowenstein (1992) and Chen et al. (1995), and but concur with those of Daly et al. (2003) and Medina et al. (2006).

Monophyly is more robustly supported by molecular than morphological data. Relative to molecular data, morphological data support monophyly with a lower bootstrap value (0.72). Although the corallimorpharians cluster together on the tree, the two anatomical characters that define corallimorpharians are shared with scleractinians: unilobed mesenterial filaments and large holotrichs. The lack of any unique character defining the order indicates that the ordinal rank assigned to corallimorpharians is not appropriate. The lack of morphological characters supporting monophyly of corallimorpharians may be evidence of close kinship between Corallimorpharia and Scleractinia, or may be caused by the small number of characters collected for the analyses. According to Daly et al. (2003), characters of ultrastructure may provide more robust evidence to support the monophyly of corallimorpharians. But I conclude that Corallimorpharia and Scleractinia are subgroups of a higher taxon.

Within Corallimorpharia, I recognize the two clades that had been recognized by den Hartog (1980, 1993) based on morphological characters. Clade C1 (Figure 4-1) includes members of Corallimorphidae, which represent cylindrical-bodied corallimorpharians characterized by long, unbranched, capitate tentacles, no zooxanthellae, pedal disc nearly as wide as oral disc, and firm body. Within the C1 clade, the shallow-water genera, *Corynactis* and *Pseudocorynactis,* are basal to the deep-water genera, *Corallimorphus, Nectactis* and *Sideractis*, based on morphological data. Clade C2 includes members of Discosomatidae and *Ricordea* (Figure 4-1), which represent discoidal-bodied corallimorpharians characterized by an oral disc much wider than the pedal disc, many short, often branched tentacles containing zooxanthellae, and soft body. Three of the data sets consistently support sister relationships between the two clades in Corallimorpharia; 18S rDNA does not. Medina et al. (2006) concluded that the discoidal-bodied clade is derived from the cylindrical-bodied clade, but they included only one taxon of the cylindrical-bodied clade (*Corynactis*) in their analyses, so their taxon sampling may not be sufficient to resolve the relationships between the two clades.

Phylogenetic resolution beyond the family level using either morphological data or molecular data is limited. Although the results based on morphology and 16S DNA resolve relationships between the two clades in Corallimorpharia, the relationships among genera of Corallimorpharia were not resolved. Morphological data generated a polytomy among genera of Discosomatidae and the position of the genera in molecular analyses varies. The lack of resolution is probably due to the conserved nature of nuclear genes and the slow evolution of the mitochondrial genome in Cnidaria (Shearer et al., 2002). The usefulness of genetic markers used in this study, 16S mtDNA, 18S rDNA, and 28S rDNA, has been debated for more than 10 years (Chen et al., 1995, 1996; France et al., 1996; Bernsten et al., 1999; Romano and Cairns, 2000; Won et al., 2001; Daly et al., 2002). Other faster evolving nuclear-loci, including complete DNA sequences of 28S rDNA and protein-coding genes, are currently under investigation by the NSF funded Assembling the Cnidarian Tree of Life project (http://cnidarian.info) to get better resolution of phylogenetic relationships at genus and species level.

I included most of valid genera in Corallimorpharia to resolve phylogenetic relationships within Corallimorpharia and among the three orders, Actiniaria, Corallimorpharia, and Scleractinia. However, three genera in family Corallimorphidae, *Sideractis, Nectactis,* and *Pseudocorynactis*, are missing in molecular analyses due to the lack of tissue samples. The inclusion of three taxa in further phylogenetic study will possibly provide better resolution on evolutionary relationships between the two clades in Corallimorpharia, and relationships in family Corallimorphidae.

Actiniaria, Corallimorpharia, and Scleractinia: interordinal relationships

The monophyly of Actiniaria is well supported by both morphological and molecular data. Within Actiniaria, Endomyaria and Acontiaria form a clade based on sphincter muscle, basilar muscle, and basitrichs. Athenaria is basal to the Endomyaria-Acontiaria cluster. The phylogenetic inferences on interorder relationships in Actiniaria concur with Daly et al. (2003). However, the taxon sample size is too small to resolve the relationships within Actiniaria.

The monophyly of Scleractinia is supported by both morphological and molecular data. Two evolutionary lineages, complex and robust clades (Romano and Cairns, 2000), are confirmed by my molecular data. Morphological data support the monophyly of Scleractinia, but do not provide evidence supporting the two clades. The lack of resolution is probably due to the limited information on scleractinian polyp anatomy. The polyp anatomy of scleractinians has received little emphasis because taxonomy of Scleractinia is based on skeletal structure (Romano and Cairns, 2000). However, the information on scleractinian polyp anatomy is important because as an independent data set from molecular data polyp anatomy may further support or refute the inferred clades.

Actiniaria is basal to the Corallimorpharia-Scleractinia cluster as Daly et al. (2003) and Brugler and France (2007) inferred. Corallimorpharia and Scleractinia are sister taxa as proposed by Duerden (1898), Schmidt (1974), den Hartog (1980), Romano and Cairns (2000), Won et al. (2001), Daly et al. (2002, 2003), and Brugler and France (2007). The Scleractinia-Corallimorpharia clade is strongly supported by morphological and molecular data. In this study, many of the traditional diagnostic features are recovered as phylogenetically informative characters. Based on data collected in this study, the similarity in tentacle arrangement between corallimorpharians and stichodactyline actiniarians is an example of parallel evolution.

The relationships among Actiniaria, Corallimorpharia, and Scleractinia provide an insight on evolution of the scleractinian skeleton in Hexacorallia. The most parsimonious interpretation of the interordinal relationships is that a skeleton arose only once in the ancestor of Scleractinia, a skeletonless polyp. The idea that scleractinians were derived from skeletonless polyps is widely accepted (Scrutton and Clarkson, 1989; Stanley and Fautin, 2001; Stanley, 2003). My findings on divergence times of corallimorpharians and the date scleractinians arose support the hypothesis that corallimorpharians diverged from the ancestor of the Corallimorpharia-Scleractinia lineage at 262 Mya and the two clades of scleractinians diverged at 240 Mya. The most parsimonious interpretation of the relationships between Scleractinia and the most-closely related skeletonless hexacorallians is reflected in the classification of Carlgren (1949), which assumes the homology of the scleractinian skeleton within Scleractinia: Corallimorpharia is primarily separated from

Scleractinia due to the lack of calcareous exoskeleton. All extant hexacorallian polyps with calcareous exoskeleton belong to Scleractinia.

However, the most parsimonious interpretation does not concur with Hand (1966), and Fautin and Lowenstein (1994) supporting the hypothesis that the ancestor to the Actiniaria-Corallimorpharia-Scleractinia clade in Hexacorallia had a calcareous exoskeleton, which was lost multiple times. Hand (1966) reasoned that paired mesenteries, which arose in the common ancestor of the three taxa, evolved in polyps having a calcareous septum between a pair of mesenteries; they persist in non-skeletalized hexacorallians, which are descendants of skeletalized polyps, with no obvious function. In Fautin and Lowenstein (1994), they inferred that a skeletalized polyp is ancestral form of non-skeletalized hexacorallians based on calibrating the tree using radioimmunoassay of proteins from animals at the known divergence point for two scleractinian lineages, 240 Mya.

Although my results support the hypothesis that scleractinians were derived from non-skeletonlized polyps, it is difficult to conclude directionality in the relationship between skeletalized and non-skeletalized taxa because of the lack of a fossil record of skeletonless hexacorallians.

Ordinal placement of Corallimorpharia

Due to the lack of unique morphological characters defining Corallimorpharia, the scleractinian skeleton, which is the only character to separate Corallimorpharia from Scleractinia, is essential to determine the ordinal placement of the Corallimorpharia in Hexacorallia. The phylogenetic value of the scleractinian skeleton has been challenged by the hypothesis that the scleractinian skeleton could have disappeared and appeared multiple times (Fautin and Lowenstein, 1994; Romano and Palumbi, 1996; Romano and Cairns, 2003). If the the scleractinian skeleton is not an essential attribute of Scleractinia, Corallimorpharia and Scleractinia may need to be combined into one order due to the similarities in their polyps. The h ypothesis of multiple origins of the scleractinian skeleton is supported by the phylogenetic relationship between Scleractinia and Corallimorpharia (Romano and Palumbi, 1996; Romano and Cairns, 2000; Medina et al., 2006), and the ephemerality of the scleractinian skeleton is supported by the fossil record (Wells, 1956; Veron, 1995; Oliver, 1996), and ecological and experimental evidence (Buddemeier and Fautin, 1996; Fine and Tchenov, 2007).

Based on the fossil record, there is an approximately 10 Mya gap between the Permian extinction (251 Mya) and the appearance of scleractinian fossils (240 Mya). The first Mid-Triassic scleractinian fossils are represented by numerous higher taxa, up to nine suborders of Scleractinia appeared in the mid-Triassic with no known common ancestor (Vaughan and Wells, 1943; Wells, 1956; Veron, 1995; Stanley, 2003). The modern scleractinians are not descendants of Paleozoic rugosan corals as has been proposed (Vaughan and Wells, 1943; Veron, 1995): they differ in septa symmetry and the crystal form of their calcium carbonate skeleton (Oliver, 1980; Scrutton and Clarkson, 1991; Romano and Palumbi, 1996; Stanley and Fautin, 2001).

The explosive appearance of scleractinian fossils after the gap may be explained by the “naked coral” hypothesis (Stanley, 2003), which supports the idea that multiple lineages of skeletonless anthozoans gave rise to various calcified scleractinian-like corals through aragonitic biomineralization; thus the scleractinian skeleton represents “a grade of organization” (Stanley, 2003, p. 224). Several molecular studies support the multiple origins of the scleractinian skeleton. Romano and Palumbi (1996) proposed the evolutionary divergence of scleractinians at 300 Mya. They stated the 60 Mya gap between the dates from fossil (240 Mya) and molecules may be explained as a period in which scleractinians did not have skeletons, and the great morphological diversity of scleractinians may represent polyphyletic origins of the scleractinian skeleton. Romano and Cairns (2000) concluded that scleractinian skeletons may have evolved as many as four times in Scleractinia.

The environmental and experimental data provide more empirical evidence of ephemerality of the scleractinian skeleton. Recent data support that physicochemical conditions of seawater have an effect on the calcification of scleractinians (Buddemeier and Fautin, 1996; Gattuso et al., 1999; Kleypas et al., 1999; Langdon, 2000; Ezaki, 2000; Stanley and Fautin, 2001; Feely et al., 2004). Calcification rates of some modern reef organisms decline with decreasing calcium carbonate saturation of sea water; saturation state is reduced by high atmospheric CO_2 values (Smith and Buddemeier, 1992; Buddemeier and Fautin, 1996; Kleypas et al., 1999). The 10 Mya gap between Permian extinction and the appearance of scleractinian fossils was the time when carbonate deposition was suppressed globally (Stanley, 1988). My finding on divergence time of Corallimorpharia (262 Mya, Late Permian) from the ancestral lineage when there was a dramatic increase of atmospheric CO_2, which would be unfavorable for calcification, and divergence time of the two clades of Scleractinia (240 Mya) is consistent with the scenario of high calcium carbonate saturation in the Middle Triassic, which would be favorable for calcification (Sandberg, 1983).

The impact of saturation state of seawater on the calcification of scleractinians was illustrated experimentally by Fine and Tchernov (2007). When they kept scleractinians of two species, *Oculina patagonica* and *Madracis pharensis*, in low pH sea water, which would occur with high atmospheric CO_2 thus low calcium carbonate saturation, the calcareous exoskeleton disappeared; when the animals were returned to high pH sea water (high calcium carbonate saturation, under current atmospheric conditions), the calcareous exoskeleton reappeared. The influence of environmental factors on calcification rates is reflected in contemporary biogeography: in the tropics, waters are supersaturated with aragonite and anthozoan communities are dominated by zooxanthellate scleractinians, while in undersaturated high latitude waters, skeletonless anthozoans, both zooxanthellate and azooxanthellate, are abundant whereas scleractinians are azooxanthellate and relatively uncommon (Buddemeier and Fautin, 1994, 1996).

Based on my results supporting the hypothesis that the ancestral form of scleractinians was a skeletonless polyp and the evidence on ephemeralism of the scleractinian skeleton, I agree with the idea of Fautin and Lowenstein (1994) that it is difficult to separate corallimorpharians from scleractinians: Scleractinia needs to be redefined, and Corallimorpharia cannot hold the rank equivalent to that of Scleractinia as currently accepted.

I, therefore, propose that the Corallimorpharia ans Scleractinia are suborders of order Madreporaria because no morphological characters uniquely distinguish Corallimorpharia from Scleractinia, as was suggested by Schmidt (1974). The etymology of Madreporaria is madre, mother (from Latin mter, mtr-) + -pora (from Latin prus, calcareous stone, stalactite).

The emended classification of Hexacorallia is

Class Anthozoa

- Subclass Hexacorallia
    - Order Actiniaria
    - Order Madreporaria
        - Suborder Scleractinia
        - Suborder Corallimorpharia

CHAPTER V. CONCLUSION

This study provides phylogenetic analyses for the Corallimorpharia. Systematic position and status of Corallimorpharia in Hexacorallia have been controversial because members of Corallimorpharia have intermediate morphology between Actiniaria and Scleractinia. Some authors (Andres, 1883; Duerden, 1898, 1900) inferred corallimorpharians are a part of Actiniaria, and others (Stephenson, 1922; den Hartog, 1980) inferred that corallimorpharians are a part of Scleractinia. Carlgren (1949) and Wells and Hills (1956) inferred that Corallimorpharia is equivalent to both Actiniaria and Scleractinia.

Previous studies on molecular phylogeny of Hexacorallia did not provide a consensus on systematic relationships of the Corallimorpharia possibly due to insufficient taxon sampling of Corallimorpharia. Some (Fautin and Lowernstein, 1994; Chen et al. 1995; Romano and Cairns, 2000; Won et al. 2001) suggested Corallimorpharia forms a paraphyletic or polyphyletic assemblage with actiniarians and/or scleractinians, and others (Daly et al. 2003; Medina et al. 2006; Brugler and France, 2007) inferred that Corallimorpharia is a monophyletic group. The interpretation of the relationship between monophyletic Corallimorpharia and Scleractinia differ among authors: Corallimorpharia is inferred to be a part of Scleractinia (Medina et al., 2006) or as a sister taxon (Daly et al., 2003; Brugler and France, 2007).

I conducted phylogenetic analyses using morphological and molecular data to provide a comprehensive investigation of phylogeny of Corallimorpharia. Morphological and molecular data were congruent, and were used to reject the hypothesis that corallimorpharians form a paraphyletic or polyphyletic assemblage with Actiniaria and Scleractinia. All data sets support monophyly of Corallimorpharia, and sister relationship with Scleractinia. Within Corallimorpharia, two evolutionary lineages, cylindrical body corallimorpharians and discoidal body corallimorpharians, were recovered. Based on estimated divergence time of Corallimorpharia and Scleractinia using molecular data, the ancestral form of Corallimorpharia-Scleractinia clade is likely to have been a skeletonless polyp.

Due to the lack of unique morphological characters defining Corallimorpharia, the scleractinian skeleton, which is the only character to separate Corallimorpharia from Scleractinia, is essential to determine the hierarchical rank of Corallimorpharia in Hexacorallia. One hypothesis is that the scleractinian skeleton is not homologous in all scleractinians, and therefore is not phylogenetically meaningful in defining Scleractinia. The hypothesis is supported by evidence from the fossil record, molecular phylogeny of Scleractinia, and environmental effects on calcification. Therefore, I propose Corallimorpharia and Scleractinia are suborders of the order Madreporaria, as Schmidt (1974) suggested.

In Corallimorpharia, there has been no consensus on the number of valid family and genera. I therefore provide a taxonomic revision at the genus-level based on re-examination of type material. The revision is focused on the seven of the16 nominal genera, for which validity is questionable. I used five morphological character categories that are phylogenetically meaningful. The type species of each genus is redescribed for those known in less detail and diagnostic keys to genera and families are provided. I conclude five of the seven genera are valid. Thus, I conclude that there are three valid families and 11 valid genera in suborder Corallimorpharia.

The revision at the genus level is the first step to revise classification at the species level. There is no consensus in the number of valid species in most corallimorpharians genera. There are 41 nominal species in Corallimorpharia. Taxonomic revision at the species level will provide information about diversity and biogeography of corallimorpharians.

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Appendix 1. List of morphological characters used in cladistic analysis:

1 Calcareous exoskeleton: absent (0); present (1)

2 Polyp body shape: cylindrical (column elongated) (0); plate-like (column short and oral disc wider than pedal disc) (1)

3 Oral disc is fully covered with tentacles: no(0); yes(1)

4 Marginal tentacle: none or very reduced (0); capitate (1); digitate (2); branched (3); papilliform (4)

5 Discal tentacle: none (0); capitate (1); digitate (2); branched (3); papilliform (4)

6 Tentacle-free zone on oral disc: absent (0); present (1)

7 Tentacle/coelenteron relationship: one tentacle per endocoel and per exocoel (0); one tentacle per exocoel, multiple per endocoel (1)

8 Tentacle retractile: no (0); yes (1)

9 Column: smooth (0); tuberculated (1)

10 Sphincter muscle: absence (0); present (1)

11 Basilar muscle: absent (0); present (1)

12 Coupled mesenteries: absent (0); present (1)

13 Paired mesenteries: absent (0); present (1)

14 Type of mesenteries: only perfect (0); perfect and imperfect (1)

15 Nature of mesenterial filaments: unilobed (0); trilobed (1)

16 Directive mesenteries: no (0); yes (1)

17 Acontia: absent (0); present (1)

18 Siphonoglyph: absent (0); present (1)

19 Catch tentacles: absent (0); present (1)

20 Spirocyst: absent (0); present (1)

21 Basitrichs: absent (0); present (1)

22 Microbasic p-mastigophors: absent (0); present (1)

23 Microbasic b-mastigophors: absent (0); present (1)

24 Holotrichs: absent (0); present (1)

25 Hoplotelic p-mastigophors: absent (0); present (1)

26 Large holotrichs (larger than 100 um): absent (0); present (1)

27 Occurrence depth: shallow (0); deep (1)

28 Occurrence area: polar (0); temperate only (1); tropical only (2); temperate and tropical (3); temperate and polar (4)

29 Polyp organization: solitary (0); colonial (1); clonal (2)

30 Zooxanthellae: absent (0); present (1)

31 Mesogleal cell inclusion: absent/rare (0); present (1)

32 Asexual reproduction: absent (0); present (1)

33 Sexuality: hermaphroditic (0); gonochoric (1); hermaphroditic and gonochoric (2)

Data matrix with taxon names. AC: Actiniaria; CO: Corallimorpharia; SC: Scleractinia; CE: Ceriantharia

Order	Genus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
CO	*Corynactis*	0	0	0	1	1	1	1	1	0	1	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	3	2	0	0	1	1
CO	*Corallimorphus*	0	0	0	1	1	1	1	0	0	1	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	1	2	0	0	0	0	1
CO	*Pseudocorynactis*	0	0	0	1	1	1	1	1	0	1	0	1	1	0	0	1	0	0	0	1	0	1	1	1	1	1	0	2	0	0	0	0	1
CO	*Sideractis*	0	1	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	1	0	0	0	0	0	1
CO	*Nectactis*	0	1	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	1	0	1	0	1	1	0	0	0	0	0	1
CO	*Actinotryx*	0	1	0	2	3	1	1	0	0	1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0	2	2	1	1	1	?
CO	*Discosoma*	0	1	1	0	4	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0	2	2	1	1	1	?
CO	*Rhodactis*	0	1	1	2	3	1	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	1	1	0	1	0	2	2	1	1	1	1
CO	*Metarhodactis*	0	1	1	0	3	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0	2	2	1	0	1	?
CO	*Amplexidiscus*	0	1	1	2	2	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0	2	0	1	1	1	1
CO	*Ricordea*	0	1	1	2	1	0	1	0	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	2	1	0	1	?
AC	*Stichodactyla*	0	1	1	2	2	0	1	0	1	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	2	2	1	0	1	2
AC	*Anthopleura*	0	0	0	2	2	1	0	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	0	0	3	2	1	0	1	2
AC	*Bathyphellia*	0	0	0	2	2	1	0	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	3	2	0	0	0	1
AC	*Metridium*	0	0	0	2	2	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	2	0	0	0	1
AC	*Aiptasia*	0	0	0	2	2	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	0	3	2	1	0	1	1
AC	*Edwardsia*	0	0	0	2	2	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	3	0	0	0	0	1
AC	*Nematostella*	0	0	0	2	2	1	0	1	0	1	0	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	4	0	0	0	1	1
SC	*Caryophyllia*	1	0	0	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	0	0	0	1	2
SC	*Porites*	1	0	0	2	1	1	?	1	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	1	1	0	1	1
SC	*Goniopora*	1	0	0	1	0	1	1	?	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	1	1	0	1	1
SC	*Balanophyllia*	1	0	0	2	2	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	0	0	0	1	1
SC	*Fungia*	1	1	1	0	2	0	1	0	0	0	0	1	1	1	0	0	0	0	0	1	0	1	1	1	0	1	0	2	0	1	0	1	1
SC	*Tubastrea*	1	0	0	2	2	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	?	?	?	1	0	1	0	2	1	0	0	1	0
SC	*Oculina*	1	0	0	2	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	1	?	?	?	?	0	1	0	2	1	0	0	1	1
CE	*Cerianthus*	0	0	0	2	2	1	0	0	0	0	0	1	0	1	1	0	0	0	1	1	0	0	1	1	0	0	0	3	0	?	0	1	1

Appendix 2. Alignment of 16S mtDNA sequences

```
[                          10        20        30        40        50]

Discosoma_num     --------------------------GGAATGTCATATGAAAGAGAA-GT
Discosoma_neg     --------------------------GGAGGG-CA-ATG-ATGTAGA-GT
Amplexidiscus     --------------------------GGCGAG-CAAATG--AGTAGA-GT
Rhodactis         --------------------------GGA-AG-CATTGA--AGTAGA-GT
Metarhodactis     --------------------------GCCCAG-CATTTG-ATGTAGAAGT
Actinotryx        --------------------------GACAAGCTAAATGCATGTAGACGT
Ricordea          -----------------------------AAG-TAA-TG-ATGTAGACGT
Corynactis_v      ----------------------------T-AA-T--CCGAAAGTTTAATT
Corynactis_c      --------------------------TGTGAA-T-TCTGAAAGTTTAATT
Corallimorphus    --------------------------TGTGAA-TATGTGGAAGTTTA-TT
Balanophyllia     --------------------------------------------------
Dendrophyllia     --------------------------------------------------
Tubastrea         --------------------------------------------------
Enallopsammia     -------------------------------------TGAAGGTAGAAGT
Porites           --------------------------------------------------
Flabellum         --------------------------------------------------
Fungiacyathus     --------------------------------------------------
Pavona            --------------------------------------------------
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Oculina           --------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        --------------------------------------------------
Anthopleura       TCGACTGTTTACCAAAAACATAGCTCTCTGCTAAAGCTAAATGCTGAAGT
Aiptasia          TCGACTGTTTACCAAAAACATAGCTCTCTGCTAAAGCTAAATGCTGAAGT
Bathyphellia      ---------------------------CTGCCAAAGCTAAATGCTGAA--
Metridium         --------------------------------------------------
Stichodactyla     TCGACTGTTTACCAAAAACATAGCTCTCTGCTAAAGCTAAATGCTGAAGT
Nematostella      --------------------------------------------------
Cerianthus        ----------------------------------AAAGGAGCCCTAAAGT

[                          60        70        80        90        100]

Discosoma_num     ATGAAGGGTGAGACCTGCCCCTATGGTTGTATCTAAAGGGGTCGG-TAGG
Discosoma_neg     ATGAAGGGTGAGACCTGCCCCTATGGTTGTATCTAAAGGGGTCGG-TAGG
Amplexidiscus     ATGAAGGGTGAGACCTGCCCA-ATGGTTGTATCTAAAGGGGTCGG-TAGG
Rhodactis         ATG-AGGGTGAGACCTGCCCA-ATGGTTGTATCTAAAGGGGTCGG-TAGG
Metarhodactis     ATG-AGGGTGAGACCTGCCCC-ATGGTTGTATCTAAAGGGGTCGG-TAGG
Actinotryx        ATGAGGGGTGAGACCTGCCCA-ATGGTTGTATCTAAAGGGGTCGG-TAGG
Ricordea          ATGGGGGGTGAGTC-TGCCCA-ATGGTTGTATCTGAAGGGGTCGG-TAGG
Corynactis_v      ATGGGGGGTGAGACCTGCCCA-ATGGTTGTATCTAAAAGGGTCGG-TTGG
Corynactis_c      ATGGGGGGTGAGACCTGCCCA-ATGGTTGTATCTAAAAGGGTCGG-TTGG
Corallimorphus    ATGGGGGGTGAGACATGCCCA-GTGGTTGTATCTAAAAGGGTCGG-TTGG
Balanophyllia     ----------------------------GTCTCTAAAAGGGTTGG-TAGA
Dendrophyllia     ----------------------------GTATCTAAAAGGGTTGG-TAGA
Tubastrea         ----------------------------GTATCTAAAAGGGTTGG-TAGA
Enallopsammia     ATGAAAGGTGAGAMCTGCCCA-ATGGTTGTATCTAAAAGGGTTGG-TAGA
Porites           ----------------------------GTATCTAAAAGGGTTGG-TAAA
Flabellum         ----------------------------GTATCTAAAAGGGTTGG-TAGA
Fungiacyathus     --------------------------------------------------
Pavona            ----------------------------GTATCTTAGAAGGTTGG-TAAG
Caryophyllia      ----------------------------GTATCTAAAAAAGTTTG-TTTT
Catalaphyllia     ----------------------------GTATCTAAAAAAGTTTG-TTTT
Oculina           ----------------------------GTATCTAAAAAAGTTTG-TTTT
Lobophyllia       ----------------------------GGATCTAAAAAAGTTTG-TTTT
Fungia            ----------------------------GTATCTAAAAAAATTTG-TTTT
Montastrea        ------------------CCT------TGATACCTGTTAGTCCTG-----
Anthopleura       ATGGAGGGTGAAGCCTGCCCG-ATGGTTGTATCTGAAAAGGTTGGCTAAC
Aiptasia          ATGGAGGGTGAGGCCTGCCCA-ATGGTTGTATCTAAAAGAGTTGGCTAAG
Bathyphellia      --------------------------------------------------
Metridium         --------------------------------------------------
Stichodactyla     ATGGAGGGTGAGGCCTGCCCA-ATGGTTGTATCTAAAAGAGTTGGCTAAG
Nematostella      ----GAGGTGACGCCTGCCCA-ATGGTTGTATCTAAAAGAGTCGATAAGA
Cerianthus        ATAGGAGGTGAAGCCTGCCCT-ATGGTTGTACCTGAAATAATAAC-AAAG
```

