Chemical Diversity in Species Belonging to Soft Coral Genus *Sarcophyton* and Its Impact on Biological Activity: A Review

Yasmin A. Elkhawas 1,*, Ahmed M. Elissawy 2,3, Mohamed S. Elnaggar 2,3, Nada M. Mostafa 2, Eman M. Kamal 2, Mokhtar M. Bishr 4, Abdel Nasser B. Singab 2,3 and Osama M. Salama 1

1 Department of Pharmacognosy and Medicinal plants, Faculty of Pharmaceutical Sciences and Pharmaceutical Industries, Future University in Egypt, Cairo 11835, Egypt; osalama@fue.edu.eg
2 Department of Pharmacognosy, Faculty of Pharmacy, Ain-Shams University, 11566 Cairo, Egypt; aelissawy@pharma.asu.edu.eg (A.M.E.); mohamed.s.elnaggar@pharma.asu.edu.eg (M.S.E.); nadamostafa@pharma.asu.edu.eg (N.M.M.); em_alsayed@pharma.asu.edu.eg (E.M.K.); dean@pharma.asu.edu.eg (A.N.B.S.)
3 Center of Drug Discovery Research and Development, Ain-Shams University, Cairo 11566, Egypt
4 Plant General Manager and Technical Director, Mepaco Co., Sharkeiya 11361, Egypt; mbishr_2000@yahoo.com
* Correspondence: yasmien.alaa@fue.edu.eg; Tel.: +20-01141633984

Received: 11 December 2019; Accepted: 3 January 2020; Published: 6 January 2020

**Abstract:** One of the most widely distributed soft coral species, found especially in shallow waters of the Indo-Pacific region, Red Sea, Mediterranean Sea, and also the Arctic, is genus *Sarcophyton*. The total number of species belonging to it was estimated to be 40. *Sarcophyton* species are considered to be a reservoir of bioactive natural metabolites. Secondary metabolites isolated from members belonging to this genus show great chemical diversity. They are rich in terpenoids, in particular, cambranoids diterpenes, tetratetpenoids, triterpenoids, and ceramide, in addition to steroids, sesquiterpenes, and fatty acids. They showed a broad range of potent biological activities, such as antitumor, neuroprotective, antimicrobial, antiviral, antidiabetic, antifouling, and anti-inflammatory activity. This review presents all isolated secondary metabolites from species of genera *Sarcophyton*, as well as their reported biological activities covering a period of about two decades (1998–2019). It deals with 481 metabolites, including 323 diterpenes, 39 biscembranoids, 11 sesquiterpenes, 53 polyoxygenated sterols, and 55 miscellaneous and their pharmacological activities.

**Keywords:** *Sarcophyton*; soft coral; terpenoids; antimicrobial; antitumor; antidiabetic; anti-inflammatory

1. Introduction

Classification of alcyonacean corals, subclass Octocorallia implies the existence of polyps with eight tentacles, which differentiates them from hexacorallian Scleractinia corals. Alcyonaceans are sessile large invertebrate with distinct stalk and a smooth, mushroom-shaped top known as capitulum, and their tissue comprises sclerites, which give support to the colony [1,2]. Traditionally, identification and classification of most soft coral have been carried out by sclerite classification. *Sarcophyton* covers 35 species, and another six species of *Sarcophyton* were described [3–8]. Later, [9] reported that, within *Sarcophyton* samples, *Sarcophyton glaucum* contains six different genetic clades, signifying that this morphologically heterogeneous species was mysterious [10]. Studies revealed that...
Sarcophyton were mostly seen in shallow water of the Indo-Pacific region [11,12], Red Sea [13], Mediterranean Sea [14], and also the Arctic area [10,15]. However, to our knowledge, nothing was reported from North and South of America (Figure 1). Sarcophyton sp. synonyms include Toadstool Mushroom Leather, Toadstool Leather Coral, Umbrella Coral, Toadstool Mushroom Coral, Mushroom Leather Coral, Sarcophyton Coral, and Mushroom Coral. Sarcophyton sp. were considered a reservoir of bioactive natural metabolites such as diterpenes, steroids, sesquiterpenes, and fatty acids [16,17]. These metabolites, mainly macrocyclic cembranes and their byproducts, represented an important natural bioactive product, with significant biological activities, including anticancer [18,19], antimicrobial [20], anti-inflammatory [21], anti-osteoporotic, antimetastatic, antiangiogenic, and neuroprotective [22]. One metabolite, sarcophytol A 15, isolated from Sarcophyton obtained from Ishigaki Island, Okinawa, Southern Japan, was studied and highlighted because of its important anticancer activity [23]. Some recent articles had partially covered the chemistry and pharmacology of secondary metabolites from Sarcophyton sp. [24–26]. This review concentrates on marine bioactive metabolites isolated from Sarcophyton species, their biological properties, and studies of the biosynthesis of marine metabolites. In this review, we reported all metabolites isolated from Sarcophyton species and their reported biological activities stated in the literature over the years from 1998 to 2019. Different online databases were utilized through this review, including Scifinder, Marinlit, and Web of Science. The present review aims to present the progress made in the last two decades regarding the potential application of biomolecules (481 compounds) isolated from Sarcophyton soft corals, to complete the previously published papers (Figures 2 and 3) on the interesting subject of Sarcophyton. It deals with the chemistry, as well as the biological activity of secondary metabolites, including terpenoids, in particular diterpenes, sesquiterpenes, biscembranoids, and polyhydroxysterols, in addition to a number of miscellaneous compounds. The percentage of different chemical classes is represented in (Figure 2), and Figure 3 shows a diagram of isolated classes from each Sarcophyton sp.
**Figure 1.** Worldwide distribution of chemically studied *Sarcophyton* soft coral.
Figure 2. Pie chart showing the percentage of each class of metabolites identified in *Sarcophytton* sp.
Figure 3. A diagram of isolated classes from each Sarcophyton sp.
2. Classes of Secondary Metabolites