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[                         110       120       130       140       150]

Discosoma_num     GCCGAAATTATAAAGACAATTGAATGGCTGCGGTAACCGTGACCGTGAAA
Discosoma_neg     GCCGAAATTATAAAGACAATTGAATGGCTGCGGTAACCGTGACCGTGAAA
Amplexidiscus     GCCGAAATTATAAAGACAATTGAATGGCCGCGGTAACCGTGACCGTGAAA
Rhodactis         GCCGAAATTATAAAGACAATTGAATGGCCGCGGTAACCGTGACCGTGAAA
Metarhodactis     GCCGAAATTATAAAGACAATTGAATGGCTGCGGTAACTGTGACCGTGAAA
Actinotryx        GCCGAAATTATAAAGACAATTGAATGGCTGCGGTAACCGTGACCGTGAAA
Ricordea          GTCGATTCTATAAAGACAATTGAATGGCTGCGGTAACAGTGACCGTGAAA
Corynactis_v      GCCGACTTTATAAAGACAATTGAATGGCTGCGGTAACACTGACCGTGAAA
Corynactis_c      GCCGACTTTATAAAGACAATTGAATGGCTGCGGTAACACTGACCGTGAAA
Corallimorphus    GCCGACTTTATAAAGACAATTGAATGGCTGCGGTAACACTGACCGTGAAA
Balanophyllia     GCCAGCTTTATAAAGACAATTAAATGGCCGCGGTAACACTGACCGTGATA
Dendrophyllia     GCCAGCTTTATAAAGACAATTAAATGGCCGCGGTAACACTGACCGTGATA
Tubastrea         GCCAGC-TTATAAAGACAATTAAATGGCCGCGGTAACACTGACCGTGATA
Enallopsammia     GCCAGCTTTATAAAGACAATTAAATGGCCGCGGTAACACTGACCGTGATA
Porites           GCCAACTTTATAAAGACAATTAAATGGCCGCGGTAACACTGACCGTGATA
Flabellum         GCCAGCTTTATAAAGACAATTTAATGGCCGCGGTAACACTGACCGTGATA
Fungiacyathus     -----------------AATTTAATGGCCGCGGTAACTTTGACCGTGATA
Pavona            GCGAATTTAATAAAGACAATTTAATGGCTGCGGTAACACTGACCGTGAAA
Caryophyllia      GCTCAC-TAATAATGACAATTAAATGGCCGCGGTAACACTGACTGTGAAA
Catalaphyllia     GCTTAT-TAATAAAGACAGCTAAATGGCCGCGGTAACACTAACTGTGAAA
Oculina           GCTTAC-TAATAAAGACAATTAAATGGCCGCGGTAACACTAACTGTGAAA
Lobophyllia       GCTTAT-TAATAAAGACAATTAAATGGCTGCGGTAACACTAACTGTGAAA
Fungia            GCTTAT-TAATAAAGACAATTAAATGGCCGCGGTAACACTAACTGTGAAA
Montastrea        GCCGTA--AACGATGAANACTAGATGTCGGCGGTAACAATAACC-----A
Anthopleura       GTCAACTTCATAAGGGCAATTGAATGGCCGCGGTAACACTGACCGTGATA
Aiptasia          GTCAACTTCATAAGGGCAATTGAATGGCCGCGGTAACACTGACCGTGATA
Bathyphellia      --------------------------------------------------
Metridium         -----------------------------------TCACTGACCGTGATA
Stichodactyla     GTCAACTTTATAAGGGCAATTGAATGGCCGCGGTAACACTGACCGTGATA
Nematostella      GTCACTTTTATAAGGACAATTGAATGGCCGCGGTAACACTGACCGTGATA
Cerianthus        CAGTTATTTATAAAGACAATTTAATGGCCGCGTTATACCTGACTGTGAAA

[                         160       170       180       190       200]

Discosoma_num     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Discosoma_neg     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Amplexidiscus     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Rhodactis         ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Metarhodactis     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Actinotryx        ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Ricordea          ATGTAGCGTAATCAATTGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Corynactis_v      ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGCC
Corynactis_c      ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGCC
Corallimorphus    ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGCC
Balanophyllia     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Dendrophyllia     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Tubastrea         ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Enallopsammia     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Porites           ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Flabellum         ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Fungiacyathus     ATGTAGCGTAATCAATAGTCAATTAATTGTTGGCCGGTATGAATGGTGTC
Pavona            ATGTAGCGAAATAAATAGTCAATTAATTGTTGACCGGTATGAATGGTGTC
Caryophyllia      ATGTAGCGCAATCAATTGTCAATTAATTGTTGACCGGTATGAATGGTGTC
Catalaphyllia     ATGTAGCGTAATCAATTGTTAATTAATTGTTGACCGGTATGAATGGTGTC
Oculina           ATGTAGCGTAATCAATTGTCAATTAATTGTTGACCGGTATGAATGGTGTC
Lobophyllia       ATGTAGCGTAATCAATTGTTAATTAATTGTTGACCGGTATGAATGGTGTC
Fungia            ATGTAGCATAATAGATTGTCAATTAATTGTTGACTGGTATGAATGGTATC
Montastrea        ATGTAGCGT-ATCTAACGTCAATTAATTGTTGACTGGGATGAATGGTAGC
Anthopleura       ATGTAGCGTAATCAATAGCCAATTAATTGTTGGCCGGTATGAATGGCATC
Aiptasia          ATGTAGCGTAATCAATAGCCAATTAATTGTTGGCCGGTATGAATGGCGTC
Bathyphellia      ------------------------------GGCCGGTATGAATGGCGTC
Metridium         ATGTAGCGTAATCAATAGCCAATTAATTGTTGGCCGGTATGAATGGCGTC
Stichodactyla     ATGTAGCGTAATCAATAGCCAATTAATTGTTGGCCGGTATGAATGGCGTC
Nematostella      ATGTAGCGTAATCAATAGCCAATTAATTGTTGGCCGGTATGAATGGCGTC
Cerianthus        ATGTAGCGCAATCAATCGTCAATTAATTGTTGACAAGTATGAATGGCGTC
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[                          210        220        230        240        250]

Discosoma_num     ACGAAGGTCTCACTGTCTTAAGAAAATCCCTTGTGAAATTGAATTTGTAG
Discosoma_neg     ACGAAGGCCTCACTGTCTTAAGAAAATCCCCTGTGAAATTGAATTTGTAG
Amplexidiscus     ACGAAGGTCTCACTGTCTTAAGAAAATCCCCTGTGAAATTGAATTTGTAG
Rhodactis         ACGAAGGTCTCACTGTCTTAAGAAAATCCCCTGTGAAATTGAATTTGTAG
Metarhodactis     ACGAAGGCCTCACTGTCTTAAGAAAATCCCCTGTGAAATTGAATTTGTAG
Actinotryx        ACGAAGGTCTCACTGTCTTAAGAAAATCCCTTGTGAAATTGAATTTGTAG
Ricordea          ACGAAGGCCTCACTGTCTTAAGAAAATCTCCTGTGAAATTGAATTTGTAG
Corynactis_v      ACGAGGGTCTCACTGTCTTAAGAAAATCCCCAGTGAAATTGAATTTGTAG
Corynactis_c      ACGAGGGTCTCACTGTCTTAAGAAAATCCCCAGTGAAATTGAATTTGTAG
Corallimorphus    ACGAGGGTCTCACTGTCTTAAGAAAATCCCCAGTGAAATTGAATTTGTAG
Balanophyllia     ACGAGGGTCTCACTGTCTTAAGGAAATTTCCAGTGAAATTGATT---TGG
Dendrophyllia     ACGAGGGTCTCACTGTCTTAAGGAAATTTCCAGTGAAATTGAATTTGTAG
Tubastrea         ACGAGGGTCTCACTGTCTTAAGGAAATTTCCAGTGAAATTGAATTTGTAG
Enallopsammia     ACGAGGGTCTCACTGTCTTAAGGAAATTTCCAGTGAAATTGAATTTGTAG
Porites           ACGAGGGTCTCACTGTCTTAAGAAAATGTCCAGTGAAATTGAATTTGTAG
Flabellum         ACGAGGGTCTCACTGTCTTAAGGAAATTTCCAGTGAAATTGAATTTGTAG
Fungiacyathus     ACGAGGGTCTCACTGTCTTAAGAAAATTTCCAGTGAAATTGAATTTGTAG
Pavona            ACGAGGGTCTCGCTGTCTTAAGGAAGTTTCCAGTGAAATTGAACTTGTAG
Caryophyllia      ACGAAAGTTCTTCTGTTTTAAAAAAACACTCAAGGAAATTGAATTTGTAG
Catalaphyllia     ACGAAAGTTTCTCTGTCTTAAAAAAATACTTAATGAAATTGAATTTGTAG
Oculina           ACGAAAGTTCCTCTGTCTTAAAAAAATACTTAATGAAATTGAATTTGTAG
Lobophyllia       ACGAAAGTTTCTCTGTCTTAAAAAAATACTTAATGAAATTGAATTTGTAG
Fungia            ACGAAAGTTTTTCTGTCTTAAAAAAATACTTAATGAAATTGAATTTGTAG
Montastrea        ACGAAAGTTTTTCTGTATTGAGAAACTCGCTAATGAAATTGAATATGTAG
Anthopleura       ACGAAGGCCCCACTGTCTTAAGAGGACTCTCCATGAAATTGAAATCGTAG
Aiptasia          ACGAAGGCCCCACTGTCTTAAGAGGACTCTCCATGAAATTGAATTCGTAG
Bathyphellia      ACGAAGGCCCCACTGTCTTAAGAGGACTCTCCATGAAATTGAATTCGTAG
Metridium         ACGAAGGCCCCACTGTCTTAAGAGGACTCTCCATGAAATTGAATTCGTAG
Stichodactyla     ACGAAGGCCCCACTGTCTTAAGAGGACTTTCCATGAAATTGAATTCGTAG
Nematostella      ACGAAGGCCCCACTGTCTCAAGAAGACCCCCCGTGAAATTGAATTCGTAG
Cerianthus        ACGAGTGCTTGACTGTCTTAAGAAAAAACCCAGTGAAATTGAATTCGTAG

[                          260        270        280        290        300]

Discosoma_num     TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Discosoma_neg     TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Amplexidiscus     TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Rhodactis         TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Metarhodactis     TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Actinotryx        TGAAGATGCTACATTCAAATTGTTAGACGAAAAGTCCCCATGGAACTTTA
Ricordea          TATTGATGCTACATCAAATTTGTTAGACGAGAAGTCCCCATGGAACTTTA
Corynactis_v      TGATGATGCTACATAAAAATTGTTGGACGAGAAGTCCCCATGAAACTTTA
Corynactis_c      TGATGATGCTACATAAAAATTGTTGGACGAGAAGTCCCCATGAAACTTTA
Corallimorphus    TGATGATGCTACATAAAAATTGTTGGACGAGAAGTCCCCATGAAACTTTA
Balanophyllia     TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Dendrophyllia     TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Tubastrea         TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Enallopsammia     TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Porites           TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Flabellum         TGAAGATGCTACATCCAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Fungiacyathus     TGAAGATGCTACATCCA-ATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Pavona            TGAAGATGCTACATCTAAATTGTTAGACAAGAAGTCCCCATGGAACTTTA
Caryophyllia      TGAAGATGCTACATTAAAATGGTTAGACGAGAAGTCCCCATGGAGCTTTA
Catalaphyllia     TGAAGATGCTACATTAAAATTGTAAGACGAGAAGTCCCCATGGAGCTTTA
Oculina           TGAAGATGCTACATTAAAATTGTAAGACGAGAAGTCCCCATGGAGCTTTA
Lobophyllia       TGAAGATGCTACATTAAAATTGTAAGACGAGAAGTCCCCATGGAACTTTA
Fungia            TGAAGATGCTACATTATAATTGTAAGACGAGAAGTCCCCATGGAGCTTTA
Montastrea        TTAAGATGCAACG-CGAAAAAGTAAGCCGAGAAGTCACCATGTAGCTTTA
Anthopleura       TGAAGATGCTACGTCCATATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Aiptasia          TGAAGATGCTACGTCCATATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Bathyphellia      TGAAGATGCTACGTCCATATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Metridium         TGAAGATGCTACGTCCATATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Stichodactyla     TGAAGATGCTACGTCCATATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Nematostella      TGAAGATGCTACGTCCAAATTGTAAGACGAAAAGACCCCATTGAGCTTTA
Cerianthus        TTAAGATGCTACG-TAATTTTGTAAGACGAAAAGACCCTATTAAGCTTTA
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```
[                                   310       320       330       340       350]

Discosoma_num     CTGGAGACTTATGTGG-------------------------TCTATCTG-
Discosoma_neg     CTGGAGACTTATGTGG-------------------------TCTATCTG-
Amplexidiscus     CTGGAGACTTATGTGG-------------------------TCTATCTG-
Rhodactis         CTGGAGACTTATGTGG-------------------------TCTATCTG-
Metarhodactis     CTGGAGACTTATGTGG-------------------------TCTATCTG-
Actinotryx        CTGGAGACTTATGTGG-------------------------TCTATCTG-
Ricordea          CTGGAGATTTATATGG-------------------------CCTATCTG-
Corynactis_v      CTGGAGACTTATGTGGCTTGTGCTGACTGATCGAACTAGGCTCAATCAGT
Corynactis_c      CTGGAGACTTATGTGGCTTGTGCTGACTGATCGAACTAGGCTCAATCAGT
Corallimorphus    CTGGAGACTTATAAGGCTTGTGCTGACTGATCGAACTAGGCTCAATCAGT
Balanophyllia     CTGGAAACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Dendrophyllia     CTGGAAACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Tubastrea         CTGGAAACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Enallopsammia     CTGGAAACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Porites           CTGGAAACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Flabellum         CTGGAGACTTATGTGGCTT----AAATTAATT---------TATTTCTT-
Fungiacyathus     CTGGAGACTTATGAGGCTT----AAATTAATT---------TATTTCTT-
Pavona            CTGGAGACTTATGTG-CT-----CCCTTAATTG--------GCTGACTT-
Caryophyllia      CTGAAAGCCTAAAAGACT-----CCCTTAATTG--------AATTTTTT-
Catalaphyllia     CTGAGGGCTTAGAAGACT-----CCCTTAATTG--------ATTTTATA-
Oculina           CTGAAAGCTTAAGAGACT-----CCCTTAATTG--------ATTTTCTA-
Lobophyllia       CTGAGGGCTTAGGGGGCT-----CCGTTAATTG---------TTTTCTA-
Fungia            CTGAAAACTTAAGAGGCT-----CCGTTAATTG--------ATTTTCTA-
Montastrea        CTAGAAATTTGAGAGACT-----CCGTTAATTG--------GTTTTCTA-
Anthopleura       CTAAAGACTTGTATGGC--------CGA-------------AATAACTT-
Aiptasia          CTAAAGACTTGCATGGC------------------------TCAAAATA-
Bathyphellia      CTAAAGACTTGCATGGC------------------------TCAAAATA-
Metridium         CTAAAGACTTGCATGGC------------------------TCAAAATA-
Stichodactyla     CTAAAGACTTGCATGGC------------------------TCAAAATA-
Nematostella      CTAGAAACTTGCATGGCTT----AA----------------ATTAACTT-
Cerianthus        CTGGATGCTTATGTTGTCT----TAATAAATAGATATAATGAATGGTTAA

[                                   360       370       380       390       400]

Discosoma_num     -----------ACGAATAGATAGTTTAGATTATGTGGTGTTAACTGTT--
Discosoma_neg     -----------ACGAATAGATAGTTTAGATTAGGTGGTGTTAACTGTT--
Amplexidiscus     -----------ACGAATAGATAGTTTAGATTATGTGGTGTTAACTGTT--
Rhodactis         -----------ACGAATAGATAGTTTAGATTATGTGGTGTTAACTGTT--
Metarhodactis     -----------ACGAATAGATAGTTTAGATTAGGTGGTGTTAACTGTT--
Actinotryx        -----------ACGAATAGATAGTTTAGATTATGTGGTGTTAACTGTT--
Ricordea          -----------ACAGATAAATTGTTTAGATTATGTGGTGTTAACTGTTTT
Corynactis_v      GAAAGCATCTAACAAATAAATAGCTTAGACTATGTGGTGTTAACCGTTTT
Corynactis_c      GAAAGCATCTAACAAATAAATAGCTTAGACTATGTGGTGTTAACCGTTTT
Corallimorphus    GAAAGCATCTAACAAATAAATAGCTTAGACTATGTGGTGTTAACCGTTTT
Balanophyllia     -----------ACAAATAAATAG-TTTTTAAATGTGGTGTTAACCTCT--
Dendrophyllia     -----------ACAAATAAATAG-TTTTTAAATGTGGTGTTAACCTCT--
Tubastrea         -----------ACAAATAAATAG-TTTTTAAATGTGGTGTTAACCTCT--
Enallopsammia     -----------ACAAATAAATAGTTTTTTAAATGTGGTGTTAACCCCT--
Porites           -----------ACAAATAAGTAG-TTTTAAAATGTGGTGTTAACCTCT--
Flabellum         -----------ACAAATAAATAG-TTTTAAAATGTGGTGTTAACCCCT--
Fungiacyathus     -----------ACAAATAAATAG-TTTTAAAATGTGGTGTTAACCTCT--
Pavona            -----------------AAATAG-TTTTAAAATGTGGTGTGACTCAAC--
Caryophyllia      ----------------------------------------TATTTATT--
Catalaphyllia     --------------------------------------------------
Oculina           --------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        -------------------------------------TGTCGTCAGCT--
Anthopleura       -------------AAATAAAAAGTTTAGATAATGTGG---GATCCGTT--
Aiptasia          ----ATTTGATTTAAATAAAAAGTTTAGATAATGTGG---GACCCGTT--
Bathyphellia      ----ATTTGATTTAAATAAAGAGTTTAGATAATGTGG---GATCCGTT--
Metridium         ----ATTTGATTTAAATAAAAAGTTTAGATAATGTGG---GACCCGTT--
Stichodactyla     ----ATTTGATTTAAATAAAGAGTTTAGATAATGTGG---GATCCGTT--
Nematostella      -------------AAATAAAAAGTTTAGATAA---GGTGGGATCCGTT--
Cerianthus        TGCATATTAAATAAGATAATTAATATAGTTAATAAAGAAGAAATAGTA--
```

```
[                          410       420       430       440       450]

Discosoma_num     --------------------------------------------------
Discosoma_neg     --------------------------------------------------
Amplexidiscus     --------------------------------------------------
Rhodactis         --------------------------------------------------
Metarhodactis     --------------------------------------------------
Actinotryx        --------------------------------------------------
Ricordea          AAGTGAAAAAATATATAGGTGTTCTTAGAGTAGTCTTCAGACTAAAGTAA
Corynactis_v      ATTTAAAACTTTAGGGAGTAGTGTTTAGAGTAGTCTTCAGACTAAAGTAA
Corynactis_c      ATTTAAAACTTTAGGGAGTAGTGTTTAGAGTAGTCTTCAGACTAAAGTAA
Corallimorphus    ATTTAAAACTTTAGGGAGTAGTGCTTAGAGTAGTCTTCAGACTAAAGTAA
Balanophyllia     -------------------TGGATTAAC----------------------
Dendrophyllia     -------------------TGGATTAAC----------------------
Tubastrea         -------------------TGGATTAAC----------------------
Enallopsammia     -------------------TGGATTAAC----------------------
Porites           -------------------TGGATTAAT----------------------
Flabellum         -------------------CGGATTAAC----------------------
Fungiacyathus     -------------------CGGATTACC----------------------
Pavona            -------------------CGGGTAG------------------------
Caryophyllia      -------------------CGGGTAG------------------------
Catalaphyllia     -------------------CGGGTAG------------------------
Oculina           -------------------CGGGTAG------------------------
Lobophyllia       -------------------CGGGTAG------------------------
Fungia            -------------------CGGGTAG------------------------
Montastrea        -------------------CGTGTAGTG----------------------
Anthopleura       --------------------------------------------------
Aiptasia          --------------------------------------------------
Bathyphellia      --------------------------------------------------
Metridium         --------------------------------------------------
Stichodactyla     --------------------------------------------------
Nematostella      --------------------------------------------------
Cerianthus        -------------------ATATTCTTA----------------------

[                          460       470       480       490       500]

Discosoma_num     -----------------------------------------------GTT
Discosoma_neg     -----------------------------------------------GTT
Amplexidiscus     -----------------------------------------------GTT
Rhodactis         -----------------------------------------------GTT
Metarhodactis     -----------------------------------------------GTT
Actinotryx        -----------------------------------------------GTT
Ricordea          AAAACACATGTAT------------------------GAAAATTTTAGTT
Corynactis_v      AAAACACATATGTTTTTTTTACA---CCCGCCTCTTTCAAAATTTAGGTT
Corynactis_c      AAAACACATATGTTTTTTTTACAGACCCGGCCTCTTTCAAAATTTAGGTT
Corallimorphus    AAAACACATGTATATTTTTTAGAGACCCGGCCTCTTTCAAAATTTTGGTT
Balanophyllia     -------------------------------------------GAGGGTT
Dendrophyllia     -------------------------------------------GAGGGTT
Tubastrea         -------------------------------------------GAGGGTT
Enallopsammia     -------------------------------------------GAGGGTT
Porites           -------------------------------------------TGGGGTT
Flabellum         -------------------------------------------TAGGGTT
Fungiacyathus     -------------------------------------------TAGGGTT
Pavona            -------------------------------------------TAGGGTT
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Oculina           --------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        -----------------------------------------------GTT
Anthopleura       --------------------------------------------TTGGTT
Aiptasia          -------------------------------------------TCCGGTT
Bathyphellia      -------------------------------------------TTCGGTT
Metridium         -------------------------------------------TCCGGTT
Stichodactyla     -------------------------------------------TCCGGTT
Nematostella      --------------------------------------------AAGGCT
Cerianthus        -------------------------------------------TTCAGTA
```

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[                         510       520       530       540       550]

Discosoma_num     AGTAAAATTCA-CTCTTTTATTTTAAGAG---GGCTAACTCTTCTTTTGA
Discosoma_neg     AGTAAAATTCA-CTCTTTTATTTTAAGAG---GGCTAACTCTTCTTTTGA
Amplexidiscus     AGTAAAATTCA-CTCTTTTATTTTAAGAG---GGCTGACTCTTCTTTTGA
Rhodactis         AGTAAAATTCA-CTCTTTTATTTTAAGAG---GGCTGACTCTTCTTTTGA
Metarhodactis     AGTAAAATTCA-CTCTTTTATTTTAAGAG---GGCTAACTCTTCTTTTGA
Actinotryx        AGTAAAATTCA-CTCTTTTATTTTAAGAG---GACTAACTCTTCTTTTGA
Ricordea          AGTAAAACTCA-CTTTTTTATTTTTAGAG---GGTTAACTCTTCTTTTGA
Corynactis_v      AGTCAAACTCA--TCTTTTATTTTAAGAA---AGCTAACTCTTCTTTTGA
Corynactis_c      AGTCAAACTCA-CTCTTTTATTTTAAGAA---AGCTAACTCTTCTTTTGA
Corallimorphus    AGTCAAACTCA-CTCTTTTATTTTAAGAA---AGCTAACTCTTCTTTTGA
Balanophyllia     AGAAAAGCTCA-CTCTTTTATTTTAAGAA---AGCCAACTCAAAATTTTA
Dendrophyllia     AGAAAAGCTCA-CTCTTTTATTTTAAGAA---AGCCAACTCAAAATTTTA
Tubastrea         AGAAAAGCTCA-CTCTTTTATTTTAAGAA---AGCCAACTCAAAATTTTA
Enallopsammia     AGAAAAGCTCA-CTCTTTTATTTTAAGAA---AGCCAACTCAAAATTTTA
Porites           AGAAAAGCTCA-CTCTTTTATTTTAAGAA---AGCCAACTCAAAAACTTA
Flabellum         ATAAAGGCCCA-CTCTTTTATTTAAAGAA---AGCCAACTCAAAACTTTA
Fungiacyathus     AGAAAAGCTCA-CTCTTTTATTTAAAGAA---AGCCAACTCAAAGAATTA
Pavona            AGAAAAGCTCA-CT-TTTTATTTTAAGAA---AGGCAACTTAAAAATATA
Caryophyllia      ---------------------------------GGCAACGCAACCCACGT
Catalaphyllia     ---------------------------------GGCAACGCAACCCACGT
Oculina           ---------------------------------GGCAACGCAACCCACGT
Lobophyllia       ---------------------------------GGCAACGCAACCCACGT
Fungia            ---------------------------------GGCAACGCAACCCACGT
Montastrea        AGAAAAGCTCA-TGC-----------------AGGGAACGCAACCCACGT
Anthopleura       AATGAAACACCACTCTTTTATTTTAAGAG---AGCTAACCTTGT------
Aiptasia          AATGAAACACCACTCTTTTATTTTAAGAG---AGCTAACATTAC------
Bathyphellia      AATGAAACACCACTCTTTTATTTTAAGAG---AGCTAACATTAC------
Metridium         AATGAAACACCACTCTTTTATTTTAAGAG---AGCTAACATTAC------
Stichodactyla     AATGAAACACCACTCTTTTATTTTAAAAG---AGCTAACATTGC------
Nematostella      AATGAAACACCACTCTTTTATTTTAAGAG---AGCTAAC-CTTT------
Cerianthus        TATTTAATCCT-TTATATCAATATAAATGAAAGACTATTTCTCCAC----

[                         560       570       580       590       600]

Discosoma_num     GTAAAGTTA-ATT-GTGGGG--TACC--ACCAC-TT---G-AGT-GT-AA
Discosoma_neg     GTAAAGTTA-ATT-GTGG----TACC--ACCAC-TT---G-AGT-GT-AA
Amplexidiscus     ATAAAGTTA--TT-CTGG----TACC--ACCAC-TT---G--GT-GT-AA
Rhodactis         ATAAAGTTA--TT-CTG-----TACC--ACCAC-TT---G--GT-GT-AA
Metarhodactis     ATAAAGTTAGATT-CTGGG---TACCC-ACCAC-TTTTAG-AGT-GT-AA
Actinotryx        GTAAAGTTAGATTGCTG-----TACCC-ACCAC-TT--AG-A---GT-AA
Ricordea          ATTAAGTTCGATTGGTGGGGGGTACC--ACC-C-TTTT-GGAG--GTGAA
Corynactis_v      ATTAAGTTCGATTGGTGGGGGGTACCCCACCACATTTTAGGAGTGGTGAA
Corynactis_c      ATTAAGTTCGATTGGTGGGGGGTACCCCACCACATTTTAGGAGTGGTGAA
Corallimorphus    ATTAAGTTCGATTGGTGGGGGGTACCCCACCACATTTTAGGAGTGGTGAA
Balanophyllia     T-------------------------------------------------
Dendrophyllia     T-------------------------------------------------
Tubastrea         T-------------------------------------------------
Enallopsammia     T-------------------------------------------------
Porites           T-------------------------------------------------
Flabellum         T-------------------------------------------------
Fungiacyathus     T-------------------------------------------------
Pavona            T-------------------------------------------------
Caryophyllia      TT------------------------------------------------
Catalaphyllia     --------------------------------------------------
Oculina           T-------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        T-------------------------------------------------
Anthopleura       --------------------------------------------------
Aiptasia          --------------------------------------------------
Bathyphellia      --------------------------------------------------
Metridium         --------------------------------------------------
Stichodactyla     --------------------------------------------------
Nematostella      --------------------------------------------------
Cerianthus        --------------------------------------------------
```

```
[                          610       620       630       640       650]

Discosoma_num      TT---GGATTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Discosoma_neg      TT---GGATTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Amplexidiscus      TT---GGGTTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Rhodactis          TT---GGGTTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Metarhodactis      TTTCTGGGTTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Actinotryx         TT-C-GGATTAGAGAAATGAGGTAAGTTAGACAGTTTGGTTGGGGCGATC
Ricordea           --TCTGGGTTAGAGAAATGAGGTAAGTTAGAAAATTTGGTAGGGGCGATC
Corynactis_v       TTTCTGGGTTAGAGAAATGGGGTAAGTTAGACAGTTTGGTAGGGGCGATC
Corynactis_c       TTTCTGGGTTAGAGAAATGGGGTAAGTTAGACAGTTTGGTAGGGGCGATC
Corallimorphus     TTTCTGGGTTAGAGAAATGGGGTAAGTTAGACAGTTTGGTAGGGGCGATC
Balanophyllia      -------GTCTTTGGGATTTGATAAGTGGGACAGTTTGGTTGGGGCGACC
Dendrophyllia      -------GTCTTTGGGATTAGATAAGTGGGACAGTTTGGTTGGGGCGACC
Tubastrea          -------GTCTTTGGGATTAGATAAGTGGGACAGTTTGGTTGGGGCGACC
Enallopsammia      -------GTCTTTGGGATTTGATAAGTGGGACAGTTTGGTTGGGGCGACC
Porites            -------GTCTTTGGGATTGGATAAGTGGGACAGTTTGGTTGGGGCGACC
Flabellum          -------GTCTTTGGGATTTGATAAGTGGGACAGTTTGGTTGGGGCGACC
Fungiacyathus      -------GTCTTTGGGATTTGATAAGTGGGACAGTTTGGTTGGGGCGACC
Pavona             -------GTTTTTGGGATTGGATAAGTGAGACAGTTTGGTTGGGGCGACC
Caryophyllia       ------------TTGCAAGCAATAGGCTAGACAGTTTTGTTGGGGTGATA
Catalaphyllia      ------------TTGCCAGCTTTAAGCGGGACAGTTTTGTTGGGGCGACA
Oculina            ---------TAGTTGCAAGCTTTAAGCGGGACAGTTTTGTTGGGGCGACA
Lobophyllia        ---------CCGTTGCCAGCATTAAGCGGGACAGTTTTGTTGGGGCGACA
Fungia             ------------TTGCAAGCTTTAAGTAGGACAGTTTTGTTGGGGCGACA
Montastrea         -------TTTAGTTGCCAGCATTCAGTTGGACAGTTTTGT---GGCGACA
Anthopleura        ------------AGGGAGAATGCAAGTTGGATAGTTTGGTTGGGGCGACC
Aiptasia           ------------AGGGATAGTGTAAGTTGGATAGTTTGGTTGGGGCGACC
Bathyphellia       ------------AGGGATAGTGTAAGTTGGATAGTTTGGTTGGGGCGACC
Metridium          ------------AGGGATAGTGTAAGTTGGATAGTTTGGTTGGGGCGACC
Stichodactyla      ------------ATGGATAATGTAAGTTGGATAGTTTGGTTGGGGCGACC
Nematostella       ------------AGGGACAATGCGAGTTTGATAGTTTGGTTGGGGCGACC
Cerianthus         -------TTAAGAATGGATTAGTATGTTAGACAGTTTGGTTGGGGCGACC

[                          660       670       680       690       700]

Discosoma_num      GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Discosoma_neg      GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Amplexidiscus      GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Rhodactis          GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Metarhodactis      GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Actinotryx         GCCTTTTAAAAAGTAACGAAGGTGGGCTTAAGATACATATTTAATAGTT-
Ricordea           GCCTTTTAAAAAG-AACGAAGGTGG-CGTAAGATACATATTTAATAGCT-
Corynactis_v       GCCTTTTAAAAAGTAACGAAGGTGAGCGTAAGATACATATTTAATAGCT-
Corynactis_c       GCCTTTTAAAAAGTAACGAAGGTGAGCGTAAGATACATATTTAATAGCT-
Corallimorphus     GCCTTTTAAAAAGTAACGAAGGTGAGCGTAAGATACATATTTAATAGCT-
Balanophyllia      GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATATATCTTTAGT-----
Dendrophyllia      GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATATATCATTAGT-----
Tubastrea          GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATATATCATTAGT-----
Enallopsammia      GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATAACTCTTTAGT-----
Porites            GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATATATCTTTAGT-----
Flabellum          GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATACATAATTAGT-----
Fungiacyathus      GCCTTTAAAAAAGTAACGAAGGCGGGCTTAAGATACATATTTAGT-----
Pavona             GCCTTTAAAAAAGTAACGAAGGCGGACTTAAGATGTATGATTAGT-----
Caryophyllia       GTTTTTTAAAAAGTAACGAAAACGAACTATGAA----TCATTAGT-----
Catalaphyllia      GTTTTTTAAAAAGTAACAAAAACGAACTATGGA----TCATTAGT-----
Oculina            GTTTTTTAAAAAGTAACGAAAACGAACTATGG-----TCATTAGT-----
Lobophyllia        GTTTTTTAAAAAGTAACAAAAACGAACTATGG-----TCATTAGT-----
Fungia             GTTTTTTAAAAAGTAACGAAAATGAACTATGGTAA--TCATTAGT-----
Montastrea         GCCTTTTAAAA---ACCGGAGGTAGGCTTTGACGACGTCAATAGT-----
Anthopleura        ACCTTTTAAAAGGTAACGAAGGTGAGCTTAAGGTCCGTAGTTAATAGCTA
Aiptasia           ACCTTTTAAAAGGTAACGAAGGTGAGCTTAAGGTCCGTAGTTAATAGCCG
Bathyphellia       ACCTTTTAAAAGGTAACGAAGGTGAGCTTAAGGTCCGTAGTTAATAGCCG
Metridium          ACCTTTTAAAAGGTAACGAAGGTGAGCTTAAGGTCCGTAGTTAATAGCCG
Stichodactyla      ACCTTTTAAAAGGTAACGAAGGTGAGCTTAAGGTCCGTAGTTAATAGCCG
Nematostella       ACCTTTTAAAAGGTAACGAAGGCGAGCTTAAGGTCCGTAGTTAATAACAA
Cerianthus         CCCTTAAAAAGGATAACTGAGGGGCACTAAGGTAATAAAGAAAGA-----
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```
[                             710       720       730       740       750]

Discosoma_num     GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAGAAAAAGCC-T
Discosoma_neg     GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAGAAAAAGCC-T
Amplexidiscus     GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAAAAAGAGCC-T
Rhodactis         GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAAAAAAAGCC-T
Metarhodactis     GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAAAAAGAGCC-T
Actinotryx        GTCGTCTGACTGTGAAGGGGGAGCCCTGAGCAGACACTAAAAAGAGCC-T
Ricordea          GTCGTCTGACTGTGAAGGGGGGGCCCTGAGCAGACACTAAAAACAGCC-T
Corynactis_v      GTCGTCTGACTGTGAAGGGGGGGCCCTGAGCAGACACTAAAAACCGCC-T
Corynactis_c      GTCGTCTGACTGTGAAGGGGGGGCCCTGAGCAGACACTAAAAACCGCC-T
Corallimorphus    GTCGTCTGACTGTGAAGGGGGGGCCCTGAGCAGACACTAAAAACCGCC-T
Balanophyllia     TATGTCATACTGCCAAGGGGGAATCCTGAGCAGGCACTT-------ACTT
Dendrophyllia     TATGTCATACTGCCAAGGGGGAATCCTGAGCAGGCACTT-------ACTT
Tubastrea         TATGTCATACTGCCAAGGGGGAATCCTGAGCAGGCACTT-------ACTT
Enallopsammia     TATGTCATACTGCCAAGGGGGGATCCTGAGCAGACACTT-------ACTT
Porites           TATGTCATACTGCGAAGGGGGAATCCTGAGCAGGCACTT--------ATT
Flabellum         GATGTCATACTGCCAAGGGGAGATCCTGAGCAGACACTT-------ACTT
Fungiacyathus     GATGTCATACTGCCAAGGGGAGATCCTGAGCAGACACTT-------CTTT
Pavona            TATGTCATACTGCTAAGGGGAGACCCAGAGCAGACACTT------GTCTT
Caryophyllia      --TGTCATAGTGCGCATGTTTCACTCTGA----AAACTTGAAGAGACATT
Catalaphyllia     --TGTCATACTTAGC----TTCACCCTGAAAA-ATTTTTTAAGGGACA-T
Oculina           --TGTCAT-CGGAGC----TTCACCCTGAAAA-ATTTTTTAAGGGACA-T
Lobophyllia       --TGTCAT-CGTAGC----TTCACCCTGAAAA-ACTTTTTAAGGGACA-T
Fungia            --TGTCATAAGGC------TTCACTCTGA-AAGATTTTTTAAGAGACATT
Montastrea        ---GTCATCATGCCCC--TTACGCCTTGAGCT-ACTTTCTAAGGGACATT
Anthopleura       GTGGCCTGACTGCAACGGGGACATCCCGAGCAGACACTGGTAATCTCT--
Aiptasia          GTGGCCTGACTGCAAGGGGGACGTCTCGAGCAGACACGT-------CCTT
Bathyphellia      GTGGCCTGACTGCAAGGGGGACGTCTCGAGCAGACACGT-------CCTT
Metridium         GTGGCCTGACTGCAAGGGGGACGTCTCGAGCAGACACGT-------CCTT
Stichodactyla     GTGGCCTGACTGCAAGGGGGACGTCTCGAGCAGACACGT-------CCTT
Nematostella      GTGGCCTGACTGAGA-GGGGACACCCCGAACAGACACTG----------A
Cerianthus        ---GCTTGACTGTAAG--AGGGCCCTCAAACAGACACGA-----------

[                             760       770       780       790       800]

Discosoma_num     TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAAGA
Discosoma_neg     TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAAGA
Amplexidiscus     TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAATA
Rhodactis         TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAATA
Metarhodactis     TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAAGA
Actinotryx        TGTGCGGGTAATGGTGGGTTGCAGTGACCCGTTA-ATTTAAGGTGAAATA
Ricordea          TGTGCGGGTAATAGTG-GTTGCAGTGACCCGTTT--TTTAAGGTGAAATA
Corynactis_v      TGTGCGGGGAATAGTGGGTTGCAGTGACCCGTTG-ATTTAAGGTGAAATA
Corynactis_c      TGTGCGGGGAATAGTGGGTTGCAGTGACCCGTTG-ATTTAAGGTGAAATA
Corallimorphus    TGTGCGGGGAATAGTGGGTTGCAGTGACCCGTTG-ATTTAAGGTGAAATA
Balanophyllia     TTT--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Dendrophyllia     TTT--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Tubastrea         TTT--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Enallopsammia     TTT--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Porites           TTT--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Flabellum         TTT--------AGGTGGGTTTAAGTGACCCGTTG-ATTTAGGGTGAAATA
Fungiacyathus     TTG--------AGGTGGGTTTAAGTGACCCGTTA-ATTTAGGGTGAAATA
Pavona            TGGA-------TGGTGGGTTTAAGTGACCCGTTA-GCTCAGAGTGAAAGG
Caryophyllia      TGG---------GGTGTGTTTTA-TGATCTATTG--TTTTGAATGCAAAA
Catalaphyllia     TTT--------TGGTGTGTTTTA-TGATCCGTTG--TTTGGAATGAAAAA
Oculina           CTT--------TGGTGTGTTTTA-CGATCCGTTG--TTTGGAATGAAAAA
Lobophyllia       TTT--------TGGTGTGTTTTA-TGAACCGTTG--TTTGGAATGAAAAA
Fungia            TTT--------TAGTGTGTTTTA-TGATCCGTTG--TTTGGAATGAAAAA
Montastrea        TTTT---------GTGTGCTACAATGCTACGGAGATTGTGTAGTGAAAAT
Anthopleura       -----------CAGTGGGTTATAGTGACCCGTCA-TCTTAGAGTGGAATA
Aiptasia          AGGG-------ATGTGGACTATAGTGACCCGTCA-TCTTAGTGTGGAATA
Bathyphellia      AGGG-------ATGTGGACTATAGTGACCCGTCA----------------
Metridium         AGGG-------ATGTGGACTATAGTGACCCGTCA-TCTTAGTGTGGAATA
Stichodactyla     AGGG-------ATGTGGGCTATAGTGACCCGTCA-TCTTAGTGTGGAATA
Nematostella      TGTTC-------AGTGGGTCATAATGACCCGTCTGTTTTAGAGTGTAATA
Cerianthus        -----------AAGTGGGTAAAT-TGACCCGTTA--ATAAAAGTGGGATT
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[                           810       820       830       840       850]

Discosoma_num     GTTAACGATAAACAAATAAAAGTTACTCTGGGGATAACAGCGCAATAACG
Discosoma_neg     GTTAACGATAAACAAATAAAAGTTACTCTGGGGATAACAGCGCAATAACG
Amplexidiscus     GTTAACGATAAACAAATAAAAGTTACCCTGGGGATAACAGCGCAATAGCG
Rhodactis         GTTAACGATAAACAAATAAAAGTTACCCTGGGGATAACAGCGCAATAGCG
Metarhodactis     GTTAACGATAAACAAATAAAAGTTACCCTGGGGATAACAGCGCAATAACG
Actinotryx        GTTAACGATAAACAAATAAAAGTTACCCTGGGGATAACAGCGCAATAACG
Ricordea          GTTAACGATAAACAAATAAAAGTTACCCTGGGGATAACAGCGCAAT-GCG
Corynactis_v      GTTAACGATAAACAAATAAAAGTTACTCTGGGGATAACAGCGCAATAACG
Corynactis_c      GTTAACGATAAACAAATAAAAGTTACTCTGGGGATAACAGCGCAATAACG
Corallimorphus    GTTAACGATAAACAAATAAAAGTTACTCTGGGGATAACAGCGCAATAACG
Balanophyllia     GTTAACGATAAGCAAATAAG------------------------------
Dendrophyllia     GTTAACGATAAGCCAATAAA-GTTACCCTGGGGAT---------------
Tubastrea         GTTAACGATAAGCAAATAAAAGTTACCCTGGGGAT---------------
Enallopsammia     GTTAACGATAA-CAAATAAAAGTTACCCTGGGGATAA-------ATAACG
Porites           GTTAACGATAAACAAATAAAAGTTACCCTGGGGAT---------------
Flabellum         GTTAACGATAAAC-AATTAAAGTTACCCTGGGGAT---------------
Fungiacyathus     GTTAAACGATAACAGATCAAAGTTACCCTG--------------------
Pavona            GTTAACGATAAACAAATAAAAGTTACCCTGGGGAT---------------
Caryophyllia      GATAATG-AAAGCAGATCCCAGTTACCCTGGGGAT---------------
Catalaphyllia     AACAACG-AAAACAAATAAAAGTTACCCTGGGGAT---------------
Oculina           AATAACG-AAAACAAATAAAAGTTACCCTGGGGAT---------------
Lobophyllia       AATAACG-AAAACAAATAAAAGTTACCCTGGGGAT---------------
Fungia            AATAACG-AAAACAAATAAAAGTTACCCTGGGGAT---------------
Montastrea        AATAACG-AAAGCTAATATCGGTTACCGTGG---------CGT-------
Anthopleura       GTTGGCGATCAACGAATAAAAGCTACCATGGGGATAACAGCGTTATATCG
Aiptasia          GTTGACGATCAACGAATAAAAGCTACCATGGGGATAACAGCGTTATATCG
Bathyphellia      ------------------------TC------------------------
Metridium         GTTGACGATCAACGAATAAAAGCTACCATGGGGA----------------
Stichodactyla     GTTGACGATCAACGAATAAAAGCTACCATGGGGATAACAGCGTTATATCG
Nematostella      GGCGACGATCAACGGATAAAAGCTACCATGGGGATAACAGCGTTATATCG
Cerianthus        GTTAACGATAAACAAATAAAAGTTACTATAGGGATAACAGCGTAATATTG

[                           860       870       880       890       900]

Discosoma_num     TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Discosoma_neg     TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Amplexidiscus     TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Rhodactis         TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Metarhodactis     TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Actinotryx        TTTGAGGGGTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Ricordea          T-AGAGGGTTT--C------------------------------------
Corynactis_v      TTAGAGGGTTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Corynactis_c      TTAGAGGGTTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Corallimorphus    TTAGAGGGTTTTTCTTGATGACGATGTTTGCGACCTCGATGTTGAATTGC
Balanophyllia     --------------------------------------------------
Dendrophyllia     --------------------------------------------------
Tubastrea         --------------------------------------------------
Enallopsammia     TTTGAGAG------------GCGATG---------TCGATGTTGA----C
Porites           --------------------------------------------------
Flabellum         --------------------------------------------------
Fungiacyathus     --------------------------------------------------
Pavona            --------------------------------------------------
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Oculina           --------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        ---------------------CGTAGGCTGCAACT--------------C
Anthopleura       TTAGAGAG-CTTTATCGACGACGATGTTTGCGACCTCGATGTTGAATTGC
Aiptasia          TTAGAGAGTTTTCATCGACGACGATGTTTGCGACCTCGATGTTGAATTGC
Bathyphellia      --------------------------------------------------
Metridium         --------------------------------------------------
Stichodactyla     TTAGAGAG-TTTCATCGACGACGATGTTTGCGACCTCGATGTTGAATTGC
Nematostella      TTAGAGAG-TTTAATCGACAACGATGTTTGCGA-----------------
Cerianthus        TTAGAGAGTTCACATTAACAACAATGTTTGCGACCTCGATGTTGAATTGC
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[                          910       920       930       940       950]

Discosoma_num     GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Discosoma_neg     GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Amplexidiscus     GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Rhodactis         GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Metarhodactis     GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Actinotryx        GGCATCCTG-GGGTGCAGTCGCTCCCAAGGGTGGGTCTGTTCGTCCATTA
Ricordea          --------------------------------------------------
Corynactis_v      GGCATCCTG-GGGTGCAGTCGCCCCCAAGGGTGGGTCTGTTCGTCCCTTA
Corynactis_c      GGCATCCTG-GGGTGCAGTCGCCCCCAAGGGTGGGTCTGTTCGTCCCTTA
Corallimorphus    GGCATCCTG-GGGTGCAGTCGCCCCCAAGGGTGGGTCTGTTCGTCCCTTA
Balanophyllia     --------------------------------------------------
Dendrophyllia     --------------------------------------------------
Tubastrea         --------------------------------------------------
Enallopsammia     GGCATCCTG-GGGTGC----------------------------------
Porites           --------------------------------------------------
Flabellum         --------------------------------------------------
Fungiacyathus     --------------------------------------------------
Pavona            --------------------------------------------------
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Oculina           --------------------------------------------------
Lobophyllia       --------------------------------------------------
Fungia            --------------------------------------------------
Montastrea        GCCTACGTGAAGGAG-----------------------GATCGT------
Anthopleura       GGCACCCTG-GGGTGCAGCCGCCCCCAAGGGTTGGTCTGTTCGACCTTTA
Aiptasia          GGCACCCTG-GGGTGCAGCCGCCCCCCAGGGTTGGTCTGTTCGACCTTTA
Bathyphellia      --------------------------------------------------
Metridium         --------------------------------------------------
Stichodactyla     GGCACCCTG-GGGTGCAGCCGCCCCCAAGGGTTGGTCTGTTCGACCTTTA
Nematostella      --------------------------------------------------
Cerianthus        GGCATCCTGAGGGTGCAGAAGCTCTTAAAGGTTAGTCTGTTCGACTATGA

[                          960       970       980  ]

Discosoma_num     AAGCCTTACATGATTTGATTT-------------
Discosoma_neg     AAGCCTTACATGATTTGATTTTTCATT---CGGT
Amplexidiscus     AAGCCTTACATGATTTGTTTTTATCTTCCGCGGT
Rhodactis         AAGCCTTACATGATTTGTTTTCCTTTTCC-CGAG
Metarhodactis     AAGCCTTACATGATTTGG-TTTCCTTT---CGGT
Actinotryx        AAGCCTTACATGA-TTGATTTCAATTTTC-GGTA
Ricordea          ----------------------------------
Corynactis_v      AAGCCTTACATGATTTGGGTTTCATTC-------
Corynactis_c      AAGCCTTACATGATTTGGGTTTCATTC---CGAT
Corallimorphus    AAGCCTTACATGATTTGGGTTTCATTC---CGAT
Balanophyllia     ----------------------------------
Dendrophyllia     ----------------------------------
Tubastrea         ----------------------------------
Enallopsammia     ----------------------------------
Porites           ----------------------------------
Flabellum         ----------------------------------
Fungiacyathus     ----------------------------------
Pavona            ----------------------------------
Caryophyllia      ----------------------------------
Catalaphyllia     ----------------------------------
Oculina           ----------------------------------
Lobophyllia       ----------------------------------
Fungia            ----------------------------------
Montastrea        ----------------------------------
Anthopleura       A---------------------------------
Aiptasia          AA--------------------------------
Bathyphellia      ----------------------------------
Metridium         ----------------------------------
Stichodactyla     AA--------------------------------
Nematostella      ----------------------------------
Cerianthus        AA--------------------------------
```