2.1. Diterpenes

*Sarcophyton ehrenbergii* dichloromethane extract yielded sarcophytol T 1, (1E,3E,7E,11R*12R*)-15-(acetoxy)methylcembra-11,12-epoxy-1,3,7-triene 2, and (11S*,12S*)-15-(acetoxy)methyl cembra-3,4,11,12-diepoxo-1,7-diene 3, together with known isoneocembrene A 4, an isomer to neocembrene A 5, and (2S*,11R*,12R*)-isosarcophytolide 6. Compound 2 was found to possess several structural similarities with the former two isolates in conjugated diene system (C-1 and C-4) and Δ3,4 double bond and 11,12-epoxy functional group [27].

Another three cembranol diterpenes identified as cressolide 7, sarcocassulide A 8, and 13-acetoxyisocassulide 9, alongside known cembrenal denticulatolide 10, were reported from *S. cassincola* [28].

From *S. trocheliophorum*, the isolation of 7,8-epoxy-1(E),3(E),11(E)cembratrien-15-ol 11, 7,8-epoxy1(E),3(E),11(E)-cembratriene 12, and sarcophin 13 was reported, and the absolute configuration of sarcophin 13 was investigated through modified Mosher’s assay [29].

Using chromatographic techniques, cembranol alcohol identified as acutanol 14 beside sarcophytol A 15 and sarcophytol A acetate 16 were isolated from *S. acutangulum* extract. The absolute configuration of sarcophytol A 15 was assessed with the use of many chiral anisotropic reagents, as 1-naphthylmethoxyacetic acid [30].

Four cembranes, (15(E),2,4R,6E,8S,11S,12S)-11,12-Epoxy-2,6-cembrene-4,8-diol 17, (1S,2E,4R,6E,8R,11S,12S)-11,12-Epoxy-2,6-cembrene-4,8-diol 18, (1S,2E,4R,7S)-11,12-Epoxy-2,8(19)-cembraadiene-4,7-diol 19, and (1S,2E,4R,7R)-11,12-Epoxy-2,8(19)-cembraadiene-4,7-diol 20, were isolated from *Sarcophyton* sp. It is worth noticing that these metabolites were not previously found in nature. The absolute configurations were validated with X-ray analysis [31].

The hydropyridine cembranol diterpenoid, sarcophydrasulide A 21, together with sarcophydrasulide B 22 and compound 8, was reported from *S. cassincola*. Identification of compound 21 was resolved by using X-ray diffraction and spectral analysis [32].