Appendix 3. Alignment of 28S rDNA sequences

```
[                         10        20        30        40        50]
Actinotryx        -----TATC-GGGA-G-AAGA--ACTAACAAGGATTACCTCAGTAACGGC
Amplexidiscus     ------AGCGGGAG----CAAGAACTAACACGGATTACCTCAGTAACGGC
Discosoma_neg     -----AAGCCGGAA-GAAGAAGAACTAAAAAGGATTACCTCAGTAACGGC
Discosoma_num     -----AAGCCGGAA-GAAGAAG-ACTAAAAAGGATTACCTCAGTAACGGC
Metarhodactis     -----AAGC-AGAG---ACGG--ACTAAACAGGATTACCTCAGTAACGGC
Rhodactis         -----AAGCCGGAG-GGAATG--ACTAAACAGGATTACCTCAGTAACGGC
Ricordea          ------AGC-GGCA-GGACGA--ACTAAC-AGGATTACCCCAGTAATGGC
Corynactis_v      -------AC-GGTA-GCAGA---ACTAAC-AGGATTACCCTAGTAATGGC
Corynactis_c      -------AC-GGTA-GCAGC----CTAACAAGGATTACCCTAGTAATGGC
Corallimorphus    -----CAACCGTAACGCAGAAGAACTAAC-AGGATTACCCTAGTAATGGC
Catalaphyllia     -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCTCAGTAACGGC
Caryophyllia      -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCTAGTAACGGC
Oculina           ------------------------CTAACAAGGATTACCCCAGTAACGGC
Fungia            -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Lobophyllia       -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCTCAGTAACGGC
Montastrea        ------------------------CTAACAAGGATTACCTCAGTAACGGC
Dendrophyllia     -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Tubastrea         -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Enallopsammia     -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Balanophyllia     -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Flabellum         -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCCCAGTAACGGC
Fungicyathus      -------TC-GGGG-GGAAGA--ACTAACAAGGATTACCCTAGTAACGGC
Porites           -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTACCTCAGTAACGGC
Pavona            ------------------------CTAACAAGGATTACCCCAGTAACGGC
Edwardsia         -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCCAGTAACGGC
Nematostella      -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCCAGTAACGGC
Anthopleura       -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCTAGTAATGGC
Stichodactyla     -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCTAGTAATGGC
Bathyphellia      -TAGTAAGC-GGAG----AAAGAACTAAC-AGGATTCCCCTAGTAATGGC
Aiptasia          TAAGTAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCTAGTAATGGC
Metridium         TAAGTAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCTAGTAATGGC
Cerianthus_28S    -TAATAAGC-GGAG-GAAAAGAAACTAACAAGGATTCCCCTAGTAACGGC

[                         60        70        80        90        100]
Actinotryx        GAGTGAAGCGGGAACGGCTCAAATTGGAAATCTCCGTTGC-TTGCAGC-A
Amplexidiscus     GAGTGAAGCGGGAACGGCTCA-ATTGGAAATCTCCGTTGCTTTGCAGC-A
Discosoma_neg     GAGTGAAGCGGGAACGGCTCAAATTGGAAAACTCCGTTGC-TTGCAGCCA
Discosoma_num     GAGTGAAGCGGGAACGGCTCAAATTGGAAAA--CTGTTGCTTTGGAGCCA
Metarhodactis     GAGCGAAGCGGGAACGGCTCAAATTGGAAA---CTGTTGCTCTGGAGC-C
Rhodactis         GAGCGAAGCGGGAACGGCTCAAATTGGAAA---CTGTTGCTCTGGAGC-C
Ricordea          GAGCGAAGCGGGAAGGGCTCAAATTGGAAAACTCCGTTGCTCTGCAGC-C
Corynactis_v      GAGCGAAGCGGGAAGAGCTCAAATTGGAAATCTCCGTTGCTTTGCAGCAA
Corynactis_c      GAGCGAAGCGGGAAGAGCTCAAATTGGAAATCTCCGTTGCTCTGCAGCAC
Corallimorphus    GAGCGAAGCGGGAAGAGCTCAAATTGGAAATCTCTGTCGCTCCGCGGCAA
Catalaphyllia     GAGTGAAGCGGGAAGAGCTCAAATTGGAAATCTCTGATGC-CTGCAGC-T
Caryophyllia      GAGTGAAGCGGGACCAGCTCAAATTGGAAATCTCTGATGC-CTGCAGC-T
Oculina           GAGTGAAGCGGGAACAGCTCAAATTGGAAATCTCTGGTGC-TTGCAGC-C
Fungia            GAGTGAAGCGGGATGAGCTCAAATTGGAAATCTCTGGTGC-TTGCAGC-C
Lobophyllia       GAGTGAAGCGGGAGGAGCTCAAATTGGAAATCTCCGATGC-TTGCAGC-T
Montastrea        GAGTGAAGCGGGAAGAGCTCAAATTGGAAATCTCCAATGC-CTGCAGC-T
Dendrophyllia     GAGTGAAGCGGGAATAGCTCAAATTTGAAATCTCCAACGC-TTGCGGC-T
Tubastrea         GAGTGAAGCGGGAATAGCTCAAATTGGAAATCTCCAACGC-TTGCGGC-T
Enallopsammia     GAGTGAAGCGGGAATAGCTCAAATTGGAAATCTCCAACGC-TTGCGGC-T
Balanophyllia     GAGTGAAGCGGGAATAGCTCAAATTGGAAATCTCCAACGC-TTGCGGC-T
Flabellum         GAGTGAAGCGGGAAGAGCTCAAATTGGAAATCTCCAACGC-TTGCGGC-T
Fungicyathus      GAGCGAAGCGGGAATAGCTCAAATTGGAAATCTCCAACGC-TTGCGGC-T
Porites           GAGTGAAGCGGGAATAGCTCAAATTTGAAATCTCCAACGC-TTGCGGC-T
Pavona            GAGTGAAGCGGGAAGAGCTCAAATTGGAAATCTCCAAGGC-CTGAAGC-T
Edwardsia         GAATGAAAC-GGAAGAGCTCAAATTTGAAATCGCCGTTGCCTTGCACC-A
Nematostella      GAATGAAAC-GGAAGAGCTCAAATTTGAAATCGCCGTTGCCTTGCAC--A
Anthopleura       GAATGAAGCGGGAACAGCTCAAATTTGAAATCTCCGTTGC-CGGC-----
Stichodactyla     GAATGAAGCGGGAACAGCTCAAATTTGAAATCTCCGTTGC-TTGGA----
Bathyphellia      GAATGAAGCGGGAAGAGCTCAAATTTAAAATCTGCGTTGC-GTGCG---A
Aiptasia          GAATGAAGCGGGAACAGCTCAAATTTGAAATCTCCGTTGC-TTGCAC--A
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Metridium        GAATGAAGCGGGAACAGCTCAAATTTAAAATCTCCGTTGC-TTGCAC--A
Cerianthus_28S   GAGTGAAGC-GGAACAGCTCAAACTTGAAATCTCCATTGCTTTGCG---A

[                         110       120       130       140       150]

Actinotryx       CGGCGAATTGTAATT-TCGAGAAGCGCTTTCTCGGCGGA-CCGGGCGCGC
Amplexidiscus    CGGCGAATTGTAATT-TCGAGAAGCGCGTTCTCGGCGGA-CCGGGCGCGC
Discosoma_neg    CGGCGAATTGTAATT-TCGAGAAGCGCGTTCTCGGCGGA-CCGGGCGCGC
Discosoma_num    CG-CGAATTGTAATTTTCGAGAAGCGCGTTCTCGGCGGA-CCGGGCGCGC
Metarhodactis    C--CGAATTGTAATTTTCGAAAAGCGCGTTCTCGGCGGA-----GCGCGC
Rhodactis        C--CGAATTGTAATTTTCGGAAAGCGCTTTCTCGGCGGA-----GCGCGC
Ricordea         CGGCGGATTGTAATTTTCGAGAAGCGCGTTCTCGGCGGA-TCGGACCCGC
Corynactis_v     CGGCGGATTGTAGTT-TCGAGAAGCACTTTCTCGGCGGA-TCGGACTTGC
Corynactis_c     CGGCGGATTGTAGTT-TCGAGAAGCACTTTCTCGGCGGA-TCGGACTTGC
Corallimorphus   CGGCGAATTGTAGTT-TCGAGAAGCACTTTCTCGGTGGA-TCGGACGCGC
Catalaphyllia    CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTAGGTGGA-TCGGCAGTGC
Caryophyllia     CGGCGAGTTGTAGTTTGCGAGAAGCAC-TTCTAGGTGGA-TCGGTCGTGC
Oculina          CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTAGGTGGA-TCGGTCGTGC
Fungia           CGGCGAGTTGTAGTT-GCGAGAAGCACTTTCTCGGCGGA-TCGGCGGCGC
Lobophyllia      CGGCGAGTTGTAATT-GCGAGAAGCACTTTCTAGGCGGA-TCGGTGGTGC
Montastrea       CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTAGGTGGA-TCGGCGGTGC
Dendrophyllia    CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTCGGCGGA-TCGGGCGTGC
Tubastrea        CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTCGGCGGA-TCGGGCGTGC
Enallopsammia    CGGCGAATTGTAATTTGCGAGAAGCGCTTTCTCGGCGGA-TCGGGCGTGC
Balanophyllia    CGGCGAGTTGTAGTT-GCGAGAAGCACTTTCTCGGCGGA-TCGGGCGTGC
Flabellum        CGGCGAGTTGTAGTT-GCGAGAAGCACTTTCTCGGCGGA-TCGGACGCGC
Fungicyathus     CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTCGGCGGA-TCGGTGGCGC
Porites          CGGCGAATTGTAGTTTGCGAGAAGCACTTTCTAGGCGGA-TCGGTCGTGC
Pavona           CGGCGAGTTGTAGTTTGCGAGAAGCACTTTCTCAGCGGA-CCGACCGTGC
Edwardsia        CGGCGACTTGTAGTT-TCGAGAAGCGCTTTCTCGGTGTGCTCGGACGCGT
Nematostella     CGGCGACTTGTAGTTTTCGAGAAGCGCTTTCTCGGTGTGCTCGGACGCGT
Anthopleura      --CAGAATTGTAGTTTTCGAGAAGCACTTTCTAGGGGCTACCGGTGCCGT
Stichodactyla    --CCGAATTGTAGTT-TCGAGAAGCACTTTCTAGGCGGGTCCGGGGCCGT
Bathyphellia     CGCCGAATTGTAGTTTTCGAGAAGCGCTTTCTAGGCGAGTCCGGGGCCGT
Aiptasia         CGGCGAATTGTAGTTTTCGAGAAGCACTTTCTCGGCGGATCCGGTGTCGT
Metridium        CGGCGAATTGTAGTT-TCGAGAAGCACTTTCTCGGCGGATCCGAGGTCGT
Cerianthus_28S   TGGCGAATTGTAGTC-TCGAGAAGC-TTTTCAAGACGGATGCG-CTGTGC

[                         160       170       180       190       200]

Actinotryx       CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Amplexidiscus    CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Discosoma_neg    CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTGTGTGG
Discosoma_num    CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTGTGTGG
Metarhodactis    CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCTGTGTGTCG
Rhodactis        CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCTGTGTGTCG
Ricordea         CTAAGTTGCTTGGAACAGCACGTCACAGAGGGTGACAACCCCGTCTGTGG
Corynactis_v     CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Corynactis_c     CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Corallimorphus   CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCCGTGG
Catalaphyllia    CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Caryophyllia     CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Oculina          CTAAGTTGCTTGGAACAGCATGTCGCAGAGGGTGACAACCCCGTCTGTGG
Fungia           CTAAGTTGCTTGGAACAGCATGTCGCAGAGGGTGACAACCCCGTCTGTGG
Lobophyllia      CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Montastrea       CTAAGTTGCTTGGAACAGCAGGTCGCAGAGGGTGACAACCCCGTCTGTGG
Dendrophyllia    CTAAGTTGCTTGGAACAGTACGTCGCAGAGGGTGACAACCCCGTTTGTGG
Tubastrea        CTAAGTTGCTTGGAACAGTACGTCGCAGAGGGTGACAACCCCGTTTGTGG
Enallopsammia    CTAAGTTGCTTGGAACAGTACGTCGCGGAGGGTGACAACCCCGTTTGTGG
Balanophyllia    CTAAGTTGCTTGGAACAGTACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Flabellum        CTAAGTTGCTTGGAACAGTACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Fungicyathus     CCAAGTTGCTTGGAACAGTACGTCGCAGAGGGTGACAACCCCGTCCGTGG
Porites          CTAAGTTGCTTGGAACAGTACGTCATAGAGGGTGACAACCCCGTCTGTGG
Pavona           CTAAGTTGCTTGGAACAGCACGTCGCAGAGGGTGACAACCCCGTCTGTGG
Edwardsia        CCAAGTTGCCTGGAACGGTGCGTCAAGGAGGGTGAAAACCCCGTCCACGG
Nematostella     CCAAGTTGCCTGGAACGGTGCGTCAAGGAGGGTGAAAACCCCGTCCACGG
Anthopleura      CCAATTTGCTAGGAACAGCAC-TCA-AGAGGGTGACAA--CCGTCTGTGG
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Stichodactyla      CCAAGTTGCTTGGAACAGCACGTCATAGAGGGTGACAA-CCCGTCTGTGG
Bathyphellia       CCAAGTTGCTTGGAACAGCACGTCATAGAGGGTGACAACCCCGTCTGTGG
Aiptasia           CCAAGTTGCTTGGAACAGCACGTCATAGAGGGTGAAAACCCCGTCTGCGG
Metridium          CCAAGTTGCTTGGAACAGCACGTCGTAGAGGGTGAAAACCCCGTCTGCGG
Cerianthus_28S     CTAAGTTGTTTGGAACTGCACATCGTAGAGGGTGACAATCCCGTCGGCTG


                           210       220       230       240       250]
Actinotryx         C--GAGTCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGCGTTGTTTGG
Amplexidiscus      C--GAGTCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Discosoma_neg      CT-GAGTCC-CGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Discosoma_num      CT-GAGTCC-CGCCGCTCACGATGTGCTTTCGAAGAGTCGCGTTGGTTGG
Metarhodactis      CTTGAAGTC-CGCCGCTCACGATGTGCTTTCGCAGAGTCGCGTTGCTTGG
Rhodactis          CTTGAAGTC-TGCCGCTCACGATGTGCTTTCGCAGAGTCGCGTTGCTTGG
Ricordea           CA-GGGCCCCGGCCGCTCACGATGTGCTTTCGAAGAGTCGCGTTGTTTGG
Corynactis_v       CA-GAGTCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGCGTTGTTTGG
Corynactis_c       CA-GAGTCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGCGTTGTTTGG
Corallimorphus     TA-GCGCCC-GGCCGCTTACGATGTGCTTTCGCAGAGTCGCGTTGTTTGG
Catalaphyllia      CAGGCTGCCGGGCCGCTGACGATGTGCTTTCGCAGAGTCGGGTTGTTTGG
Caryophyllia       CAGGCGGCC-GGCCGCCGACGATGTGCTTTCGCAGAGTCGGGTTGTTTGG
Oculina            CAGGCGACC-GGCCGCTGACGATGTGCTTTCGCAGAGTCGGGTTGTTTGG
Fungia             CAGGCGGCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Lobophyllia        CAGGCGACC-GGCCGCTGACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Montastrea         C-GGCCGCC-GGCCGCTGACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Dendrophyllia      CT-ACGGCC-GACCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTCGG
Tubastrea          CT-ACGGCC-GACCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTCGG
Enallopsammia      CA-ACGGCC-GACCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTCGG
Balanophyllia      CA-ACGGCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTCGG
Flabellum          CACGCGTCC-GGCCGCTCACGATGCGCTTTCGAAGAGTCGGGTTGTTTGG
Fungicyathus       CACGTCGCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Porites            CCCTCGGCC-GGCCGCTCACGATGTGCTTTCGAAGAGTCGGGTTGTTTGG
Pavona             CCCGCGGAC-GGCCGCTCACGATGTGCTTTCGAAAAGTCGGGTTGTTTGG
Edwardsia          CCCGCGTTC-GGCCGCCAACGATGCGCTTTCCACAAGTCGGGTTGCTTGA
Nematostella       CCCGCGTTC-GGCCGCCAACGATGCGC-TTCGACAAGTCGGGTTGCTTGA
Anthopleura        CCC--GGAC--GCCGC-GACGATGGCCTTTCGACAAGTCGGGTTGCTTGA
Stichodactyla      CCCGGAACC-GGCCGCTGACGATGCGCTTTCGACAAGTCGGGTTGC-TGA
Bathyphellia       CCCGGAACC-GGTCGCCGACGATGCGCTTTCGACAAGTCGGGTTGCTTGA
Aiptasia           CCCGATTCC-GGCCGTTCACGATGTGCTTTCAACAAGTCGGGTTGCTTGA
Metridium          CC-GACCTC-GGTCGTTCACGATGTGCTTTCGACAAGTCGGGTTGTTTGG
Cerianthus_28S     CACACAGCG-CACTGTTGACGATGGCCTTTCACGGGCTTGGCCACCTTGG

[                           260       270       280       290       300]

Actinotryx         GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATACGGGC
Amplexidiscus      GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATACGGGC
Discosoma_neg      GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATACGGGC
Discosoma_num      GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATACGGGC
Metarhodactis      GAATGCAGCCCAAAATGGGTGGTAGATTTCATCTAAAGCTAAATACGGAC
Rhodactis          GAATGCAGCCCAAAATGGGTGGTAGATTTCATCTAAAGCTAAATACGGAC
Ricordea           GATTGCAGCCCAAAACGGGTGGTAAACTCCATCTAAAGCTAAATATCGGC
Corynactis_v       GATTGCAGCCCAAAACGGGTGGTAAACTCCACCTAAAGCTAAATATTGGC
Corynactis_c       GATTGCAGCCCAAAACGGGTGGTAAACTCCACCTAAAGCTAAATATTGGC
Corallimorphus     GATTGCAGCCCAAAACGGGTGGTAGACTTCACCTAAAGCTAAATATCGGC
Catalaphyllia      GATTGCAGCCCAAAAGTGGTGGTAGACTCCATCTAAAGCTAAATACCGGC
Caryophyllia       GAATGCAGCCCAAAATTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Oculina            GAATGCAGCCCAAAATTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Fungia             GAATGCAGCCCAAAATTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Lobophyllia        GATTGCAGCCCAAAATTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Montastrea         GATTGCAGCCCAAAATTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Dendrophyllia      GAATGCATCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATATTGAC
Tubastrea          GAATGCATCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATATTGAC
Enallopsammia      GAATGCATCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATATTGAC
Balanophyllia      GAATGCATCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATATTGAC
Flabellum          GAATGCAGCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATACTGAC
Fungicyathus       GAATGCAGCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATATTGAC
Porites            GAATGCAGCCCAAAAATGGTGGTAAACTCCATCTAAAGCTAAATACTGAC
Pavona             GAATGCAGCCCAAAACTGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
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Edwardsia          GAATGCA-CC-A----G--------------------------------
Nematostella       GAATGCAGCCCA----G--------------------------------
Anthopleura        GAATGCA-CC-A---CG--------------------------------
Stichodactyla      GAATGCA-CC-----CG--------------------------------
Bathyphellia       GAATGCAGCCCAAAACGGGTGGTAAACTCCATCTAAAGCTAAATACTGGC
Aiptasia           GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATATTGGC
Metridium          GAATGCAGCCCAAAATGGGTGGTAAACTCCATCTAAAGCTAAATATTGGC
Cerianthus_28S     -A-TCCAGTATTAA-TG--------------------------------


[                           310       320       330       ]
Actinotryx         GCGAGACCGATAGCGA-----------------------
Amplexidiscus      GCGAGACCGATAGCGA-----------------------
Discosoma_neg      GCGAGACCGATAGCGA-----------------------
Discosoma_num      GCGAGACCGATAGCGA-----------------------
Metarhodactis      GCGAGACCGATAGCGA-----------------------
Rhodactis          GCGAGACCGATAGTGA-----------------------
Ricordea           GCGAGACCGATAGTGA-----------------------
Corynactis_v       GCGAGACCGATAGTGA-----------------------
Corynactis_c       GCGAGACCGATAGTGA-----------------------
Corallimorphus     GCGAGACCGATAGTGAACAAGTACCGTGAGGGAAAGT--
Catalaphyllia      GTGAGACCGATAGTGA-----------------------
Caryophyllia       GTGAGACCGATAGTGA-----------------------
Oculina            GTGAGACCGATAGTGA-----------------------
Fungia             GTGAGACCGATAGCGA-----------------------
Lobophyllia        GTGAGACCGATAGCGA-----------------------
Montastrea         GTGAGACCGATAGCGA-----------------------
Dendrophyllia      GTGAGACCGATAGCGA-----------------------
Tubastrea          GTGAGACCGATAGCGA-----------------------
Enallopsammia      GTGAGACCGATAGCGA-----------------------
Balanophyllia      GTGAGACCGATAGCGA-----------------------
Flabellum          GTGAGACCGATAGCGA-----------------------
Fungicyathus       GTGAGACCGATAGCGAACAAGTACCGTGAGGGAAAGTT-
Porites            GTGAGACCGATAGCGA-----------------------
Pavona             GTGAGACCGATAGCGA-----------------------
Edwardsia          ---------------------------------------
Nematostella       ---------------------------------------
Anthopleura        ---------------------------------------
Stichodactyla      ---------------------------------------
Bathyphellia       ACGAGACCGATAGCGAACAAGTACCGTGAGGGAAAGTAA
Aiptasia           ACGAGACCGATAGCGA-----------------------
Metridium          ACG------------------------------------
Cerianthus_28S     ---------------------------------------
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Appendix 4. Alignment of 18S rDNA sequences

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                           111111111122222222223333333333444444444455555555556666666666777
Taxon/Node        123456789012345678901234567890123456789012345678901234567890123456789012
------------------------------------------------------------------------------------------
Aiptasia          ----------TGGTTAATCCTGCCAGTAGTCATATGCCTGTCCCAAAGATTAAGCCATGCATGTCTAAGTAT
Metridium         ------AACCTGGTTGATCCTGCCAGTAGTCATATGCCTGTCCCAAAGATTAAGCCATGCATGTCTAAGTAT
Edwardsia         ATACATAACCTGGTTGATCCTGCCAGTAGTCATATGCCTGTCCCAAAGATTAAGCCATGCATGTCTAAGTAT
Nematostella      ----------TGGTTGATCCTGTCAGTAGTCTGATGCCTGTCCCAAAGATTAAGCC-TGCATGTCTAAGTAT
Anthopleura       ------TACCTGGTTGATCCTGCCAGTAGTCATATGCCTGTCCCAAAGATTAAGCCATGCATGTCTAAGTAT
Stichodactyla     ---------------------------GGTCGGATGCCTCTTCCAAAGATTAAGCC-T-CCT--CTAAG---
Bathyphellia sp.  ------------------------------------CTCGTGTTAGA---TTAGCCATGCATGTCTAAGTAT
Corynactis c      ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Corynactis v      ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Corallimorphus    --------------------TGCCAGTCATCAGATGTGTGGCGCTAAGAGTTAAGCATGCATGTCTAAGTAT
Ricordea          ----------------------------------------ACTTACTAAGATAGCCATGCATGTGCAAGTAT
Discosoma C1      ----------------------------------CTCTTTTTCTTAAGATTAAGCCATGCATGTGCAAGTAT
Discosoma num     ----------------------------------CTCTTTTTCTTAAGATTAAGCCATGCATGTGCAAGTAT
Actinotryx        --------------------------------------ACTTACTAAGAT--AGCCATGCATGTGCAAGTAT
Rhodactis         --------------------------------------ACTAACTAAGAT--AGCCATGCATGTGCAAGTAT
Amplexidiscus     ------------------------------------ACCGTACCTCAGAT-GAGCCATGCATGTGCAAGTAT
Metarhodactis     ----------------------------------GCAGTCTCGATTAAGACTACGCCTTGCATGTGCAGTAT
Pavona            ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Fungicyathus sp.  ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Fungia            ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Enallopsammia     ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Porites           ---------------------------------ACTACCGATTGAATGGTTAAGTGAGGCATGCTTACGTGT
Tubastraea        -------TCCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Montastrea        -----------GGTGGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCTAAGTAT
Balanophyllia     ------------------------------------------------------------------------
Oculina           ----------------------------------------------------TACCATGCATGTCTAAGTAT
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    ------AACCTGGTTGATCCTGCCAGTAGTCATATGCTTGTCTCAAAGATTAAGCCATGCATGTCCAAGTAT


                                             111111111111111111111111111111111111111111111
                  777777788888888889999999999000000000011111111112222222222333333333344444
Taxon/Node        345678901234567890123456789012345678901234567890123456789012345678901234
------------------------------------------------------------------------------------------
Aiptasia          AAGCAGTTGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGCCTTTTTACT
Metridium         AAGCAGTTGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGCCTTTT-ACT
Edwardsia         AAGCAGTCGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGACCTTT-ACT
Nematostella      AAGCAGTTGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGACCTTT-ACT
Anthopleura       AAGCAGTTGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGCGTTT--ACT
Stichodactyla     -AGCAGTTGTACTGTGAAACTGTGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGCGTTT--ACT
Bathyphellia sp.  AAGCAGTTGTACTGTGAAACTGCGAACGGCTCCTTAAATCAGTTATCGTTTATTTGATTGTGCCTTTT-ACT
Corynactis c      AAGCACTAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTGCCATTT-ACT
Corynactis v      AAGCACTAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATTT-ACT
Corallimorphus    AAGCACTAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATTT-ACT
Ricordea          AAGCACCAGTACTGTGAAACTGGTAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACAATT--ACT
Discosoma C1      AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACAATT--ACT
Discosoma num     AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACAATT--ACT
Actinotryx        AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACAATT--ACT
Rhodactis         AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACGATT--GCT
Amplexidiscus     AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACAATT--ACT
Metarhodactis     AAGCACCAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACGATT--GCT
Pavona            AAGCACTTGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Fungicyathus sp.  AAGCACTTGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Fungia            AAGCACTAGTACTGTGAAACTGCGAATGGCCCATTAAATCAGTTATCGTTTATTTGATTGTACCTTT--ACT
Enallopsammia     AAGCACTAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Porites           AAGCACTCGTACTGTGAA-CTGCGAATGCCTCA-TAAGTTGGTCA--GTTTATTTGATTAT----TTTGACT
Tubastraea        GAGCACTTGTACTGTGAA-CTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Montastrea        AAGCACTTGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Balanophyllia     ------------------------------------------------------------------------
Oculina           AAGCACTAGTACTGTGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTACCATT--ACT
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    GAGCACTCGTACTGCGAAACTGCGAATGGCTCATTAAATCAGTTATCGTTTATTTGATTGTGCCCTT--ACT
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                  111111111111111111111111111111111111111111111111111111122222222222222222
                  444445555555555666666666677777777778888888888999999999900000000001111111
Taxon/Node        567890123456789012345678901234567890123456789012345678901234567890123456
------------------------------------------------------------------------------------------
Aiptasia          ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Metridium         ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Edwardsia         ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Nematostella      ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGNATTTA
Anthopleura       ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Stichodactyla     ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Bathyphellia sp.  ACTTGGATAACCGTGGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Corynactis c      ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCTTGGAAGGGATGTATTTA
Corynactis v      ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCTTGGAAGGGATGTATTTA
Corallimorphus    ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Ricordea          ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGGGAAGAGTCCCGACTTCT-GGAAGGGATGTATTTA
Discosoma C1      ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAGAGTCCCGACTTGT-GGAAGGGATGTATTTA
Discosoma num     ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAGAGTCCCGACTTGT-GGAAGGGATGTATTTA
Actinotryx        ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAGAGTCCCGACTTCT-GGAAGGGATGTATTTA
Rhodactis         ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAGAGTCCCGACTTGT-GGAAGGGATGTATTTA
Amplexidiscus     ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAGAGTCCCGACTTCT-GGAAGGGATGTATTTA
Metarhodactis     ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTGT-GGAAGGGATGTATTTA
Pavona            ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Fungicyathus sp.  ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Fungia            ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Enallopsammia     ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTAATTA
Porites           AATTGAAAAACCGTAG-AATTCCAGAGCTAA-ACATGCGAAAAGTCCCGACTTCTGGGAAAGAATGTAATTT
Tubastraea        ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTAATTA
Montastrea        ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Balanophyllia     ------------------------------------------------------------------------
Oculina           ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCT-GGAAGGGATGTATTTA
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    ACTTGGATAACCGTAGTAATTCTAGAGCTAATACATGCGAAAAGTCCCGACTTCAGTGAAGGGACGTATTTA

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Taxon/Node        789012345678901234567890123456789012345678901234567890123456789012345678
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Metridium         TTAGATTCAAAACCAATGCGGGTT---ACCTGCCCGGTTCTTTGGTGATTCATAATAACTGTTCGAATCGCA
Edwardsia         TTAGATTCAAAACCAATGCGGGTT---ACCTGCCCGGTTCTTTGGTGATTCATAGTAACTGTTCGAATCGCA
Nematostella      TTAGATTCAAAACCAATGCGGGTT---ACCTGCCCGGTCRTTTGGTGATTCATAGTAACTGTTCGAATCGCA
Anthopleura       TTAGATTCAAAACCAATGCGGGTT---ACCCGCCCGGTGTGTTGGTGATTCATAGTAACTGTTCGAATCGCA
Stichodactyla     TTAGATTCAAAACCAATGCGGGTT---ACCCGCCCGGTGTGTTGGTGATTCATAGTAACTGTTCGAATCGCA
Bathyphellia sp.  TTAGATTCAAAACCAATGCGGGTT-----CTGCCCGGTTCTTTGGTGATTCATAATAACTTTTCGAATCGCA
Corynactis c      TTAGATTAAAAACCAATGCGGGTTGG--CCTGCCCGGTTGTTTGGTGATTCATAGTAACTTCACGAATCGCA
Corynactis v      TTAGATTAAAAACCAATGCGGGTTGG--CCTGCCCGGTTGTTTGGTGATTCATAGTAACTTCACGAATCGCA
Corallimorphus    TTAGATTAAAAACCAATGCGGGTTGGC-CCCGCCCGGTTGTTTGGTGATTCATAGTAACTTCACGAATCGCA
Ricordea          TTAGATGAAAAACCAATGCGGGTGGGCAACCGCCCGGTTGTATGGTGATTCATAGTAACTTAACGAATCGCA
Discosoma C1      TTAAATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGCTGTGGTGACTCATAGTAACTGATCGAATCGCA
Discosoma num     TTAAATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGCTGTGGTGACTCATAGTAACTGATCGAATCGCA
Actinotryx        TTAGATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGGTATGGTGACTCATAGTAACTGATCGAATCGCA
Rhodactis         TTAGATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGGTGTGGTGACTCATAGTAACTGATCGAATCGCA
Amplexidiscus     TTAGATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGGTGTGGTGACTCATAGTAACTGATCGAATCGCA
Metarhodactis     TTAGATGAAAAACCAATGCGGGTGGGCAACTGCCCGGTGGTGTGGTGACTCATAGTAACTGATCGAATCGCA
Pavona            TTAGATTAAAAACCAATGCGGGTT-----CTGCCCGGTCATTTGGTGATTCATAGTAACTGATCGAATCGCA
Fungicyathus sp.  TTAGATTAAAAACCAATGCGGGTT-----CTGCCCGGTCATTTGGTGATTCATAGTAACTGATCGAATCGCA
Fungia            TTAGATTAAAAACCAATGCGGGTT-----CTGCCCGGTTCTTTGGTGATTCATAGTAACTGATCGAATCGCA
Enallopsammia     TTAGATTAAAAACCAATGCGGGTTG---ACTGCCCGGTTCTTTGGTGATTCATAGTAACTGATCGAATCGCA
Porites           TAAAATTAAAAACCAATGCGGGTTG---ACTGCCCGGTTCTTTGGTGGTTCGTAGAAACTTATCGAATTGCA
Tubastraea        CTAGATTAAAAACCAATGCGGGTTG---ACTGCCCGGTTCTTTGGTGATTCATAGTAACTGATCGAATCGCA
Montastrea        TTAGATTAAAAACCAATGCGGGTT-----CTGCCCGGTTCTTTGGTGATTCATAGTAACTGATCGAATCGCA
Balanophyllia     ------------------------------------------------------------------------
Oculina           TTAGATTAAAAACCAATGCGGGTT-----CTGCCCGGTTATTTGGTGATTCATAGTAACTGATCGAATCGCA
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    TTAGATTAAAAACCAATGCAACTGTTGATTCGGTTG-TGGATTGGTGATTCATGGTAACTTTTCGAATCGCA
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Taxon/Node       901234567890123456789012345678901234567890123456789012345678901234567890
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Aiptasia         CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Metridium        CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Edwardsia        KGGCCTCGTGCCGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Nematostella     GGGCCTCGCGCCGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTRTTGGCTTAC
Anthopleura      GGGCCTTGCGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Stichodactyla    GGGCCTTGCGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Bathyphellia sp. CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTATTGGCTTAC
Corynactis c     CGGCCTCGCGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Corynactis v     CGGCCTCGCGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Corallimorphus   CGGCCTTGCGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Ricordea         GGGCCTTGAGCTGGCGGATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Discosoma C1     GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTACTGGCTTAC
Discosoma num    GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTACTGGCTTAC
Actinotryx       GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Rhodactis        GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Amplexidiscus    GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTACTGGCTTAC
Metarhodactis    GGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Pavona           CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Fungicyathus sp. CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Fungia           CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Enallopsammia    CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTAT-AACTGTCGATGGTAAGGTAGTGGCTTAC
Porites          CGGCCTTGTCCTGGCGCATGTTTCATTCAA-TTTCTTCCCTAT-AACTGTCGATGGTAAGGTAGTGG-TTAC
Tubastraea       CGGCCTTGCGCTGGCGCATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Montastrea       CGGCCTTGAGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Balanophyllia    ------------------------------------------------------------------------
Oculina          CGGCCTTGCGCTGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Lobophyllia      -----------------ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Catalaphyllia    -----------TGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTGTCGATGGTAAGGTAGTGGCTTAC
Cerianthus 18S   CGGCCTCGCGCCGGCG-ATGTTTCATTCAAATTTCTGCCCTATCAACTTTCGATGGTAAGGTAGTGGCTTAC


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Taxon/Node       123456789012345678901234567890123456789012345678901234567890123456789012
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Metridium        CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Edwardsia        CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTWCCACATC
Nematostella     CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Anthopleura      CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAGACGGCTACCACATC
Stichodactyla    CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAGACGGCTACCACATC
Bathyphellia sp. CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAGACGGCTACCACATC
Corynactis c     CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Corynactis v     CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Corallimorphus   CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Ricordea         CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Discosoma C1     CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Discosoma num    CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Actinotryx       CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Rhodactis        CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Amplexidiscus    CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Metarhodactis    CATGGTTACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Pavona           CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAATCGGCTACCACATC
Fungicyathus sp. CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAATCGGCTACCACATC
Fungia           CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Enallopsammia    CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCATATC
Porites          CATGGTTGCAACGGGTGACGGAGAAT-AGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCTTATC
Tubastraea       CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCTTATC
Montastrea       CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Balanophyllia    ------------------------------------------------------------------------
Oculina          CATGGTTGCAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Lobophyllia      CATGGTTGCAACGCGTGACGGAAAATTAGGGTTCGATCCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
Catalaphyllia    CATGGTTGCAACGGGTGACGGAAAATTAGGGTTCGATTCCGGAAAGGGAGCCTGAAAAACGGCTACCACATC
Cerianthus 18S   CATGGTGACAACGGGTGACGGAGAATTAGGGTTCGATTCCGGAGAGGGAGCCTGAGAAACGGCTACCACATC
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Taxon/Node        3456789012345678901234567890123456789012345678901234567890123456789001234
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Metridium         CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Edwardsia         CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCASGGAGGTAGTGMMAA--AATAACAATACA
Nematostella      CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Anthopleura       CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Stichodactyla     CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Bathyphellia sp.  CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Corynactis c      CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATCGCTGATTCAGGGAGGTAGTGACAAGAAATAACAATACA
Corynactis v      CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATCGCTGATTCAGGGAGGTAGTGACAAGAAATAACAATACA
Corallimorphus    CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATCGCTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Ricordea          CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATCGGTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Discosoma C1      CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Discosoma num     CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Actinotryx        CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Rhodactis         CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Amplexidiscus     CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Metarhodactis     CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Pavona            CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Fungicyathus sp.  CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Fungia            CAAGGAAGGCAGCAGGCGCGCAAATCACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Enallopsammia     CAAGGAAGGCAGCAGGCGCGCAAATCACCCAATC-CTGACCCAGGGAGGTAGTGACAAGAAATAACAATACA
Porites           CAAGGAAGGCAGCACGCGCGCAAATGACCTAATCACTGACCCAGGGAGGTAGTGACAAGAAATAACAATACA
Tubastraea        CAAGGAAGGCAGCAGGCGCGCAAATCACCTAATC-CTGACTTAGGGAGGTAGTGACAAGAAATAACAATACA
Montastrea        CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Balanophyllia     ------------------------------------------------------------------------
Oculina           CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Lobophyllia       CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Catalaphyllia     CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATAACAATACA
Cerianthus 18S    CAAGGAAGGCAGCAGGCGCGCAAATTACCCAATC-CTGACTCAGGGAGGTAGTGACAAGAAATATCGATACG


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Taxon/Node        567890123456789012345678901234567890123456789012345678901234567890123456
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Metridium         GGGCTTTTCTAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Edwardsia         GGGCTTTTCTAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACKAGGATCCATTGGAGGGCAAG
Nematostella      GGGCTTTTCTAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Anthopleura       GGGCTTTTCTAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
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Bathyphellia sp.  GGGCTTTTCTAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Corynactis c      GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACCTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Corynactis v      GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACCTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Corallimorphus    GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACCTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Ricordea          GGGCTTTTATAAGTCTTGTAATTGGAATGAGTACTACCTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Discosoma C1      GGGCTTTTACGAGTCTTGTAATTGGAATGAGTACTACTTAAATCCTTTCACGAGGATCCATTGGAGGGCAAG
Discosoma num     GGGCTTTTACGAGTCTTGTAATTGGAATGAGTACTACTTAAATCCTTTCACGAGGATCCATTGGAGGGCAAG
Actinotryx        GGGCTTTTACGAGTCTTGTAATTGGAATGAGTACTACTTAAATCCTTTCACGAGGATCCATTGGAGGGCAAG
Rhodactis         GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Amplexidiscus     GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Metarhodactis     GGGCTTTTACAAGTCTTGTAATTGGAATGAGTACAACCTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Pavona            GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGACAAG
Fungicyathus sp.  GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGACAAG
Fungia            GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Enallopsammia     GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Porites           GGGCTTTTCTAAGTCT-GTAAACGGAATGAGTACA-CTTAAATCCTTTAACGAGGATCCATTGGAGTGCAAG
Tubastraea        GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Montastrea        GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Balanophyllia     ------------------------------------------------------------------------
Oculina           GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATTGGAGGGCAAG
Lobophyllia       GGGCTTTTCCAAGTCTTGTAATGGGAATGAGTACAACTTAAATCCTTTAACGAGGATCCATGGGAGGGCAAG
Catalaphyllia     GGGCTTTTCCAAGTCTTGTAATTGGAATGAGTACAACTTAAATCCTTTAACCAGGATCCATTGGAGGGCAAG
Cerianthus 18S    GGGCTCTAATTAGTCTCGTAATCGGAATGAGTACAATTTAAATCCCATGCGGAGGATCCGTTGGAGGGCAAG
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Taxon/Node        78901234567890123456789012345678901234567890123456789012345678901234567 8
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Metridium         TCTGGTGCCAGCAGCCGCGGTAAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Edwardsia         TCTGGTGCCAGCASCCGCGGTAAATTCCAGCTCCAATASSGTATATTAAAGTTGGT-GGAGTTAAAA-GCTC
Nematostella      TCTGGTGCCAGCAGCCGCGGTAAATTCCAGCTCCAATAGCGTATATKMWMGTWGGT-TGGATT---------
Anthopleura       TCTGGTGCCAGCAGCCGCGGTAAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Stichodactyla     TCTGGTGCCAGCAGCCGCGGTAATTTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Bathyphellia sp.  TCTGGTGCCAGCAGCCGCGGT-AATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Corynactis c      TCTGGTGCCAGCACCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTGG-TTGCAGTTAAAAAGCTC
Corynactis v      TCTGGTGCCAGCACCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTGGCTTGCAGTTAAAAAGCTC
Corallimorphus    TCTGGTGCCAGCACCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Ricordea          TCTGGTGCCAGCACCCGCGGTAAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Discosoma C1      TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Discosoma num     TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Actinotryx        TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Rhodactis         TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Amplexidiscus     TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Metarhodactis     TCTGGTGCCAGCAGCCGCGGTTAATTCCAGCTCCAATAGCGTATATTAAAGTTGGTTGCAGTTAAAAAGCTC
Pavona            TCTGGTGCCAGCACCCGCGGTGAGTTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Fungicyathus sp.  TCTGGTGCCAGCACCCGCGGTGAGTTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Fungia            TCTGGTGCCAGCAGCCGCGGTGAATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Enallopsammia     TCTGGTGCCAGCAGCCGCGGTGAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Porites           TCTGGTGCCAGCACCCGCGGTGAATTCCAGCTCCAATAGCGTATATTAAAGTTGCTTGCAGTTAAAAAGCTC
Tubastraea        TCTGGTGCCAGCAGCCGCGGTGAATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Montastrea        TCTGGTGCCAGCAGCCGCGGT-AATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Balanophyllia     ------------------------------------------------------------------------
Oculina           TCTGGTGCCAGCAGCCGCGGT-AATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Lobophyllia       TCTGGTGCCAGCAGCCGCGGTGAATTCCAGCTCCAATAGCGTATATTAAAGTGG-TTGCAGTTAAAAAGCTC
Catalaphyllia     TCTGGTGCCAGCAGCCGCGGT-AATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC
Cerianthus 18S    CCTGGTGCCAGCAGCCGCGGT-AATTCCAGCTCCAATAGCGTATATTAAAGTTG-TTGCAGTTAAAAAGCTC


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Taxon/Node        901234567890123456789012345678901234567890123456789012345678901234567890
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Metridium         GTAGTTGGATTTCGGGACGGGCCGGCCGGTCCGCCGCAAGGCGTC-GGTTTACTGACCGGGCTGTTCTTCTT
Edwardsia         GTAGTTG---TTCGGGACGGCACGGTCGGTCCGCCGCAAGGTGTC-GGTTTACTGGCCGGGCTGTTCTTCTT
Nematostella      -----------TCGGGACGGCACGGTCGGTCCGCCGCAAGGTGTC-GGTCTACTGGCCGGGCTGTTCTTCCT
Anthopleura       GTAGTTGGACTTCGGGGTGGGC--GCCGGTCCGCCGCAAG-TGTC-GGTCTACTGGCCGGGCCGCTCTTCCT
Stichodactyla     GTAGTTGGACTTCGGGGTGGGC--GCCGGTCCGCCGCAAG-TGTC-GGTCTACTGGCCGGGCCGCTCTTCCT
Bathyphellia sp.  GTAGTTGGATTTCGGGACGGCGCGGCTGGTCCGCCGCAAGGCGTC-GGTTTACTGACCGAGCTGTTCTTCTT
Corynactis c      GTAGTTGGATTTCGGGATGGCCCGGCCGGTCCGCCGCAAGGTGTGG-GTTTACTGGCCGAGCTGTTCTTCTT
Corynactis v      GTAGTTGGATTTCGGGATGGCCCGGCCGGTCCGCCGCAAGGTGTGG-GTTTACTGGCCGAGCTGTTCTTCTT
Corallimorphus    GTAGTTGGATTTCGGGATGGCTCGGCCGGTCCGCCGCAAGGT--GGTGCTTACTGGCCGCGCTGTTCTTCTT
Ricordea          GTAGTTGGATTTCGGGATGGCTCGGCCGGTCCGCCGCA-GGTGTGCTGCT-ACTGGCCGCGCTGTTCTTCTT
Discosoma C1      GTATTTGGATTTCGGGATGGCTCGGCCGGTCCGCCGCAAGGTGT---GCT-ACTGGCCGCGCTGTTCTTCCT
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Amplexidiscus     GTAGTTGGATTTCGGGATGGCTCGGCCGGTCCGCCGCAAGGTGT---GCT-ACTGGCCGCGCTGTTCTTCCT
Metarhodactis     GTAGTTGGATTTCGGGATGGCTCGGCCGGTCCGCCGCAAGGTGTG--GCT-ACTGGCCGCGCTGTTCTTCCT
Pavona            GTAGTTGGATTTCGGGATGGTTCGGCCGGTCTGCCGCAAGGTATG--GTT-ACTGGCCGAGCTGTTCTTCCT
Fungicyathus sp.  GTAGTTGGATTTCGGGATGGTTCGGCCGGTCTGCCGCAAGGTAT---GTT-ACTGGCCGAGCTGTTCTTCCT
Fungia            GTAGTTGGATTTCGGGATGGCCCGGTCGGTCTGCCGCAAGGTAT---GTT-ACTGGCCGAGCTGTTCTTCCT
Enallopsammia     GTAGTTGGATTTCGGCATGGCCCGGTCGGTCTGCCGCAAGGTAT---GTC-ACTGGCCGAGCTGTTCTTCCT
Porites           GTATTTGGATTTCGGCATGGCTCGGCTGGTCTGTCGCAAGGTATGGCGTTGACTGGCCGAGCTGTTTTTCTT
Tubastraea        GTAGTTGGATTTCGGGATGGCCCGGCCGGTCTGCCGCAAGGTAT--CGTTGACTGGCCGAGCTGTTCTTCCT
Montastrea        GTAGTTGGATTTCGGGATGGCTCGGCCGGTCTGCCGCAAGGTAT---GTTGACTGGCCGCGCTGTTCTTCCT
Balanophyllia     ------------------------------------------------------------------------
Oculina           GTAGTTGGATTTCGGGATGGCCCGGCCGGTCTGCCGCAAGGTAT---GTC-ACTGGCCGAGCTGTTCTTCCT
Lobophyllia       GTATTTGGATTTCGGGATGGCTCGGCCGGTCTGCCGCAAGGTTCCATGTT-ACTGGCCGCCCTGTTTTTCCT
Catalaphyllia     GTAGTTGGATTTCGGGATGGCTCGACCGGTCTGCCGCAAGGTAGCAAGTC-ACTGGCCGGGCTGTTTTTCCT
Cerianthus 18S    GTAGTTGGATTTCTGGTAGCATCGGATGGTCCGCCGCAAGGCGT----TGAACTGGCCGGTGTAGCCTTTCT
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Taxon/Node        123456789012345678901234567890123456789012345678901234567890123456789012
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Metridium         CGCAAAGACTGCATGTGCTCTTAACTGAGTGTGTGTAGG-ACTTGTGGCACGTTTACTTTGAAAAATTTAGA
Edwardsia         CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCACAGG-ACTTGCGGCACGTTTACTTTGAAAAATTTAGA
Nematostella      CGCAAAGACTGCGTGTGCTCTTAGCTGAGTGTGCGCAGG-ACTTGCGGCACGTTTACTTTGAAAAATTTAGA
Anthopleura       CGCAAAGACTGCGTGTGCTCTTGACTGAGTGTGCGCAGGTACTTGCGGCACGTTTACTTTGAAAAAATTAGA
Stichodactyla     CGCAAAGACTGCGTGTGCTCTTGACTGAGTGTGCGCAGGTACTTGCGGCACGTTTACTTTGAAAAAATTAGA
Bathyphellia sp.  CGCAAAGACTACATGTGCTCTTAACTGAGTGTGTGTAGG-ACTTGCGGCACGTTTACTTTGAAAAAATTAGA
Corynactis c      CGCAAAGACCGTGTGTGCTCTTAACTGAGTGTGCTCGGGCATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Corynactis v      CGCAAAGACCGTGTGTGCTCTTAACTGAGTGTGCTCGGGCATCTGCGTGACGTTTACTTTGAAAAAATTAGA
Corallimorphus    CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGTTCAGGCATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Ricordea          CGCAAAGACTGTGTGTGCCCTTAACTGAGTGTGCTCAGGCATCTGCGTGACGTTTACTTTGAAAAAATTAGA
Discosoma C1      CGCAAAGACTGTGTGTGCCCTTAACTGAGTGTGCTCAGG-ATCTGCGG-ACGTTTACTTTGAAAAAATTAGA
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Actinotryx        CGCAAAGACTGTGTGTGCCCTTAACTGAGTGTGCTCAGG-ATCTGCGG-ACGTTTACTTTGAAAAAATTAGA
Rhodactis         CGCAAAGACTGTGTGTGCCCTTAACTGAGTGTGCTCAGG-ATCTGCGG-ACGTTTACTTTGAAAAAATTAGA
Amplexidiscus     CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCGCAGG-ATCTGCGG-ACGTTTACTTTGAAAAAATTAGA
Metarhodactis     CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCTCAGG-ATCTGCGG-ACGTTTACTTTGAAAAAATTAGA
Pavona            CGCAAAGACTGGGTGTGCTCTTAACTGAGTGTGCTCAGG-ATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Fungicyathus sp.  CGCAAAGACTGGGTGTGCTCTTAACTGAGTGTGCTCAGG-ATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Fungia            CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCTCAGG-ATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Enallopsammia     CGCAAAGACTGTCTGTGCTCTTAACTGAGTGTGCTCAGGGATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Porites           CGCAAAGACTGTGTGTGCCCTTAACTGAGTGTGCTCAGGGATCTGCGTGACGTTTACTTTGAAAAAATTAGA
Tubastraea        CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCTCAGG-ATCTGCGT-ACGTTTACTTTGAAAAAATTAGA
Montastrea        CGCAAAGACTGTGTGTGCTCTTAACTGAGTGTGCATAGG-ATCTGCGT-ACGTTTACTTTGAAAAAATTACA
Balanophyllia     -------------------------------------------------------------G----------
Oculina           CGCAAAGACTGGGTGTGCTCTTAACTGAGTGTGCTCAGGGATCTGCGT-ACGTTTACTTTGAAAAAATTACA
Lobophyllia       CGCAAAGACTGTGTGTGCTTTTAACTGAGTGTGCATAGG-ATTTTCGT-ACGTTTACTTTGGAAAAATTAGA
Catalaphyllia     GGCGAAGACTGGCTGTGCTTTTAACTGAGTGTGGGCAGGGATCTGCCT-ACCTTTACTTTGAAAAAATTAGA
Cerianthus 18S    GGCGCAGACGCTGCGTGCTCTTCGTTGAGTGTGCAGGGG-ATCCGTCT-ACGTTTACTTTGAAAAAWTTAGA


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Taxon/Node        345678901234567890123456789012345678901234567890123456789012345678901234
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Edwardsia         GTGTTCAAAGCAGGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTG-CGGTTCTATTTT
Nematostella      GTGTTCAAAGCAGGCCATCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTG-CGGTTCTATTTT
Anthopleura       GTGTTCAAAGCAGGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTGG-CGGTTCTATTTT
Stichodactyla     GTGTTCAAAGCAGGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTGG-CGGTTCTATTTT
Bathyphellia sp.  GTGTTCAAAGCAGGCCAGCGCCTGAATACATAAGCATGGAATAATGGAATAGGACTTT--CGGTTCTATTTT
Corynactis c      GTGTTCCAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
Corynactis v      GTGTTCCAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTT---GGTTCTATTTT