Three furano-cembranoids and two secocembranoid acetates, which were identified as 13-dehydroxysarcoglaucol 23, 13-dehydroxysarcoglaucol-16-one 24 and sarcoglaucol-16-one 25, (3E)-7-hydroxy-4,8,15,15-tetramethyl-1-[(E)-12-methyl-10-oxo-12-pentenyl]-3,8-decadienyl acetate 26, (3E)-7-hydroxy-4,8,15,15-tetramethyl-1-[(Z)-12-methyl-10-oxo-12-pentenyl]-3,8-decadienyl acetate 27 beside sarcoglaucol 28, and decaryiol 29, were isolated from *S. cherbonnieri*. Spectral data showed that compound 25 was a 16-keto derivative of compound 28 and the 13-hydroxy derivative of compound 24 [33]. The absolute configuration of compound 25 was investigated similarly to compound 13 by using the modified Mosher’s method [34]. Another two bicyclic cembranoid metabolites, with infrequent structures in marine literature, having a 12Z double bond, identified as (4Z,8S,9S,12Z,14E)-9-Hydroxy-1-isopropyl-8,12-dimethyl-oxabicyclo[9.3.2]-hexadeca-4,12,14-trien-18-one 30, and (4Z,12Z,14E)-sarcophytolide 31, in addition to sarcophytolide 32, (4Z,8S,9R,12E,14E)-9-Hydroxy-1-isopropyl-8,12-dimethyl-oxabicyclo[9.3.2]-hexadeca-4,12,14-trien-18-one 33 and (4Z,8S,9R,12E,14E)-1-Isopropyl-8,12-dimethyl-18-oxo-oxabicyclo[9.3.2]-hexadeca-4,12,14-trien-2-yl acetate 34, were reported from *Sarcophyton* new sp. Additionally, the authors presented biosynthetic pathways for all isolated compounds which resulted from the common acyclic precursor (all-E)-geranylgeranyl pyrophosphate (GGPP), by converting geranylgeranyl-PP [GGPP] into geranyleryremyl-PP [GNPP], using diterpene synthase, followed by cyclization to cembranoid ring with a 12Z double bond [35]. Three diterpenes, sarcophytol 35, sarcophytolide B 36, and sarcophytolide C 37, were reported from *S. glaucum* [34].

Sarcophytonolides A–D 38–41, four cembranol diterpenes were isolated from *S. tortuosum*. Sarcophytolide B 39 was found to be the 12-(methoxy carbonyl) derivative of compound 38, in which it exhibited αβ-unsaturated methyl ester instead of the methyl group. Sarcophytonolide D 41 was similar in structure to compound 40, while, compound 41 possessed an extra trisubstituted C=C and acetoxy group [36]. Four more sarcophytonolides E–H 42–45 from *S. latum* were isolated. All isolated compounds were checked in structure to compound 40, with an α, β-unsaturated butanolid
cembranoids, were modified derivatives of cembranes, further known as sarcophytonolide A–F 44–49 were isolated from S. latum. All compounds were related in structure to the previously isolated compounds 38–45; all possessed α, β-unsaturated butenolactone group. The absolute configuration of compounds 38–45 still need further determination. Considering the fact that these compounds were structurally related to previously isolated sarcophytonolide, the structure of sarcophytonolide I 46 differs from sarcophytonolide D 41, in the olefinic C=Cs bond and absence of C=O group at C6 [38]. Another five cembranolide, sarcophytonolides N–R 50–54, ketoemblide 55, and (E,E,E)-1-isopropenyl-4,8,12-trimethylcyclooctadeca-3,7,11-tiene 56 were isolated from S. trocheliophorum Marenzeller. A detailed spectroscopic analysis was done, in which sarcophytonolides N–R 50–54 were found to be either mono- or bicyclic cembranoids possessing oxidized methyl groups and three/four double bonds [39].

The absolute configuration of another six metabolites isolated from S. trocheliophorum, sarcophytonolides S–U 57–59 and sartrolides H–J; α,β-unsaturated ε-lactone 60–62, along with seven known analogues, were carried out through different techniques [40]. Chemical determination of S. trocheliophorum yielded seven cembranolides, sartrolides A–G 63–69 and bissartrolide dimer 70; a third member of this scarce class of cembrane dimers [41]. Yalones A and B 71 and 72 another two cembranoids, isolated from S. trocheliophorum [42], and another two cembranoids, trochelioids A and B 73 and 74, and 16-oxosarcophytonin E 75 were isolated [43].

Five diterpenes cembrane type, sarcassins A–E 76–80, beside emblide 81 isolated from S. crassocaule were identified based on 1D and 2D NMR. Sarcassins B and C 77 and 78, cyclic diterpenes, derivatives of sarcassin A 76 in which the double bond in sarcassin A 76 was replaced by an epoxy ring in sarcassin B 77. However, in sarcassin C 78 the epoxy ring in sarcassin A 76 was replaced by a hydroxyl and methoxy group. As for sarcassin D 79, its bicyclic diterpene structure was confirmed through spectral data [44], and its absolute configuration, as well as that of emblide 81, was determined by X-ray analysis [41,45].

Investigation of ethyl acetate extract of S. crassocaule yielded six polyoxgenated cembrane-diterpenoids with a trans-fused α-methylene-γ-lactone, identified as crassocolides A–F 82–87 alongside lobophytolide 88. Absolute configuration for crassocolide A 82 was resolved by using modified Mosher’s method [46]. Another seven polyoxgenated cembranoids with α-methylene-γ-lactone group identified as crassocolides G–M 89–95, were reported. The structures of all compounds were determined through a full spectral data analysis, and the absolute configuration of crassocolide G 89 was investigated by modified reaction of Mosher’s assay [47]. Other crassocolides N–P 96–98 were isolated from S. crassocaule [48]. The CHCl₃/MiOH extract of S. flexuosum yielded three cembranes, identified through spectral data as flexusines A, B, and epimukulol 99–101 [49].