Corallimorphus    GTGTTCCAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
Ricordea          GTGTTCCAAGCAAGCCAGCGCTTGAATACGTAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
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Actinotryx        GTGTTCAAAGCAAGCCAGCGCTTGAATACGTAAGCATGGAATGATGGAATAGGACTTTG--GGTTCTATTTT
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Metarhodactis     GTGTTCAAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATGATGGAATAGGACTTT---GGTTCTATTTT
Pavona            GTGTTCAAAGCAAGCCAGCGCTTGAATACGTAAGCATGGAATAATGGAATAGGACTTT---GGTTCTATTTT
Fungicyathus sp.  GTGTTCAAAGCAAGCCAGCGCTTGAATACGTAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
Fungia            GTGTTCAAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTCT
Enallopsammia     GTGTTCAAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
Porites           GTGTTCAAAGCAAGCCAGCGCTTAAATACATAAGCA---AATAATGGAATAGGACCTTACAAGTTCTATTTC
Tubastraea        GTGTTCAAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
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Balanophyllia     -------------------------------------------------------TTTA--GGTTCTATTTT
Oculina           GTGTTCAAAGCAAGCCAGCGCTTGAATACATAAGCATGGAATAATGGAATAGGACTTTA--GGTTCTATTTT
Lobophyllia       GTGTTCAAAGCAAGCCAGCGCTTGGAAACATAAGCATGGAATAATGGGATAGGACATTA--GGTTCTATTTT
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Cerianthus 18S    GTGTTCAAAGCAGGCCAGCGCTCGGATACATAAGCATGGAATAATGGAATAGGACTCCTCCGGTTCTAGTTC
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Edwardsia         -GTTGGTTTCTGG-GAACCGAAGTAATGATTAAGAGGGACAGTTGGGGG--CATTCGTATTTCGTKK---RA
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Stichodactyla     -GTTGGTTTCGTGGGAACCGAAGTAATGATTAAGAGGGACAGTTGGGGG--CATTCGTATTTCGTTGTCAGA
Bathyphellia sp.  -GTTGGTTTCTGG-GAACCGAAGTAATGATTAAAAGGGACAGTTGGGGGG-CATTCGTATTTCGTTGTCAGA
Corynactis c      TGTTGGTTTCTGG-AAACCGAAGTAATGATTAAGAGGGACAGTTTGGGG--CATTCGTATTTCGTTGTCAGA
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Corallimorphus    TGTTGGTTTCTGG-AAACTGAAGTAATGATTAAGAGGGACAGTTTCGGG-CCATTCGTATTTCGTTGTCAGA
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Pavona            -GTTGGTTTCTGG--AACCGAAGTAATGATTAAGAGAGACAATTGGGGG--CATTCGTATTTCGTTGTCAGA
Fungicyathus sp.  -GTTGGTTTCTGG--AACCGAAGTAATGATTAAGAGAGACAATTGGGGG--CATTCGTATTTCGTTGTCAGA
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Porites           -GTTGGTTTCGGGTGAAGCG-AGGTATGATTAAAAGAGACAATCTGGGG-CCATTCGTAT--CGTCGGCAGA
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Taxon/Node        789012345678901234567890123456789012345678901234567890123456789012345678
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Edwardsia         GGTGAAATTCTTGGATTTACS-GAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Nematostella      GGTGAAATTCTTGGATTTACG-GAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Anthopleura       GGTGAAATTCTTGGATTTACG-GAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Stichodactyla     GGTGAAATTCTTGGATTTATACGAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Bathyphellia sp.  GGTGAAATTCTTGGATTTACG-GAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Corynactis c      GGTGAAATTCTTGGATTTACGC-AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
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Corallimorphus    GGTGAAATTCTTGGATTTACGC-AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Ricordea          GGTGAAATTCTTGGATTTACGCTAAAGACGAACTACTGCGAAAGCATTTGCCAAGAGTGTTTTCATTAATCA
Discosoma C1      GGTGAAATTCTTGGATTTACG-TAAAGACGAACTACTGCGAAAGCATTTGCCAAGAGTGTTTTTCATTATCA
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Amplexidiscus     GGTGAAATTCTTGGATTTACG--AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Metarhodactis     GGTGAAATTCTTGGATTTACGTTAAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Pavona            GGTGAAATTCTTGGATTTACG--AAAGACGAACTACTGCGAAAGCATTTGCCAAGAGTGTTTTCATTAATCA
Fungicyathus sp.  GGTGAAATTCTTGGATTTACG--AAAGACGAACTACTGCGAAAGCATTTGCCAAGAGTGTTTTCATTAATCA
Fungia            GGTGGAATTCTTGGATTTACGT-AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Enallopsammia     GGTGAAATTCTTGGATTTACGT-AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Porites           GGTGGAATTCCTGGATTTACGTTAAAGACGAACTACTGCGAAAGCAGTTGCCAGGAATATTTTC-TTAATCA
Tubastraea        GGTGAAATTCTTGGATTTACGT-AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Montastrea        GGTGAAATTCTTGGATTTACG--AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Balanophyllia     GGTGGAATTTTTGGATTTACG--AAAGACGAACTACTGCGA-AGCAGTTGCCAGGAATGTTTTCATTAATCA
Oculina           GGTGAAATTCTTGGATTTACG--AAAGACGAACTACTGCGAAAGCATTTGCCAAGAATGTTTTCATTAATCA
Lobophyllia       GGTGAAATTTTTGGATTTACG--AAAGACGAAATACTGCGAAAGCATTTGCCAAAGATGTTTTCATTAATCA
Catalaphyllia     GGTGGAATTTTTGGATTTACG--AAAGACGAAATACTGCGAAAGCATTTGCCAAGAAAGTTTTCATTAATCA
Cerianthus 18S    GGTGAAATTCTTGGATTTACG--AGTGACGAACTACTGCGAAAGCATTTGCCAAGAACGCTCTCATTAATCA
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Taxon/Node        901234567890123456789012345678901234567890123456789012345678901234567890
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Metridium         AGAACGAGCAAGTTAGAGGCATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCGAC
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Anthopleura       AGAACGAGCAAGTTAGAGGCCTCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCGAC
Stichodactyla     AGAACGAGCAAGTTAGAGGCCTCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACGGGATGCCGAC
Bathyphellia sp.  AGAACGAGCAAGTTAGAGGCATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCGAC
Corynactis c      AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
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Corallimorphus    AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Ricordea          AGAACGATAAAGTTAGAGGCATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Discosoma C1      AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
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Actinotryx        AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Rhodactis         AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Amplexidiscus     AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCGAC
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Fungicyathus sp.  AGAACGATAAAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Fungia            AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Enallopsammia     AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Porites           AGAACGATAAAGTTAGAGGTATCGAAGACGATCAGATACGGTCCTAGTTCGAA-------------------
Tubastraea        AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Montastrea        AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Balanophyllia     AGAACGA-------AGAGG----GAAGACGATGAGATACCGCCCTAGTTCTAACCATAAACG--ATGCCAAC
Oculina           AGAACGA--AAGTTAGAGG-ATCGAAGACGATCAGATACCGTCCTAGTTCTAACCATAAACG--ATGCCAAC
Lobophyllia       AGAACGA--AAGTTAGAGG-ATCGGAGACGATCAGA------------------------------------
Catalaphyllia     AGAACGA--AAGTTAGAGG-ATCGGAGACGATCAGA------------------------------------
Cerianthus 18S    AGAACGA--TAGTTAGAGG-CTCGAAGACGATCAGATACCGTCCTAGTTCTAACCGTAAACG--ATGCCGAC


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                  888888888999999999900000000001111111111222222222233333333334444444444555
Taxon/Node        123456789012345678901234567890123456789012345678901234567890123456789012
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Aiptasia          TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Metridium         TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Edwardsia         TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTT-ATGGGAAACCAAAGCTTTTGGGTTCCG
Nematostella      TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Anthopleura       TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTT--ATGGAAACCAAAGTTTTTGGGTTCCG
Stichodactyla     TAGGGATCAGAGAGTGTTATTGG-ATGACC-TCTTTGGCACCTTAATGGGAAACCAAAGTTTTTGGGTTCCG
Bathyphellia sp.  TAGGGATCAGAGAGTGTTATTGGGATGACCCTCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Corynactis c      TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Corynactis v      TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Corallimorphus    TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTGTTTGGGTTCCG
Ricordea          TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-TCGGGAAACCAAAGTGTTTGGGTTCCG
Discosoma C1      TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-TCGGGAAACCAAAGTGTTTGGGTTCCG
Discosoma num     TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-TCGGGAAACCAAAGTGTTTGGGTTCCG
Actinotryx        TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-TCGGGAAACCAAAGTGTTTGGGTTCCG
Rhodactis         TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-TCGGGAAACCAAAGTGTTTGGGTTCCG
Amplexidiscus     TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTC-ACGGGAAACCAAAGTGTTTGGGTTCCG
Metarhodactis     TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTCCACGGGAAACCAAAGTGTTTGGGTTCCG
Pavona            TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Fungicyathus sp.  TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Fungia            TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Enallopsammia     TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Porites           ------------------------------------------------------------------------
Tubastraea        TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Montastrea        TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Balanophyllia     TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACCTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Oculina           TAGGGATCAGAGGGTGTTATTGG-ATGACC-CCTTTGGCACTTT-ATGGGAAACCAAAGTTTTTGGGTTCCG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    TAGGGATCGGAGAGGGACATGCA---TACC-TCTTCGGCACCTT-GTGGGAAACCAAAGTTTTTGGGTTCCG
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Taxon/Node        345678901234567890123456789012345678901234567890123456789012345678901234
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Aiptasia          GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Metridium         GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Edwardsia         GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Nematostella      GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Anthopleura       GGG-AAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGG-
Stichodactyla     GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Bathyphellia sp.  GGGGAAGTAT---GGTTGCAAATC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGG
Corynactis c      GGGGAAGTATT--GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Corynactis v      GGGGAAGTATT--GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Corallimorphus    GGGGAAGTATT--GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Ricordea          GGGGAAGTATT--GGTTGCAAAGCCTGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Discosoma C1      GGGGAAGTAT---GGTTGCTAAGCCTGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Discosoma num     GGGGAAGTAT---GGTTGCTAAGCCTGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Actinotryx        GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Rhodactis         GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG--CCACCACCAGGAGTGGA
Amplexidiscus     GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG---CACCACCAGGAGTGGA
Metarhodactis     GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGG---CACCACCAGGAGTGGA
Pavona            GGGGAAGTAT---GGTTGCAAAGC-TGAGACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Fungicyathus sp.  GGGGAAGTATTATGGTTGCAAAGC-TGAGACTTAAAGGAATTGACGGAAGGGGCGCCACCACCAGGAGTGGA
Fungia            GGGGAAGTATTA-GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGGGCGCCACCACCAGGAGTGGA
Enallopsammia     GGGGAAGTATTA-GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Porites           ------------------------------------------------------------------------
Tubastraea        GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Montastrea        GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Balanophyllia     GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Oculina           GGGGAAGTAT---GGTTGCAAAGC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACCAGGAGTGGA
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    GGGGAAGTAT---GGTTGCAAATC-TGAAACTTAAAGGAATTGACGGAAGGG----CACCACAAGGAGTGGA


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                  222223333333333444444444455555555556666666666777777777788888888889999999
Taxon/Node        567890123456789012345678901234567890123456789012345678901234567890123456
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Aiptasia          GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Metridium         GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Edwardsia         GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Nematostella      GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Anthopleura       -CATGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Stichodactyla     GCCTGCG-CTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCGGACATAGGAAGGATTGACAGATTGAG
Bathyphellia sp.  GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGGAAGGATTGACAGATTGAG
Corynactis c      GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Corynactis v      GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Corallimorphus    GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Ricordea          GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Discosoma C1      GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Discosoma num     GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Actinotryx        GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Rhodactis         GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Amplexidiscus     GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Metarhodactis     GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Pavona            GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Fungicyathus sp.  GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Fungia            GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTAAGGATTGACAGATTGAG
Enallopsammia     GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Porites           ------------------------------------------------------------------------
Tubastraea        --CTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGTCAGATTGAG
Montastrea        GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTAAGGATTGACAGATTGAG
Balanophyllia     GCCTGCG-CTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Oculina           GCCTGCGGCTTAATTTGACTCAACACGGGGAAACTCACCAGGTCCAGACATAGTGAGGATTGACAGATTGAG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    GCCTGCGGCTTAATTTGACTCAACACGGGAAAACTCACCAGGTCCGGACATGGGAAGGATTGACAGATCGAG
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Taxon/Node        789012345678901234567890123456789012345678901234567890123456789012345678
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Aiptasia          AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Metridium         AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Edwardsia         AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Nematostella      AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Anthopleura       AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Stichodactyla     AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Bathyphellia sp.  AGACTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Corynactis c      AGACTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Corynactis v      AGACTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Corallimorphus    AGACTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Ricordea          AGACTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Discosoma C1      AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Discosoma num     AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Actinotryx        AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Rhodactis         AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Amplexidiscus     AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Metarhodactis     AGCCTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Pavona            AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Fungicyathus sp.  AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Fungia            AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Enallopsammia     AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Porites           ------------------------------------------------------------------------
Tubastraea        AG-CGCGTGCTTGAGTCTATGGGTGGTGGTGCATGGCCGGGCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Montastrea        AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Balanophyllia     AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Oculina           AG-CTCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGTGATTTGTCTGGTTAAT
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    AGACCCTTTCTTGATTCTATGGGTGGTGGTGCATGGCCGTTCTTAGTTGGTGGAGCGATTTGTCTGGTCAAT


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Taxon/Node        901234567890123456789012345678901234567890123456789012345678901234567890
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Aiptasia          TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGCGGCTAACTTCTTAGAGG
Metridium         TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCTCGATTCGCGGCTAACTTCTTAGAGG
Edwardsia         TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCTCGATTCGCGGCTAACTTCTTAGAGG
Nematostella      TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCTAATCTCGATTGGCGGCTAACTTCTTAGAGG
Anthopleura       TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGTCG-TCTCGACGGGCGGCTAACTTCTTAGAGG
Stichodactyla     TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCTCGATTGGCGGCTAACTTCTTAGAGG
Bathyphellia sp.  TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTCACGCGAATCTCGATTCTCGGCTGACTTCTTAGAGG
Corynactis c      TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTGACGCGAATCCCGATTCGCGGTTCACTTCTTAGAGG
Corynactis v      TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTGACGCGAATCCCGATTCGCGGTTCACTTCTTAGAGG
Corallimorphus    TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTGACGCGAATCCCGATTCGCGGTTAACTTCTTAGAGG
Ricordea          TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTCGCGGTTCACTTCTTAGAGG
Discosoma C1      TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Discosoma num     TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Actinotryx        TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Rhodactis         TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Amplexidiscus     TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Metarhodactis     TCCGTTAACGAACGAGACCTTGACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAGCTTCTTAGAGG
Pavona            TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGCGGTTAACTTCTTAGAGG
Fungicyathus sp.  TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGCGGTTAACTTCTTAGAGG
Fungia            TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGCGGTTAACTTCTTAGAGG
Enallopsammia     TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGTGGTAAACTTCTTAGAGG
Porites           ------------------------------------------------------------------------
Tubastraea        TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTAC-CGAATCCCGATTCGCGGTAAACTCCTTAGAGG
Montastrea        TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCCAATCCCGATTGGCGGTTAACTTCTTAGAGG
Balanophyllia     TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGAATCCCGATTCGTGGTAAACTTCTTAGAGG
Oculina           TCCGTTAACGAACGAGACCTTAACCTGCTAAATAGTTACGCGGATCCCGATCCGCGGTGAACTTCTTAGAGG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    TCCGATAACGAACGAGACCTTTACCTGCTAGTTAGCGCGGCAGTTTTCGAACGAGCACGAGCTTCTTAGAGG
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Taxon/Node        123456789012345678901234567890123456789012345678901234567890123456789012
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Aiptasia          GACTGTTGGTGTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Metridium         GACTGTTGGTGTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Edwardsia         GACTGTTGGTGTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Nematostella      GACTGTTGGTGTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Anthopleura       GACTGTTGGTGTTTAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGG-CCGG
Stichodactyla     GACTGTTGGTGTTTAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Bathyphellia sp.  GACTGTTGGTGTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Corynactis c      GACTGTTGGTGTTTAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Corynactis v      GACTGTTGGTGTTTAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Corallimorphus    GACTGTTGGTGCTTAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Ricordea          GACTGTTGGTGCCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Discosoma C1      GACTGTTGGTTTCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTATATGTTCTGGGCCGC
Discosoma num     GACTGTTGGTTTCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTATATGTTCTGGGCCGC
Actinotryx        GACTGTTGGTTTCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Rhodactis         GACTGTTGGTTTCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Amplexidiscus     GACTGTTGGTTTTCAACCAAAGTCAGGAAGGCAAATAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Metarhodactis     GACTGTTGGTTTTCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Pavona            GACTGTTGGTATGCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Fungicyathus sp.  GACTGTTGGTATGCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Fungia            GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Enallopsammia     GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Porites           ------------------------------------------------------------------------
Tubastraea        GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGGCTGTGATGCCCTTAGATGTTCTGGGCCGC
Montastrea        GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Balanophyllia     GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Oculina           GACTGTTGGTATCCAACCAAAGTCAGGAAGGCAA-TAACAGGTCTGTGATGCCCTTAGATGTTCTGGGCCGC
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    GACTGTTGCTGCGTAAGAAAAGTCAGAAAGGCGA-TAACAGGTCTGTGATGCCCTTAGACGTTCTGGGCCGC


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Taxon/Node        345678901234567890123456789012345678901234567890123456789012345678901234
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Aiptasia          ACGCGCGCTACACTGACGATGTCAACGAGTCTCTCCTTCGCCGAAAGGCGTGGGTAATCTTCTGAAACATCG
Metridium         ACGCGCGCTACACTGACGATGTCAACGAGTCTCTCCTTCGCCGAAAGGCGTGGGTAATCTTTTGAAACATCG
Edwardsia         ACGCGCGCTACACTGACGGTGTCAACGAGTCTTTCCTTCGCCGGAAGGCGTGGGTAATCTTTTGAAACATCG
Nematostella      ACGCGCGCTACACTGACGGTGTCAACGAGTCTTTCCTTCGCCGGAAGGCGTGGGTAATCTTGTGAAACATCG
Anthopleura       ACGCGCGCTACACTGACGATGTCAACGAGTCTCTCCTTGGCCGAAAGGTCTGGGTAATCTTATGAAACATCG
Stichodactyla     ACGCGCGCTACACTGACGATGTCAACGAGTCTCTCCTTGGCCGAAAGGTCTGGGTAATCTTGGCAAACATCG
Bathyphellia sp.  ACGCGCGCTACACTGACGATGTCAACGAGTCTCTCCTTCGCCGATAGGCGTGGGTAATCTTGTGAAACATCG
Corynactis c      ACGCGCGCCACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTGT-AAACATCG
Corynactis v      ACGCGCGCCACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTGT-AAACATCG
Corallimorphus    ACGCGCGCCACACTGACGATGTCAGAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTAC-AA-CATCG
Ricordea          ACGCGCGCCACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Discosoma C1      ACGCGCGCTACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Discosoma num     ACGCGCGCCACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Actinotryx        ACGCGCGCTACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Rhodactis         ACGCGCGCTACACTGACGATGTCAAAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Amplexidiscus     ACGCGCGCTACACTGACGATGTCAAAGAGTGTCTCCTTCGCCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Metarhodactis     ACGCGCGCTACACTGACGATGTCAAAGAGTGTCTCCTTCGCCGAGAGGTGTGGGTAATCTTTC-AAACATCG
Pavona            ACGCGCGCTACACTGACGATGTCAAAGAGTATCTCCTTCACCGAGAGGTGTGGGTAATCTTCT-AAACATCG
Fungicyathus sp.  ACGCGCGCTACACTGACGATGTCAAAGAGTATCTCCTTCACCGAGAGGTGTGGGTAATCTTCT-AAACATCG
Fungia            ACGCGCGCTACACTGACGATGTCAGAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTGT-AAACATCG
Enallopsammia     ACGCGCGCTACACTGACGATGTCAGAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTTG-AAACATCG
Porites           ------------------------------------------------------------------------
Tubastraea        GCGCGCGCTACACTGTCGATGTCAGAGAGTATCTCCTTCACCGCGAGGTGTGGGGGATCTTTT-AAACATCG
Montastrea        ACGCGCGCTACACTGACGATGTCAGAGAGTGTCTCCTTCACCGAGAGGTGTGGGTAATCTTGC-AAACATCG
Balanophyllia     ACGCGCGCTACACTGACGATGTCAGAGAGTACTTCCTTCACCGAGAGGT-TGGGTAATCTTGG-AAACATCG
Oculina           ACGCGCGCTACACTGACGATGTCAAAGAGTGCATCCTTCACCGAGAGGTGTGGGTAATCTTGG-AAACATCG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    ACGCGCGCTACACTGACGGCCTCAGCGAGCCGGTCCTTTGCCGGAAGGCACGGGAAATCTTCTGAAATGTCG
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                  555555555555555666666666666666666666666666666666666666666666666666666666
                  888889999999999000000000011111111112222222222333333333344444444445555555
Taxon/Node        567890123456789012345678901234567890123456789012345678901234567890123456
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Aiptasia          T-CGTGCTGGGGATAGATCATTGCAATTCTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Metridium         T-CGTGCTGGGGATAGATCATTGCAATTCTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Edwardsia         T-CGTGCTGGGGATAGATCATTGCAATTATTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Nematostella      T-CGTGCTGGGGATAGATCATTGCAATTATTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Anthopleura       T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Stichodactyla     T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Bathyphellia sp.  T-CGTGCTGGGGATAGATCATTGCAATTCTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Corynactis c      T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Corynactis v      T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Corallimorphus    T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Ricordea          T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCACCAG
Discosoma C1      T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCACCAG
Discosoma num     T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCACCAG
Actinotryx        T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCACCAG
Rhodactis         T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCACCAG
Amplexidiscus     TTCGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Metarhodactis     T-CGTGCTGGGGATAGATCATTGCAATTGTTGATCTTGAACGAGGAATTCCCTAGTAAGCGCGAGTCATCAA
Pavona            T-CGTGCTGGGGATAGATCATTGCAATTATTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Fungicyathus sp.  T-CGTGCTGGGGATAGATCATTGCAATTATTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Fungia            T-CGTGCTGGGGATAGATCATTGCAATTATTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Enallopsammia     T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Porites           ------------------------------------------------------------------------
Tubastraea        C-CGTGCTGGGGATAGAGCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Montastrea        T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Balanophyllia     T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Oculina           T-CGTGCTGGGGATAGATCATTGCAATTTTTGATCTTGAACGAGGAATTCC-TAGTAAGCGCGAGTCATCAG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    T-CGTGATGGGGATAGGTCGTTGCAATTCTCGACCTTGAACGAGGAATTCC-TTGTAAGCGCGAGTCATCAG


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                  666666666666666666666666666666666666666666677777777777777777777777777777
                  555666666666677777777778888888888999999999900000000001111111111222222222
Taxon/Node        789012345678901234567890123456789012345678901234567890123456789012345678
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Aiptasia          C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Metridium         C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Edwardsia         C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCN-GTCGCTACTACCG-ATTGAATGGTTTAG
Nematostella      C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Anthopleura       C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Stichodactyla     C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Bathyphellia sp.  C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGA-TGGTTTAG
Corynactis c      C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Corynactis v      C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Corallimorphus    CTCGCGTGATTACGTCCCTGCCCTTTGTACACACGCCGTCGCT-ACTACGATGGATTGATTAGTGAGCTTC-
Ricordea          C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Discosoma C1      CCTCGCGT-TGATTACGTCCCTGCTCTTT-GTACACACCGTCCCGTCGCTACTACCG-ATGGACTGATTTA-
Discosoma num     CCTCGCGT-TGATTACGTCCCTGCTCTTT-GTACACACCGTCCCGTCGCTACTACCG-ATGGACTGATTTA-
Actinotryx        C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Rhodactis         C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Amplexidiscus     C-TCGCGT-TGATTACGTCCCTGCCCTTTTGTACACACCGCCCGTTCGCTACTACCGGATTGAATGATTTAG
Metarhodactis     GCTCGCGTTTGATTACGTCCCTGCCCTTTTGTACACACCGCCC-GTCGCTACTACCGGATTGAATTGGTTT-
Pavona            C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACCACCG-ATTGAATGGTTTAG
Fungicyathus sp.  C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACCACCG-ATTGAATGGTTTAG
Fungia            C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Enallopsammia     C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Porites           ------------------------------------------------------------------------
Tubastraea        C-TCGCGT-TGATTACGTGCCTGTCCTTT-GTACACACCGCCC-GTCGCTACTATCG-ATTGAATGGTTTAG
Montastrea        C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Balanophyllia     C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Oculina           C-TCGCGT-TGATTACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATTGAATGGTTTAG
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    C-TCGCGT-TGAATACGTCCCTGCCCTTT-GTACACACCGCCC-GTCGCTACTACCG-ATCGAATGGTTTAG
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                  777777777777777777777777777777777777777777777777777777777777777777777778
                  233333333334444444444555555555566666666667777777777888888888899999999990
Taxon/Node        901234567890123456789012345678901234567890123456789012345678901234567890
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Aiptasia          TGAGGACTCCTGA-TTGGCGCCGCCGC--CCCGGCAACGGAGCAGCGGACTGCCGAAAAGTTGTTCAAA-CT
Metridium         TGAGGACTCCTGA-TTGGCGCCGCCGC--CCCGGCAACGGAGCAGCGGACTGCCGAAAAGTTGTTCAAA-CT
Edwardsia         TGAGGCCTCCTGA-TTGGCGCCGCCGC--CCCGGCAACGGAGCAGTGGATTGTCGAAAAGTTGGTCAAA-CT
Nematostella      TGAGGCCTTCTGA-TTGGCGCCGCGGC--CCCGGCAACGGAGCCACGGATTGTCGAAAAGTTGGTCAAA-CT
Anthopleura       TGAGGACTCCTGA-TTGGCGCCG-CGC--CCCGGCAACGGAGCAGCGGAATGCCGAAAAGTTGTTCAAA-CT
Stichodactyla     TGAGGACTCCTGA-TTGGCGCC--------------------------------------------------
Bathyphellia sp.  TGAGA-CTCCTGA-T-GGCGCCGCCGC--CCCG--CACG-AGCAG-AGACTGCCGAAG---TGGTCAAA-CT
Corynactis c      TGAGGCCTCCTGA-TTGACGCCGATAT--TCTGGCAACAGAGCGTCGGA-TGTTGGGAAGTTGGTCAAA-CT
Corynactis v      TGAGGCCTCCTGA-TTGACGCCGATAT--TCTGGCAACAGAGCGTCGGA-TGTTGGGAAGTTGGTCAAA-CT
Corallimorphus    TGAATGCGCGATTTCTGCAACGAGCGTCCGATGCCGGAAGTGGTCACCT-GATCATAAGAGTAAAGTCG-TA
Ricordea          TGAGGCCTCCTGA-CTGGCGCCGGCGC--TCTGGCGACAGAGGGTTGGA-TGCCGGGAAGTTGGTCAAA-CT
Discosoma C1      TGAGGCCTCCTGACTTGACGTCGGCACCTCTGCACGCGCTT-------------------------------
Discosoma num     TGAGGCCTCCTGACTTGACGTCGGCACCTCTGCACGCGCTT-------------------------------
Actinotryx        TGAGGCCTCCTGA-CTGGCGCCGGCGC-TCTGG-CGACAGAGGGTTGGA-TGCCGGGAAGTTGGTCAAA-CT
Rhodactis         TGAGGCCTCCTGA-CTGGCGCCGGCGC-TCTGG-CGACAGAGGGTTGGA-TGCCGGGAAGTTGGTCAAA-CT
Amplexidiscus     TGAGGCCTCCTTGACTGGCGCGGACCCCGCTTGCCGACCGGAGGGGTAA-TGCCGGTAAGTTGGGTCAA-CT
Metarhodactis     AGTGGAGGCCCTCCTTGAACTTGGCGCCGAACGCCTCC----------------------------------
Pavona            TGAGGCCTCCTGA-CTGGCGCCGATAC--TCTGGCAACAGAGCGCCGGA-TGCCGGAAAGTTGGTCAAA-CT
Fungicyathus sp.  TGAGGCCTCCTGA-CTGGCGCCGATAC--TCTGGCAACAGAGCGCCGGA-TGCCGGAAAGTTGGTCAAAACT
Fungia            TGAGGCCTTCTGA-CTGGCGCCGATGC--TCTGGCAACAGAGCGCCGGA-TGCCGGAAAGTTGGTCAAA-CT
Enallopsammia     TGAGGCCTTCTGA-CTGGCGCCGATAC--TCTGGCAACAGAGCGCCGGA-TGCCGGGAAGTTGGTCAAA-CT
Porites           ------------------------------------------------------------------------
Tubastraea        TGAGGGCTTCTGA-CTGTCGCCGCTAC---CTGGCAACAGAGCGGCGGA-TTTCGGGAAGTTGGGGAAG-CT
Montastrea        TGAGGCCTCCTGA-CTGGCGCCGATAC--TCTGGCAACAGAGCGCCGGA-TGCCGGAAAGTTGGTCAAA-CT
Balanophyllia     TGAGGCCTTCTGA-CTGGCGCCGATGC--TCTGGCAACAGAGCGTCGGC-CGCCGGGAAGTTGTTCAAA-CT
Oculina           TGAGGCCTTCTGA-CTGGCGCCGACAC--TCTGGCGACAGAGAGTCGGA-TGCCGGAAAGTTGGTCAAA-CT
Lobophyllia       ------------------------------------------------------------------------
Catalaphyllia     ------------------------------------------------------------------------
Cerianthus 18S    TGAGGCCTCCCGA-TCGGCGCCGCCTC----CTTCAAAGGAAAGCGGACCGTCCGAAAAGTCGGTCAAA-CT

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                  88888888888888888888888888888888888888888888888888888888888888888888888
                  00000000011111111112222222222333333333344444444445555555555666666666677
Taxon/Node        12345678901234567890123456789012345678901234567890123456789012345678901
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Aiptasia          TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCA--------
Metridium         TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCTGCAGAAGGATCA--------
Edwardsia         TGA--------------------------------------------------------------------
Nematostella      TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGG-------------------------------------
Anthopleura       TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGATCATTA-----
Stichodactyla     -----------------------------------------------------------------------
Bathyphellia sp.  GGATCATTTA----AAGAGTAAGTCGTAACAAAGTTCGTATG-----------------------------
Corynactis c      TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATCA-----
Corynactis v      TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATCA-----
Corallimorphus    ACAGTCCGTAGTGTGAC------------------------------------------------------
Ricordea          TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGACAGGGAAGGAAAAAAAAAAAAAAA
Discosoma C1      -----------------------------------------------------------------------
Discosoma num     -----------------------------------------------------------------------
Actinotryx        TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGACAGGGAAGGAAAAAAAAAAAAAAA
Rhodactis         TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGACAGGGAAGGAAAAAAAAAAAAAAA
Amplexidiscus     TGATCAATTTAAGCAAGTAAAGTTTCGTACACAGGTTTTCCTGCTCGTGAAG-------------------
Metarhodactis     -----------------------------------------------------------------------
Pavona            TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATCA-----
Fungicyathus sp.  TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCCTATGCAGAAGGATCA-----
Fungia            TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATCA-----
Enallopsammia     TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATCA-----
Porites           -----------------------------------------------------------------------
Tubastraea        TGAGTATTTAGAGGAAGTTAAAGTCGTAACAAGGTTTCCGTAGGTGAACTGCGGAAGGGGTCATTA-----
Montastrea        TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACC---TGCAGAAGGATC------
Balanophyllia     TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCTGCGGAAGGA-----------
Oculina           TGATC------------------------------------------------------------------
Lobophyllia       -----------------------------------------------------------------------
Catalaphyllia     -----------------------------------------------------------------------
Cerianthus 18S   TGATCATTTAGAGGAAGTAAAAGTCGTAACAAGGTTTCCGTAGGTGAACCTGCAGAAGGATC---------
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Appendix 5. Alignment of combined molecular data

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[                         10        20        30        40        50]
Actinotryx        GACAAGTAATGTTAGCGAGGGAAAGGGGCGTAGGCCGAAATAATGTACGG
Amplexidiscus     GGCGAGCAATGATAG-GAAGGAAAGGGGCGTAGGCCGAAATAATGCACGG
Anthopleura       TCTGCTAGCTATCTGAGGAGAGGGAAGGTGTAACTCAACTCGGTGCAACG
Aiptasia          TCTGCTAGCTATCTGAGGAGGGAAAGAGTGTAAGTCAACTCGGTGCAACG
Balanophyllia     -----------------------AAGGGTGTAGACCAGCTTAATACAACG
Bathyphellia      -CTGCCAGCTATCTGA----------------------------------
Caryophyllia      -----------------------AAAAGTTTTTTCTCAC-ATATACAACG
Catalaphyllia     -----------------------AAAAGTTTTTTCTTAT-AAACACAACA
Cerianthus        -------AAGGCCTAAGGGAAGTGATAAAAAAAGAGTTATTAATTCTCCG
Corallimorphus    TGTGAATTGTGATTT-TGGGGAAAAGGGCGTTGGCCGACTTAATGTAACG
Corynactis_c      TGTGAATTCTGATTTATGGGGAAAAGGGCGTTGGCCGACTTAATGTAACG
Corynactis_v      --T-AAT-CCGATTTATGGGGAAAAGGGCGTTGGCCGACTTAATGTAACG
Dendrophyllia     -----------------------AAGGGTGTAGACCAGCTTAATACAACG
Discosoma_neg     GGAGGGC-ATGTTAG-GAAGGACAGGGGCGTAGGCCGAAATAATGTACGG
Discosoma_num     GGAATGCTATGAAGA-GAAGGACAGGGGCGTAGGCCGAAATAATGTACGG
Edwardsia         ------------------GACGAAAGAGCGAAGATCACTTTGATGCAACG
Enallopsammia     ---------TGGTAGAGAAAGAAAAGGGTGTAGACCAGCTTAATACAACG
Flabellum         -----------------------AAGGGTGTAGACCAGCTTAATTCAACG
Fungia            -----------------------AAAAATTTTTTCTTAT-AAATACAACA
Fungiacyathus     -------------------------------------------TTCATTG
Lobophyllia       -----------------------AAAAGTTTTTTCTTAT-AAATATAACA
Metarhodactis     GCCCAGCTTTGTTAGAG-AGGACAGGGGCGTAGGCCGAAATAATGTATGG
Metridium         ----------------------------------------------TACG
Montastrea        ----------------------TTTAGTCT----CCGTA-ATACAGTGAC
Nematostella      ------------------GACGAAAGAGCGAAGATCACTTTGATGCAACG
Oculina           -----------------------AAAAGTTTTTTCTTAC-AAATACAACA
Pavona            -----------------------TAAGGTGTAAGCGAATTAAATTTAACG
Porites           -----------------------AAGGGTGTAAACCAACTTAATACAACG
Rhodactis         GGA-AGCTTGAATAG-G-AGGAAAGGGGCGTAGGCCGAAATAATGCACGG
Ricordea          ---AAGTA-TGTTAGCGGGGGTAGGGGGCGTAGGTCGATTTAATGTAAGG
Tubastrea         -----------------------AAGGGTGTAGACCAGC-TAATACAACG
Stichodactyla     TCTGCTAGCTATCTGAGGAGGGAAAGAGTGTAAGTCAACTTGGTGCAACG

[                         60        70        80        90        100]
Actinotryx        CATCATCGCTGTAGTCTCAGAAATCCCTTGTAGAAATCAATAGATGGAGG
Amplexidiscus     CATCATCGCTGTAGTCTCAGAAATCCCCTGTAGAAATCAATAGATGGAGG
Anthopleura       CTTCACCGCCATAGCCCCAGAGGCTCTCCACAGAAGCCTAAAGAATGGAA
Aiptasia          CTTCACCGCCGTAGCCCCAGAGGCTCTCCACAGAAGCCTAAAGAATGGAA
Balanophyllia     CTTCATCGCTGTGGTCTCAGGAATTTCCAG-GGAAACCAATAAGTGGAGG
Bathyphellia      -------GCCGTAGCCCCAGAGGCTCTCCACAGAAGCCTAAAGAATGGAA
Caryophyllia      TACCTTCACTGTAATTCTTAAAACACTCAATAGAAATAAATAGGTGGGGA
Catalaphyllia     TATCTTTACTGTAATTTCTAAAATACTTAATAGAAATAAAAAGGTGGGGA
Cerianthus        TACCCTCAACGTGTCTTGAGAAAAACCCAGCATAAGTATTAAGAATAGGG
Corallimorphus    CATCATCGCTGCGGTCTCAGAAATCCCCAGTAGATAAAAATGGGTGAAGG
Corynactis_c      CATCATCGCTGCGGTCTCAGAAATCCCCAGTAGATAAAAATGGGTGAAGG
Corynactis_v      CATCATCGCTGCGGTCTCAGAAATCCCCAGTAGATAAAAATGGGTGAAGG
Dendrophyllia     CTTCATCGCTGTGGTCTCAGGAATTTCCAGTAGAAACCAATAAGTGGAGG
Discosoma_neg     CATCATCGCTGTAGCCTCAGAAATCCCCTGTAGAAATCAATAGATGGAGG
Discosoma_num     CATCATCGCTGTAGTCTCAGAAATCCCTTGTAGAAATCAATAGATGGAGG
Edwardsia         CTTCACCGCCGTAGCCCCAGAAGCCCCCCGCAGAAGCCAAAAGAATGGAG
Enallopsammia     CTTCATCGCTGTGGTCTCAGGAATTTCCAGTAGAAACCAATAAGTGGAGG
Flabellum         CTTCATCGCTGTGGTCTCAGGAATTTCCAGTAGAAACCAATAAGTGGAGG
Fungia            TATATTCATTATAATTTTTAAAATACTTAATAGAAATAAAAAGGTGGGGA
Fungiacyathus     CTTCATCGCTGTGGTCTCAGAAATTTCCAGTAGAAACC-ATAAGTGGAGG
Lobophyllia       TATCTTTACTGTAATTTCTAAAATACTTAATAGAAATAAAAAGGTGGAGA
Metarhodactis     CATCATCGCTGTAGCCTCAGAAATCCCCTGTAGAAATCAATAGATGGAGG
Metridium         CTTCACCGCCGTAGCCCCAGAGGCTCTCCACAGAAGCCTAAAGAATGGAA
Montastrea        C-TCCCGCTACGGTAAACTGGGGCCGCACATGTTAGCGAATTAGAGTAAG
Nematostella      CTTCACCGCCGTAGCCCCAGAAGCCCCCCGCAGAAGCCAAAAGAATGGAG
Oculina           TATCTTCACTGTAATTCCTAAAATACTTAATAGAAATAAAAAGGTGGGGA
Pavona            CAAAATCACTGTGGTCTCGGGAATTTCCAGTAGAAACTAATAAGTGGAGG
Porites           CTTCATCGCTGTGGTCTCAGAAATGTCCAGTAGAAACCAATAAGTGGAGG
Rhodactis         CATCATCGCTGTAGTCTCAGAAATCCCCTGTAGAAATCAATAGATGGAGG
Ricordea          CATCTTCGCTGTAGCCTCAGAAATCTCCTGTAATTACAATTAGGTGGAGG
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Tubastrea         CTTCATCGCTGTGGTCTCAGGAATTTCCAGTAGAAACCAATAAGTGGAGG
Stichodactyla     CTTCACCGCCGTAGCCCCAGAGGCTTTCCACAGAAGCCTAAAGAATGGAA

[                        110       120       130       140       150]
Actinotryx        AGACATGTG-------TCTATCTG------ACGAGTTAGATTTTTACTGT
Amplexidiscus     AGACATGTG-------TCTATCTG------ACGAGTTAGATTTTTACTGT
Anthopleura       AGACGTATG--CGA--AATAACTT--------AAAATAGATAT-GTCCGT
Aiptasia          AGACGCATG-------TCAAAATAATTGATTTAAAATAGATAT-GCCCGT
Balanophyllia     AAACATGTGAAATTATTATTTCTT------ACAAAT-TTTAATTTACCTC
Bathyphellia      AGACGCATG-------TCAAAATAATTGATTTAAAGTAGATAT-GTCCGT
Caryophyllia      AAGCAAAAACCCTTATAATTTTTT--------------------TTTTAT
Catalaphyllia     GGGCAGAAACCCTTATATTTTATA--------------------------
Cerianthus        ATGCATGTGTAATAAAAATGGTTATATAAATAAGATTAGTTATGAATAGT
Corallimorphus    AGACATAAGTGACTGCTCAATCAGGCACTAACAAATCAGACTTTTACCGT
Corynactis_c      AGACATGTGTGACTGCTCAATCAGGCACTAACAAATCAGACTTTTACCGT
Corynactis_v      AGACATGTGTGACTGCTCAATCAGGCACTAACAAATCAGACTTTTACCGT
Dendrophyllia     AAACATGTGAAATTATTATTTCTT------ACAAAT-TTTAATTTACCTC
Discosoma_neg     AGACATGTG-------TCTATCTG------ACGAGTTAGATTGTTACTGT
Discosoma_num     AGACATGTG-------TCTATCTG------ACGAGTTAGATTTTTACTGT
Edwardsia         AAACGCATGAA-----ATTAACTT--------AAAATAGATA-GGTCCGT
Enallopsammia     AAACATGTGAAATTATTATTTCTT------ACAAATTTTTAATTTACCCC
Flabellum         AGACATGTGAAATTATTATTTCTT------ACAAAT-TTAAATTTACCCC
Fungia            AAACAAGAGCCGTTATATTTTCTA--------------------------
Fungiacyathus     AGACATGAGAAATTATTATTTCTT------ACAAAT-TTAAATTTACCTC
Lobophyllia       GGGCAGGGGCCGTTAT-TTTTCTA--------------------------
Metarhodactis     AGACATGTG-------TCTATCTG------ACGAGTTAGATTGTTACTGT
Metridium         AGACGCATG-------TCAAAATAATTGATTTAAAATAGATAT-GCCCGT
Montastrea        AAATGAGAACCGTTATGCCTTCGG----GAACGCGC-GGTGCTTCTCAGC
Nematostella      AAACGCATGAA-----ATTAACTT--------AAAATAGATA-GGTCCGT
Oculina           AAGCAAGAACCCTTATATTTTCTA--------------------------
Pavona            AGACATGT-CCCTTATGCTGACTT----------AT-TTAAATTGCTCAA
Porites           AAACATGTGAAATTATTATTTCTT------ACAAAT-TTAAATTTACCTC
Rhodactis         AGACATGTG-------TCTATCTG------ACGAGTTAGATTTTTACTGT
Ricordea          AGATATATG-------CCTATCTG------ACAGATTAGATTTTTACTGT
Tubastrea         AAACATGTGAAATTATTATTTCTT------ACAAAT-TTTAATTTACCTC
Stichodactyla     AGACGCATG-------TCAAAATAATTGATTTAAAGTAGATAT-GTCCGT

[                        160       170       180       190       200]
Actinotryx        --------------GTAAATTATGGGACTATCTTCTTTTGAGAACATAGA
Amplexidiscus     --------------GTAAATTATGGGGCTGTCTTCTTTTGAAAACGTAGA
Anthopleura       -----------TTGATGAACACTGGAGCTACTTGT--------------A
Aiptasia          ----------TCCGATGAACACTGGAGCTAATTAC--------------A
Balanophyllia     TGATTAAC--GAGGGAAAGCTATGAAGCCATCAAAATTTTAT---GCTTT
Bathyphellia      ----------TTCGATGAACACTGGAGCTAATTAC--------------A
Caryophyllia      CGGTAG--------------------GGCAGCAACCCACGTT-------T
Catalaphyllia     CGGTAG--------------------GGCAGCAACCCACGT--------T
Cerianthus        AATTCTTA--TTCAATTTATCTTAGGACTATCTCCAC--------TAAGA
Corallimorphus    ATGCTTAGGATTTGGTCAACTATGAAGCTATCTTCTTTTGAATCGGTAGA
Corynactis_c      ATGTTTAGAGTTAGGTCAACTATGAAGCTATCTTCTTTTGAATCGGTAGA
Corynactis_v      ATGTTTAGAGTTAGGTCAACTATGAAGCTATCTTCTTTTGAATCGGTAGA
Dendrophyllia     TGATTAAC--GAGGGAAAGCTATGAAGCCATCAAAATTTTAT---GCTTT
Discosoma_neg     --------------GTAAATTATGGGGCTATCTTCTTTTGAGAAGATAGA
Discosoma_num     --------------GTAAATTATGGGGCTATCTTCTTTTGAGAAGATAGA
Edwardsia         -----------AAGATGAACACTGGAGCTA-CTTT--------------A
Enallopsammia     TGATTAAC--GAGGGAAAGCTATGAAGCCATCAAAATTTTAT---GCTTT
Flabellum         CGATTAAC--TAGGTAAAGCCAAGAAGCCATCAAAACTTTAT---GCTTT
Fungia            CGGTAG--------------------GGCAGCAACCCACGT--------T
Fungiacyathus     CGATTACC--TAGGGAAAGCTAAGAAGCCATCAAAGAATTAT---GCTTT
Lobophyllia       CGGTAG--------------------GGCAGCAACCCACGT-----CCGT
Metarhodactis     --------------GTAAATTATGGGGCTATCTTCTTTTGAAAACGTAGA
Metridium         ----------TCCGATGAACACTGGAGCTAATTAC--------------A
Montastrea        CTGTAGTG--AGATGGTTAGTC---AACGAGCAACCCACGTT---TTAGT
Nematostella      -----------AAGATGAACACTGGAGCTA-CTTT--------------A
Oculina           CGGTAG--------------------GGCAGCAACCCACGTT----TAGT
Pavona            CGGTAG----TAGGGAAAGCTATGAAGGCATTAAAAATATAT---GTTTT
Porites           TGATTAAT--TGGGGAAAGCTATGAAGCCATCAAAAACTTAT---GCTTT
Rhodactis         --------------GTAAATTATGGGGCTGTCTTCTTTTGAAAACGTAGA
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Ricordea          TTTCTTAGGATTTAGTAAACTATGGGGTTATCTTCTTTTGAATCGGTAGA
Tubastrea         TGATTAAC--GAGGGAAAGCTATGAAGCCATCAAAATTTTAT---GCTTT
Stichodactyla     ----------TCCGATGAACACTAGAGCTAATTGC--------------A


[                          210       220       230       240       250]
Actinotryx        GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Amplexidiscus     GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Anthopleura       GGGAGAATGCTTGTGTCCACCTGGAGGTAGTTAAGGTCCGAGTACTAGTG
Aiptasia          GGGATAGTGTTTGTGTCCACCTGGAGGTAGTTAAGGTCCGAGTACCGGTG
Balanophyllia     GGGATTTGATTGGCGTCCGCCAAGAGGCGGTTAAGATATACTTG---TAT
Bathyphellia      GGGATAGTGTTTGTGTCCACCTGGAGGTAGTTAAGGTCCGAGTACCGGTG
Caryophyllia      TGCAAGCAATCTACTTTAGTTTAGAAACAATATGAA----CATG-----T
Catalaphyllia     TGCCAGCTTTCGGCTTCAGTTTAAAAACAATATGGA----CATG-----T
Cerianthus        ATGGATTAGTTTACGTCCCCCAGTGGGGCATAAGGTAATAAGAG------
Corallimorphus    GAAATGGGGTTTACGATCGCCTAGAGGTAGGTAAGATACAATTACT-GTC
Corynactis_c      GAAATGGGGTTTACGATCGCCTAGAGGTAGGTAAGATACAATTACT-GTC
Corynactis_v      GAAATGGGGTTTACGATCGCCTAGAGGTAGGTAAGATACAATTACT-GTC
Dendrophyllia     GGGATTAGATTGGCGTCCGCCAAGAGGCGGTTAAGATATACATG---TAT
Discosoma_neg     GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Discosoma_num     GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Edwardsia         GGGACAATGCTTTTGTCCACCTGGAGGCAGTTAAGGTCCGAGTACAAGTG
Enallopsammia     GGGATTTGATTGGCGTCCGCCAAGAGGCGGTTAAGATAACCTTG---TAT
Flabellum         GGGATTTGATTGGCGTCCGCCAAGAGGCGGTTAAGATACAAATG---GAT
Fungia            TGCAAGCTTTTAGCTTCAGTTTAGAAATAATATGGTAA--CATG-----T
Fungiacyathus     GGGATTTGATTGGCGTCCGCCAAGAGGCGGTTAAGATACAATTG---GAT
Lobophyllia       TGCCAGCATTCGGCTTCAGTTTAAAAACAATATGG-----CATG-----T
Metarhodactis     GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Metridium         GGGATAGTGTTTGTGTCCACCTGGAGGTAGTTAAGGTCCGAGTACCGGTG
Montastrea        TGCCAGCATTTTGCT-CAGCCG-GGGGAGGTTGGACGACGCAAG------
Nematostella      GGGACAATGCTTTTGTCCACCTGGAGGCAGTTAAGGTCCGAGTACAAGTG
Oculina           TGCAAGCTTTCGGCTTCAGTTTAGAAACAATATGG-----CATG-----T
Pavona            GGGATTGGATTGACGTCCGCCAAGAGGCGATTAAGATGTAGATG---TAT
Porites           GGGATTGGATTGGCGTCCGCCAAGAGGCGGTTAAGATATACTTG---TAT
Rhodactis         GAAATGAGGTTTACGTTCGCCTAGAGGTGGTTAAGATACAATTATT-GTC
Ricordea          GAAATGAGGTTTAAGATCGCCTAGAGGTG-GTAAGATACAATTACT-GTC
Tubastrea         GGGATTAGATTGGCGTCCGCCAAGAGGCGGTTAAGATATACATG---TAT
Stichodactyla     TGGATAATGTTTGTGTCCACCTGGAGGTAGTTAAGGTCCGAGTACCGGTG

[                          260       270       280       290       300]
Actinotryx        TTGCTGTGAAGGGAGCCCTGCACACTAAAGAGCCTGTGTTGGGTGCGCTA
Amplexidiscus     TTGCTGTGAAGGGAGCCCTGCACACTAAAGAGCCTGTGTTGGGTGCGCTA
Anthopleura       CTGCTGCAACGGACATCCCGCACACTGGATCTCT-----CAGGTATGCCA
Aiptasia          CTGCTGCAAGGGACGTCTCGCACACGT-----CCAGGG-ATGACATGCCA
Balanophyllia     TATCTGCCAAGGGAATCCTGCGCACTT-----ACTTT--AGGGTTAGCTA
Bathyphellia      CTGCTGCAAGGGACGTCTCGCACACGT-----CCAGGG-ATGACATGCCA
Caryophyllia      TATGTGCGCATTTCACTCT--AAACTTGGAGACATGG---GTGTTT-TTG
Catalaphyllia     TATCTTAGC--TTCACCCTAAATTTTTTGGGACATTT--TGTGTTT-TTG
Cerianthus        CTGCTGTAAGAGGGCCCTCACACACGA------------AAGGTAA-CTA
Corallimorphus    TTGCTGTGAAGGGGGCCCTGCACACTAAACCGCCTGTGGTAGGTGCGCTG
Corynactis_c      TTGCTGTGAAGGGGGCCCTGCACACTAAACCGCCTGTGGTAGGTGCGCTG
Corynactis_v      TTGCTGTGAAGGGGGCCCTGCACACTAAACCGCCTGTGGTAGGTGCGCTG
Dendrophyllia     TATCTGCCAAGGGAATCCTGCGCACTT-----ACTTT--AGGGTTAGCTA
Discosoma_neg     TTGCTGTGAAGGGAGCCCTGCACACTAGAAAGCCTGTGTTGGGTGCGCTA
Discosoma_num     TTGCTGTGAAGGGAGCCCTGCACACTAGAAAGCCTGTGTTGGGTGCGCTA
Edwardsia         CTGCTGAGA-GGACACCCCACACACTG-------TGTT--AGGTATACCT
Enallopsammia     TATCTGCCAAGGGGATCCTGCACACTT-----ACTTT--AGGGTTAGCTA
Flabellum         TATCTGCCAAGGAGATCCTGCACACTT-----ACTTT--AGGGTTAGCTG
Fungia            TATAGGC----TTCACTCT-AATTTTTTGAGACATTT--TATGTTT-TTG
Fungiacyathus     TATCTGCCAAGGAGATCCTGCACACTT-----CTTTG--AGGGTTAGCTA
Lobophyllia       TATCGTAGC--TTCACCCTAAACTTTTTGGGACATTT--TGTGTTT-ATG
Metarhodactis     TTGCTGTGAAGGGAGCCCTGCACACTAAAGAGCCTGTGTTGGGTGCGCTA
Metridium         CTGCTGCAAGGGACGTCTCGCACACGT-----CCAGGG-ATGACATGCCA
Montastrea        TATATGCCCCTTACGCCTTGCACACACTGGGACATTTT---TGCACATAC
Nematostella      CTGCTGAGA-GGACACCCCACACACTG-------TGTT--AGGTATACCT
Oculina           TATCGGAGC--TTCACCCTAAATTTTTTGGGACACTT--TGTGTTT-TTG
Pavona            TATCTGCTAAGGAGACCCAGCACACTT----GTCTGGA-TGGGTTAGCTA
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Porites           TATCTGCGAAGGGAATCCTGCGCACTT------ATTT--AGGGTTAGCTA
Rhodactis         TTGCTGTGAAGGGAGCCCTGCACACTAAAAAGCCTGTGTTGGGTGCGCTA
Ricordea          TTGCTGTGAAGGGGGCCCTGCACACTAAACAGCCTGTGTTA-GTGCGCTT
Tubastrea         TATCTGCCAAGGGAATCCTGCGCACTT-----ACTTT--AGGGTTAGCTA
Stichodactyla     CTGCTGCAAGGGACGTCTCGCACACGT-----CCAGGG-ATGGCATGCCA

[                        310       320       330       340       350]
Actinotryx        ATTAAGGATAGTTACTAAAAAATCCCAATGGTCTTGTTTGTAATCAATT-
Amplexidiscus     ATTAAGGATAGTTACTAAAAAATCCCAGTGGTCTTGTTTGTATTTATTG-
Anthopleura       TCTAGAGGTAGTTGCTCAGAAACCATTTAA-TACCGCCCTAT-------T
Aiptasia          TCTAGTGGTAGTTGCTCAGAAACCATTTAATCACCGCCCTAT-------T
Balanophyllia     ATTAGGGATAGTTACTAGAAAG----------------------------
Bathyphellia      --------------------------------------------------
Caryophyllia      -TTTGAACAAGATATAAGAGCCTCC-------------------------
Catalaphyllia     -TTGGAAAAAAACACAAAAAAATCC-------------------------
Cerianthus        -AAAAAGGTTGTTACTAAAAAATTATATAATCATCATATTAA-------T
Corallimorphus    ATTAAGGATAGTTACTAAAAAATTCCAAAGTTCTTGTTCGTCGGTCACAG
Corynactis_c      ATTAAGGATAGTTACTAAAAAATTCCAAAGTTCTTGTTCGTCGGTCACAT
Corynactis_v      ATTAAGGATAGTTACTAAAAAATTCCAAAGTTCTTGTTCGTCGGTCAC-T
Dendrophyllia     ATTAGGGATAGTTACTAGCAAATCC-------------------------
Discosoma_neg     ATTAAGGAGAGTTACTAAAAAATTCCAATGGTCTTGTTTGTAATTTCTG-
Discosoma_num     ATTAAGGAGAGTTACTAAAAAATTCCAATGGTCTTGTTTGTAAT------
Edwardsia         TTTAGAGTTAGGCGCTCAGGAACCATTTAA-AACCA-------------G
Enallopsammia     ATTAGGGATAGTTACTA-AAAATCC--ATA------T------------T
Flabellum         ATTAGGGATAGTTACTAA-ATATCC-------------------------
Fungia            -TTGGAAAAAATACAAAAAAAATCC------------------------T
Fungiacyathus     ATTAGGGATAGTTAAATAAGCATCC------------------------T
Lobophyllia       -TTGGAAAAAATACAAAAAAAATCC-------------------------
Metarhodactis     ATTAAGGAGAGTTACTAAAAAATCCCAATGGTCTTGTTTGTAG-TCCTG-
Metridium         TCTAGTGGTAGTTGCTCAGAAACCA------------------------T
Montastrea        AAAGTAGATTGCGAATTGTACCACGCAC--------A---T--------T
Nematostella      TTTAGAGTTAGGCGCTCAGGAACCATTTAA-AACCA-------------G
Oculina           -TTGGAAAAAATACAAAAAAAATCC-------------------------
Pavona            GCCAGAGAGGGTTACTAAAAAATCC------------------------T
Porites           ATTAGGGATAGTTACTAAAAAATCC-------------------------
Rhodactis         ATTAAGGATAGTTACTAAAAAATCCCAGTGGTCTTGTTTGTATTCCTTA-
Ricordea          -TTAAGGATAGTTACTAAAAAATCCCAGAGT-C-----------------
Tubastrea         ATTAGGGATAGTTACTAGAAAATCC------------------------T
Stichodactyla     TCTAGTGGTAGTTGCTCAGAAACCATTTAA-CACCGCCCTAT-------G

[                        360       370       380       390       400]
Actinotryx        ----ACTTACTAAGAT-GCAGCACAACAAAGC-TGGAGATGGTACGGATG
Amplexidiscus     --ACCGTACCTCAGATGGCAGCACAACAAAGC-TGGAGATGGTGCGGATG
Anthopleura       TGCTTGTCTCAAAGATAGCACTATTACGTGAC-TGTCTCCGTGTTGGTTG
Aiptasia          TGCTTGTCTCAAAGATAGCACTATTACCTGAC-TGTCTCTTGTTTAGTTC
Balanophyllia     --------------------------------------------------
Bathyphellia      --CTCGTGTTAGA---TGCACTATTACCTGAC-TGTCT-TTCTTTATTTC
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Cerianthus        TGCTTGTCTCAAAGATAGCACCGTCGCCCAACGTGTAGTCGGATTGTTTC
Corallimorphus    TGTGTGGCGCTAAGAGTAGACTATAACCAAAC-TGTATCCTGTTTGTCAC
Corynactis_c      TGCTTGTCTCAAAGATAGCACTATAACCAAACTTGTATCTTGTTTGTCAC
Corynactis_v      TGCTTGTCTCAAAGATAGCACTATAACCAAACTTGTATCTTGTTTGTCAC
Dendrophyllia     --------------------------------------------------
Discosoma_neg     CTCTTTTTCTTAAGATAGCAGCACAACAAAGG-TAGAGATGCTGCGGATG
Discosoma_num     CTCTTTTTCTTAAGATAGCAGCACAACAAAGG-TAGAGATGCTGCGGATG
Edwardsia         TGCTTGTCTCAAAGATAGCACTATT-ACCGAC-TGTCTCTC{AG}TTTGG
Enallopsammia     TGCTTGTCTCAAAGATAGCACTATAACCAAAC-AGTATATTCTTTGGATC
Flabellum         --------------------------------------------------
Fungia            TGCTTGTCTCAAAGATAGCACTATAACCTAAC-TGTAT-TTCTTTGGATC
Fungiacyathus     TGCTTGTCTCAAAGATAGCACTATTACCAAAC-TGTAT-TCATTTGGATC
Lobophyllia       --------------------------------------------------
Metarhodactis     GCAGTCTCGATTAAGATCGCTGACAACGAAAG-TGGAGATGGTGCGGATG
Metridium         TGCTTGTCTCAAAGATAGCACTATTACCTGAC-TGTCTCTTCTTTAGTTC
Montastrea        TGCTTGTCTCAAAGATAGCACTATTACCAAAC-TGTAT-TTCTTTGGATC
Nematostella      TGCTTGTCTCAAAGATAGCACTATT-ACCGAC-TGTCTCTC{AG}TTTGG
Oculina           -----------------ACACTATAACCAAAC-TGTAT-TTATTTGGATC
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Pavona            TGCTTGTCTCAAAGATAGCACTATTACCAAAC-TGTAT-TCATTTGGATC
Porites           CTACCGATTGAATGGTAGTATTATC----AACGAATATATTCTTTGTATC
Rhodactis         --ACCGTACCTCAGATGGCAGCACAACAAAGC-TGGAGATGGTGCGGATG
Ricordea          ------ACTTACTAAGTGCAGCACAACAAAGC-TGGAGACTGTATGTAAG
Tubastrea         TGCTTGTCTCAAAGATAGCACTGTTACCAAAC-AGTATATTCTTTGGATC
Stichodactyla     TGCCTCTTTCAAAGATAGCCCT-TTACGTGAC-TGTCTCCGTGTTGGTTG

[                          410       420       430       440       450]

Actinotryx        TAT-GAGAAACTCCTACGTTTCGGTATCCGTGATCTCCCTG---CT-GCT
Amplexidiscus     TAT-CAGAAACTCCTACATATAGGTATGCGTGATCTCCCTG---CT-GCT
Anthopleura       TCTGTAGGAACTCCTCTATATAGGAATGCGCGGTGCCCCTGC-GTCTGGC
Aiptasia          TCT-TAGAAACTCCTCTATATAGGAATGCGTGACGCCCCCGC-GTTTAGT
Balanophyllia     --------------------------------------------------
Bathyphellia      TCT-TAGGAACTCCTCTATATAGG-ATGCGTGACCGCTCCGC-GTTTAAT
Caryophyllia      --T-GGAAAACTCCTCCATATAGG-AT-CGTGATCTCCTTACAATC-GGT
Catalaphyllia     --T-GGAAAACTCCTCCATATAGG-AT-CGTGATCTCCTTACAATC-GGT
Cerianthus        CCC-GAGAAACTCCTATTCATGGG-AT-CGTGTAATATCCG---TGAGGT
Corallimorphus    TCTGGAGAAACTCCTACATACAGCTATCCGTGATCTCCCT-GGTCTTGCT
Corynactis_c      CCTGGAGAAACTCTTACATACAGCTAG-CGTGATCCCCCTGGG-TTTGAT
Corynactis_v      CCTGGAGAAACTCTTACATACAGCTAGCCGTGATCCCCCTGGG-TTTGAT
Dendrophyllia     --------------------------------------------------
Discosoma_neg     TAT-CAGAAACTCCTACGTTTCGGTATGCTTGATCTCCCTG---CT-GCT
Discosoma_num     TAT-CAGAAACTCCTACGTTTCGGTATGCTTGATCTCCCTG---CT-GCT
Edwardsia         CCC-TAGAAACTCCTCTATATAGGAA{AT}GG--GACCATCCTGC-GTCT
Enallopsammia     TCT-GGGAAATCCCCCCATATAGGGATCCGTCATCCTCTTA---TC-GAT
Flabellum         --------------------------------------------------
Fungia            TCT-GGGAAACCCCTCCATATAGGGAT-CGTGATCCTCTTA---TT-GAT
Fungiacyathus     TCT-GGGATACTCCTCCATATAACGGT-CGTGATTTCCTTA---TT-GAT
Lobophyllia       ----GGAAAACTCCTCCAGATAGGGAG-CTTGATCTCCTTTCATTT-GCT
Metarhodactis     TAT-GAGAAACTCCTACATACAGGTATGCGTGATCTCCCTGG--CT-GCT
Metridium         TCT-TAGAAACTCCTCTATATAGGAATGCGTGACGCCCCCGC-GTTTAGT
Montastrea        TAT-GGGAAACTCCTCCATATAGG-AT-CGTGATCTCCTTA---TTGGCT
Nematostella      CCC-TAGAAACTCCTCTATATAGGAA{AT}GG--GACCATCCTGC-GTCT
Oculina           TCT-GGGAAACTCCTCCATATAGG-AT-CGTGATCCCCTTA---TC-GAT
Pavona            TCT-GGGATACTCCTCCATATAACGGT-CGTGATTTCCTTAG--TT-GAT
Porites           TTTCGGGAATTGTCCCTACATAGCGATCCTTCATCTCTTTAGGCTTGGAT
Rhodactis         TAT-CAGAAACTCCTACATATAGGTATGCGTGATCTCCCTG---CT-GCT
Ricordea          TATGGAGAAACTCCTATATTCAGCAATCCGTGATCTCCCTGGCTCT-GCT
Tubastrea         TCTCGGGAATTCTCTCCATATAGGGAT-CGTGATCCCCTTA--CTTGGAT
Stichodactyla     TCTGTAGGAACTCCTCTATATAGGATTGCGCGGTGCCCCTGC-GTCTGGC

[                          460       470       480       490       500]
Actinotryx        TCCCATTGCCAACTCA-TCCGG-AAGAAGATGGTGTTG--CAGGGGTGGA
Amplexidiscus     TCCCATTGTCAACGCA-TCCGG-AAGAAGATAGTGTTG--CAGGGGTGGA
Anthopleura       CCCCATCGTCGACGCATCTCGGCAAGAGGATAAGGTGTGGCAAGGGTGGA
Aiptasia          TCTCATCATCAATGTA-GTTGGCATGAGGATAATGTTG-GCAAAGGTGGA
Balanophyllia     -----------------------G---------TATTG-GTAAGAGTGGG
Bathyphellia      TCTCATCATCAATGTA-CTCGGCAAGAGGATAAT-TTG-GCAAAGGTGGA
Caryophyllia      TTCGGTGCTTAAGGCAGTCCCT-AAGAAGAAAAT-TTG-GCCGGAGTGGG
Catalaphyllia     TTCGGTGCTTAAGGCAGTCCCT-AAGAAGAAAAT-TTG-GCCGGAGTGGG
Cerianthus        GCCGGGTGTCCGCAGG-TCTCT-A{AT}GAGGGTAACTCCG--GGATGGC
Corallimorphus    TCTCATTGTCAATTCACTCCGT-AAGCAGATAATATTG-ATAAGGGTTCA
Corynactis_c      TCTCACTGTCAACTCGCTCCGT-AAGCAGATAATATTG-ACAAGGGTTGA
Corynactis_v      TCTCACTGTCAACTCGCTCCGTGAAGCAGATAAT-TTG-ACAAGGGTTGA
Dendrophyllia     --------------------------------------------------
Discosoma_neg     TCCCATTGCCAACTCA-TCCGG-AAGAAGATGGTGTTG-GCAGGGGTGGA
Discosoma_num     TCCCATTGCCAACTCA-TCCGG-AAGAAGATGGTGTTG-GCAGGGGTGGA
Edwardsia         TCCCATCGTCAGCGCA-CTCGGCATGAGGATAATGTTG-GCAAGGGTGGA
Enallopsammia     TCCCATTCTCAACTCAGTCCGT-AAGAAGATAATATTG-GCCAGAGTGGA
Flabellum         --------------------------------------------------
Fungia            TCCCATTGTCAACTCA-TCCGT-AAGAAGATAATATTGT-CAAGAGTGGG
Fungiacyathus     TCCCATGGTCAACTCA-TCCGT-AAGAAGATGATATTG--CAAGAATGGA
Lobophyllia       TTCCATTGTTAACATA-TTCGT-GAGAAGGAAATATTG--TAAGAGTGGA
Metarhodactis     TCCCATTGTCAACTCA-TCCGG-AAGAAGATAGT-TTGTGCAGGGGTGGA
Metridium         TCTCATCATCAATGTA-CTTGGCATGAGGATAATGTTG-GCAAAGGTGGA
Montastrea        TCCCATTGTCAACATA-TCCGT-AACAAAATAATATTG-GTAAGAGTGGA
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Nematostella      TCCCATCGTCAGCGCA-CTCGGCATGAGGATAATGTTG-GCAAGGGTGGA
Oculina           TCCCATGGTCAACTCAGTCCGT-AACAAGATAATATTG--CAAGAGTGGA
Pavona            TCCCATGGTCAACTCA-TCCGT-AAGAAGATGAT-TTG--CAAGAATGGA
Porites           TTTCATTGCCAACTCAGTCCGTGAAGAAAATAATACGGTGC-AAAACTGG
Rhodactis         TCCCATTGTCAACGCA-TCCGG-AAGAAGATAGTGTTG--CAGGGGTGGA
Ricordea          TCTCATTGCCAACTCACTCCGTGAAGCAGATGATATTGGACAGGGGTTCA
Tubastrea         TCCCATTGTCAACTCA-TCCGT-AAGAAGATAATATTG-GCAGGAGTGGA
Stichodactyla     CCCCATCGTCGACGCATCTCGGCAAGAGGATAAGGTGTGGCAAGGGTGGA


[                        510       520       530       540       550]
Actinotryx        C--CTAGCATA--AAAGCTTCGAGAATGCGTCACTGCTTAGTTCCGTAAA
Amplexidiscus     C--CTAACATA--AAGGCCACGAGAATGCGTCACTGCTTAGTTTCGTAAA
Anthopleura       C-GCTAACATAGCCAGATT-ATAGAAGA-ATCGTGGCCTAAGTTTGTAAC
Aiptasia          C-GCTAACATAGCAAGATTATTAGAAGA-ATGACTCCCTAAGTTCGTAAC
Balanophyllia     T--CGGACATA---AAGCTATTAGAATG-ATGACTCTTAAAATCCGTAGA
Bathyphellia      C-GCTAACATAGCAAGATTATTATAAGAAACGATTCCCTGAGTTCGTAAC
Caryophyllia      T--ATAACATA--AG-----------------------------------
Catalaphyllia     T--ATAACATA--AG-----------------------------------
Cerianthus        C--CTAACATA--CAGATTGTTATAGGAATGAGTCGGCGAGGCGTGTGGC
Corallimorphus    CC-CTAACATA--AAAGCTATGAGAATGAAGGACTCCTTAAGCTTGCAGA
Corynactis_c      CC-CTAACATA--AAAGCTATTAGAATGAAGGACTCCTTCAGTTTGCAAA
Corynactis_v      CC-CTAACATA--AAAGCTATTAGAATGAAGGACTCCTTCAGTTTGCAAA
Dendrophyllia     --------------------------------------------------
Discosoma_neg     C-TCTAGTCAT--AAAGCTTCGTGAATGCGTCACTGCTTAGTTCCTTAAA
Discosoma_num     C-TCTAGTCAT--AAAGCTTCGTGAATGCGTCACTGCTTAGTTCCTCAAA
Edwardsia         C-GCTAACATAGCAAGATTATTAGAAGA-ATTATTGCCTAAGTTCGTGAC
Enallopsammia     CT-CTAACATA--AAAGCTATTAGAATG-ATGACTCTTAAAATCCGTAGA
Flabellum         --------------------------------------------------
Fungia            CT-CTAACATA--AAAGCTATTAGAATA-ATGACTCCTTAAATCCGTAGA
Fungiacyathus     C--CTAGCATATAAAAGCTATTAGGATG-ATGACTCCTTAAATGCGTAAA
Lobophyllia       T--ATAACATA--AG-----------------------------------
Metarhodactis     CTTCTAACATA--AAGGCCACGAGAATGCGTCACTGCTTAGTTTCGTAAA
Metridium         C-GCTAACATAGCAAGATTATTAGAAGA-ATGATTCCCTAAGTTCGTAAC
Montastrea        C--CTAACATA--AAAGCTATTAGAATA-ATCACTGCTTAAATCCGTAGA
Nematostella      C-GCTAACATAGCAAGATTATTAGAAGA-ATTATTGCCTAAGTTCGTGAC
Oculina           C--CTAACATA--AAAGCTATTAGAATG-ATGGCCCCTGAAATCCGTAAA
Pavona            C--CTAGCATA--AAAGCTATTAGGATG-ATGACTCCTTAAATGCGTAAA
Porites           CTTCGGAC-TATAAA-----------------------------------
Rhodactis         C--CTAACATA--AAGGCCACGAGAATGCGTCACTGCTTAGTTTCGTAAA
Ricordea          CCTCTAGCATATAAAAGCTTCGAGAATGAGTCACTCCTTCAGCCCGCAAA
Tubastrea         CT-CTAACATA--AAAGCTATTAGAATG-ATGACTCCTAAAATCCGTAGA
Stichodactyla     CCGCTAACATAGCCAGATTATTAGAGGA-ATGATTGCCTAAGTTTGTAAC

[                        560       570       580       590       600]
Actinotryx        GTCCAAGTGTCGCCCCTTAGCTCTGCGCCCGCGCTCTGG-GACAGAGGGT
Amplexidiscus     GTCCGAGTGTCGTCCCTTAACTCTTCGCCGACCCGCTTGCGACCGGAGGG
Anthopleura       CTCGGAATCATTTCCCTTAGATCTGTGCCC-CGC-CCCGGAACGGAGCAG
Aiptasia          CTCCGAACGCTCTCCCTTAGATCTGTGCCCCCGC-CCCGGAACGGAGCAG
Balanophyllia     ACTCAAGT-GGTTCCCTTAGCTTTGCGCCCATGC-TCTGGAACAGAGCGT
Bathyphellia      CTCCGATCGGTCTCCCTT-G-TCTGTGCCCCCGC-CCCG-CACG-AGCAG
Caryophyllia      --------------------------------------------------
Catalaphyllia     --------------------------------------------------
Cerianthus        CGGTGGACACTCTCCCTCAGCTCCGTGCCCCCTC---CTTAAAGGAAAGC
Corallimorphus    GTCCAAGTGACTTTTGGTTGGGCATCCACGGCGTCGATGCGGAAGTGGTC
Corynactis_c      GTCCAAGTGGTTTCCCTTAGCTCTGTACCCATAT-TCTGGAACAGAGCGT
Corynactis_v      GTCCAAGTGGTTTCCCTTAGCTCTGTACCCATAT-TCTGGAACAGAGCGT
Dendrophyllia     --------------------------------------------------
Discosoma_neg     GTCCAAGTGTCGCCTTTGCACTCTGTACTCGCACTCTGCAGCGCTT----
Discosoma_num     GTCCAAGTGTCGCCTTTGCACTCTGTACTCGCACTCTGCAGCGCTT----
Edwardsia         CTTCGGACGGTATCCCTTAGCTTTGTGCCCCGGC-CCCGGAACGGAGCCA
Enallopsammia     GTCCAAGTGTGTTCCCTTAGCTTTGCGCCCATAC-TCTGGAACAGAGCGC
Flabellum         --------------------------------------------------
Fungia            GTCCAAGTGGTATCCCTTAGCTTTGCGCCCATGC-TCTGGAACAGAGCGC
Fungiacyathus     ATCCAAGTGCTATCCCCTAGCTCTGCGCCCATAC-TCTGGAACAGAGCGC
Lobophyllia       --------------------------------------------------
Metarhodactis     GTCCGAGTGTCGTCCCTTAGAGCCTTAATTGCGCGAACGCTCC-------
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Metridium        CTCCGAACGTTCTCCCTTAGATCTGTGCCCCCGC-CCCGGAACGGAGCAG
Montastrea       GTCCAAGTGGCTTCCCTTAGCTCTGCGCCCATAC-TCTGGAACAGAGCGC
Nematostella     CTTCGGACGGTATCCCTTAGCTTTGTGCCCCGGC-CCCGGAACGGAGCCA
Oculina          GCACAAGTGGGTTCCCTTAGCTTTGCGCCCACAC-TCTGGGACAGAGAGT
Pavona           ATCCAAGTGCTATCCCCTAGCTCTGCGCCCATAC-TCTGGAACAGAGCGC
Porites          --------------------------------------------------
Rhodactis        GTCCGAGTGTCGTCCCTTAACTCTTCGCCGACCCGCTTGCGACCGGAGGG
Ricordea         GTCCAAGTGTCGCCCCTTAGCTCTGCGCCCGCGC-TCTGGGACAGAGGGT
Tubastrea        ATCCACGTGTTTTTCCTTAGGTTTGCTCCCCTAC--CTGGAACAGAGCGG
Stichodactyla    CTCGGAATCGGTTCCCTTAGATCTGTGCCC--------------------


[                         610        620        630        640        650]
Actinotryx       TGA-TGCCGGGTCATCGCCAGGAAGAAAAAA--TGA-AGA-CAATCCGTG
Amplexidiscus    GAA-TGCCGTGGTATCATTGAA------------GAG-CAAGCAATCCGTG
Anthopleura      CGAATGCCAATTCATCGCACCTCGAGGTCTTTAGAGAAAGACACCTTATG
Aiptasia         CGACTGCCAATTCATCGCACCTCGAGGTC--AGGAGAAAGACACCTTATG
Balanophyllia    CGC-CGCCGGTTCATCGCACCTCGAGG----TAGAGAAAGACAACCCGTG
Bathyphellia     -GACTGCCAAGTCATCAT-------------TGGAG-AAAGC-CCTTATG
Caryophyllia     -------------------------------TAGAGAAAGACAACTCGTG
Catalaphyllia    -------------------------------TAGAGAAAGACAATCCGTG
Cerianthus       GACCGTCCAAGTCATCGCACCTCAAGGTC--TAGAGAAAGACACCTCGTG
Corallimorphus   ACT-GATCTAAAGGGT-----------------AAACGAAGC-ACTTGCG
Corynactis_c     CGA-TGTTGGGTCATCGCACC--TCGAGGTC--ATACGC--CAACTTGCG
Corynactis_v     CGA-TGTTGGGTCATCGCACC--TCGAGGTC--ATACGA--C-ACTTGCG
Dendrophyllia    -------------------------------TAGAGAAAGACAACCCGTG
Discosoma_neg    ---------------------------------GAAAGAAGAAATCCGTG
Discosoma_num    ---------------------------------GAAAGAAGAAATCCGTG
Edwardsia        CGATTGTCAAGTCATCG--------------TAGAGAAAGACACCCCATA
Enallopsammia    CGA-TGCCGGGTCATCGCACC--TCGAGGTCTAGAGAAAGACAACCCGTG
Flabellum        -------------------------------TAGAGAAAGACAACCCGTG
Fungia           CGA-TGCCGAGTCATCGCACC--TCGAGGTCTAGAGAAAGACAACCCGTG
Fungiacyathus    CGA-TGCCGAGTCATCGCACCCATCGAGGTC--TGGGAGA-CAACTCGCG
Lobophyllia      -------------------------------TAGAGAAAGACAATCCGTG
Metarhodactis    ---------------------------------GAG-CGG-ACATCCGCG
Metridium        CGACTGCCAATTCATCGCACCTCAAGGTC---------------------
Montastrea       CGA-TGCCGAGTCATCGCACC--TCGAGGTC----------CAATCCGTG
Nematostella     CGATTGTCAAGTCATCG--------------TAGAGAAAGACACCCCATA
Oculina          CGA-TGCCGAGTCATC-------------------------CAACCCGTG
Pavona           CGA-TGCCGAGTCATCGCACC--TCGAGGTC----------CAACCCGTG
Porites          -------------------------------TAGAGAAAGACAATCCGTG
Rhodactis        GAA-TGCCGTGGTATCATTGAA------------GAGGATG-ACATCCGCG
Ricordea         TGA-TGCCGGGTCATCGCCAGGAAGAAAAAA--GCAGCGA-C-ACCTGCG
Tubastrea        CGA-TTTCGGGGGGGTGCACTGGGAGGTCTTTAGAGAAAGACAACCCGTG
Stichodactyla    -------------------------------TAGAGAAAGACACCTTATG

[                         660        670        680        690        700]
Actinotryx       CGGGTTCGTT-TCAG-AGAAATGGTCCGA-CGGCGCCTTACACGCACCCT
Amplexidiscus    CGGGTTCGTTTTCAG-AGAAATGGGCCGA-CGGCGCCTTACACGCACCCT
Anthopleura      CATGTTCGTT-CC----CAAGTGATAGCTACGTGCCTCTACACA-ACCCT
Aiptasia         CATGTTCGTT-TCAC-AGAAGTGATCCGATCGTGTCTCTACACATAACCT
Balanophyllia    TAGGTTCAAC-TCGG-TGAGGGGATCCGA-TGGCGTCTTATACGCACCCT
Bathyphellia     GATATTCGTT-GCG--ACAAGTGGTACAGTCGGGCCTCTACACATACCCT
Caryophyllia     CAGGTTTGAT-CCAG-TGAGGGGA-ATGA-TGTCGTCTTACACGCACCCT
Catalaphyllia    GAGGTTTGAT-CCAG-TGAGGGGATATGA-TGCAGTCTTACACGCACCCT
Cerianthus       CATGTTCATTTTCG--AGAAGTG-TACGATG-CTGTCTTTCACGTACCCG
Corallimorphus   GAGGTTTGTCTCCGGAAGAAGTGATCTGA-TGACGCCTTACACGCACCCC
Corynactis_c     GAGGTTCGTTTCCAGACGGAGTGATCCGA-TGACTTCTTACACGCACCCT
Corynactis_v     GAGGTTCGTTTTCAGAAGGAGTGATCCGA-TGACTTCTTACACGCACCCT
Dendrophyllia    TATGTTCAAC-TCGG-TGAGGGGATCCGA-TGGCGTCTTATACGCACCTT
Discosoma_neg    CGGGATCGTT-TCAGCAGAAATGGGCCGA-CGGCGCCTTACACGCACCGT
Discosoma_num    CGGGA-TGTTTTGAGCA-AAATGGGCCGA-CGGCGCCTTACACGCACCGT
Edwardsia        GATGTGCGTTCTCAC-AGACGTGGTCTTGCTGACGCTCCGTGCAAGACCC
Enallopsammia    TAGGTTCAAC-TCGG-TGAGGGGATCCGA-TGGCGTCTTATACGCACCTT
Flabellum        GAGGTTCAAC-TCGG-TGAGGGGATCCGA-TGACGCCTTATACGCACCCT
Fungia           GAGGTTTGGT-TCAG-CGAGGGGATCCGA-TGCGGCCTTACATGCACCCT
Fungiacyathus    TAGGTTCAAC-TCGG-TGAGGGGATCCGA-TGTGGCCCTATACGCACCCC
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Lobophyllia      GAGGTTCGAT-TCAG-TGAGAGGATACGA-TGTGGTCTTACACGCACCCT
Metarhodactis    CGGG--TGTTTCGAG-C-AAATAGGCCGA---GCGCCTTACACGCACTGT
Metridium        --------------------------------------------------
Montastrea       GAGGTTCAAT-CCAG-TGAGGGGATATGA-TGCGGTCTTACAGGCACCCT
Nematostella     GATGTGCGTTCTCAC-AGACGTGGTCTTGCTGACGCTCCGTGCAAGACCC
Oculina          CAGGTTTGGT-TCAG-CGAGGGGATATGA-TGTCGTCTTACATGCACCCT
Pavona           GAGGTTCAAG-CAAG-TGAGGGGATCCGA-CACCGTCTTACACGCACCCT
Porites          TATGTTCAAC-TCGG-TGAAGGGATACGA-TGTCGTCTTATACATACCCT
Rhodactis        CGGG--TGTTTCGAG-C-AAATAGTCCGA---GCGCCTTACACGCACTGT
Ricordea         GGGGATCGTTTCCAG-CGGAATGGGCCGA-TGACCCCTTACACACACCCT
Tubastrea        TAGGTTCAAC-TCGG-TGAGGGGATCCGA-TGGCGTCTTATACGCACCTT
Stichodactyla    CATGTTCGTT-TGA---CAAGTGATACGGTCGGGCCTCTACACATACCCT

[                         710       720       730       740]

Actinotryx       GTG--GAGTCGGCCTCTGGAAGCTTGAGTGACCTCGGGCC
Amplexidiscus    GTG--GAGTCGGCCTCTGGAAGGTTGAGTGACCTCGGGCC
Anthopleura      GTGCC--GGA-GCC-GGCGACAGCTAA-CG----------
Aiptasia         GCGCCGATTCGGCTTCTGAACAGCTAAGTGACCTTTGACC
Balanophyllia    GTGA-ACGGCGGCCTCTGGAAGGTCGATCTACCTTTAGTC
Bathyphellia     GTGCCGGAACGGTCCGCGGACAGCTAAGCGACCTCTGACC
Caryophyllia     GTGAGGCGGCGGCCCGTGGCAGGTTGAGTTACCTCTGGTT
Catalaphyllia    GTGAGGCTGCGGCCTGTGGCAGGTTGTGGTGCCTCCGGTT
Cerianthus       GCTACACAGCCACTTGGCACGGGCTG-GTG----------
Corallimorphus   GTGA-GCGCCGGCCTTTGGCAGCTTGTGCGGCTCTCGGCT
Corynactis_c     GTGA-GAGTCGGCCTCTGGAAGCTTGTGCGACCCTTGGCT
Corynactis_v     GTGA-GAGTCGGCCTCTGGAAGCTTGTGCGACCCTTGGCT
Dendrophyllia    GTGT-ACGGCGACCTCTGGAAGGTCGATCTACCTTTAGTC
Discosoma_neg    GTGT-GAGTCCGCCTCTGGAAGGTTGAGTGACCTCGGGCC
Discosoma_num    GTGT-GAGTCCGCCTCTGGAAGCGTGAGTGACCTCGGGCC
Edwardsia        ACGCCGCGTTGGCCCACGGACAGCTAAG-G----------
Enallopsammia    GTGT-ACGGCGACCTCTGGAAGGTCGATCTACCTTTAGTC
Flabellum        GTGACGCGTCGGCCTCCGGAAGGTTGAGCTACCTCTAGTC
Fungia           GTGAGGCGGCGGCCTCTGGAAGGTTGAGTTACCTCTGGTC
Fungiacyathus    GTGACGTCGCGGCCTCTGGAAGGTTGAGCTACCTTTAGTC
Lobophyllia      GTGAGGCGACGGCCTGTGGAAGGTTGTGTTACCTCTGGTC
Metarhodactis    GTCTTGAAGTCGCCTCTGGCAGCCTGAGTGGTTTCGAGCC
Metridium        ----------------------------------------
Montastrea       GTG-GGCCGCGGCCTGTGGAAGGTTGTGTTACCTCTGGTC
Nematostella     ACGCCGCGTTGGCCCACGGACAGCTAAG-G----------
Oculina          GTGAGGCGACGGCCTGTGGCAGGTTGAGTTACCTCTGGTT
Pavona           GTGCCGCGGAGGCCTCTGGAAAGTTGAGCTACCTCTGGTC
Porites          GTGCCTCGGCGGCCTCTGGAAGGTTGAGATACCTCTAGTC
Rhodactis        GTCTTGAAGTTGCCTCTGGCAGCCTGAGTGGTTTCGAGCT
Ricordea         GTGA-GGGCCGGCCTCTGGAAGCTTGTGCGACCTTCGGCT
Tubastrea        GTGT-ACGGCGACCTCTGGAAGGTCGATCTACCTTTAGTC
Stichodactyla    GTGCCGGAACGGCCTGCGGACAGCTAA-CG----------
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