From ethyl acetate extract of S. stolidotum, seven cembranes, sarcostolides A–G 102–108, alongside isosarcophin 109, were reported, and their structures were elucidated through spectral data. The authors also proposed a reasonable biogenetic pathway for all isolates, in which cyclization of GPP with lactonization and oxidation may lead to the production of sarcostolide C 104. Sarcostolides A and B 102 and 103 and D–G 105–108 were converted from sarcostolide C 104 through migration and isomerization of double bonds [50].

Sarcophyton miliatensis methanol extract yielded cembranoid diterpenes identified as (−)-7β-hydroxy-8α-methoxy-deepoxy-sarcophytoxide 110, (−)-7β,8β-dihydroxy-deepoxy-sarcophytoxide 111, (−)-17-hydroxysarcophytonin A 112, sarcophytol V 113, and sarcophytoxide 114 [51].

Two cembrane diterpenes known as 17-hydroxysarcophytoxide 115 and 7β-acetoxy-8α-hydroxydeepoxysarcophine 116, along with 7β,8α, dihydroxydeepoxysarcophine 117, sarcophytonin A 118, and (−)-β-elmene 119 reported from Sarcophyton sp., were isolated from S. glaucum [52]. Investigation of S. glaucum extract led to the isolation of two cembranoids, (7R,8S,8S)-dihydroxydeepoxy-ent-sarcophine 120 and secosarcophinolide 121, in addition to, ent-sarcophin 122.
Structural elucidation of the isolates was established by their spectral data and chemical correlation, as (7R,8S)-dihydroxyde epoxy-ent-sarcophine 120 was found to be the enantiomer of (75,8R) -dihydroxydeepsarcophine 123 and compound 121 has a unique butyl ester group at C-16 [53].

Seven cembranoids were isolated from Sarcophyton sp., 5-epi-sinuleptolide 124, lobohedroleolide 125, (7Z)-lobohedroleolide 126, and two uncommon cembranoids, sarcouranocembreolide A 127, with a unique carbon skeleton of 8,19-bisnorfurancembreolide, and sarcouranocembreolide B 128, a furanocembreolide [54]. Sarcophytonins F and G 129 and 130, another two dihydrofurancembranoids, were reported from Sarcophyton sp. [55]. Nineteen compounds from Sarcophyton sp., of which five cembreane diterpenoids were isolated and identified as 7-acetyl-8-epi-sinumaximol G 131, 8-epi- sinumaximol G 132, 12-acetyl-7,12-epi- sinumaximol G 133, 12-hydroxysarcoph-10-ene 134, and 8-hydroxy-epi-sarcophinone 135, together with sinumaximol G 136, were reported [56].

Five isolated cembranoids, sarcocrassocolides A–E 137–141, together with sinularolide 142, were isolated from S. crassocaule. Structural elucidation of the compounds was determined through spectral analysis, and the absolute configuration of sarcocrassocolide A 137 was investigated by modified Mosher’s method. It is worth mentioning that sarcocrassocolides A–D 137–140 possessed a tetrahydrofurane group with a seldomly found 4,7-ether bond, which was discovered previously in Eunicia mammosa soft coral [57,58]. Another seven cembranoids with α-methylene-γ-lactone group and rare trans 6,7-disubstituted double bond, uncovered earlier only in soft coral Eunicia pinta, identified as sarcocrassocolides F–L 143–149, were isolated from S. crassocaule [59]. Besides the abovementioned sarcocrassocolides, another three sarcocrassocolides, M–O 150–152, from S. crassocaule, were identified. Through structural analysis, sarcocrassocolide N 151 was found to have the same relative configuration of sarcocrassocolide M 150, while sarcocrassocolide O 152 was found to be the 13-deacetoxy derivative of sarcocrassocolide M 150 [60]. Three more cembranoids, sarcocrassocolides P–R 153–155, were identified, and their structures were investigated by an extensive spectral study [61].

Investigation of n-hexane fraction for S. ehrenbergi led to the isolation of (+)-7,8-epoxy-7,8dihydrocembrene C 156, in which its optical rotation indicated that it was (+)- (75,8S)-7,8-epoxy-7,8-dihydrocembrene C 156, not (-)-7,8-Epoxy-7,8-dihydrocembrene C, which was reported previously from S. crassocaule [62].

Six cembranoids, (+)-12-carboxy-11Z-sarcophytoxide 157, (+)-12-methoxycarbonyl-11Z-sarcophine 158, ehrenberoixides A–C 159–161 and lobophylin C 162 were isolated from S. ehrenbergi. Compound 157 has a 2,5-dihydrofurane ring attached to a 14 membered ring at carbon-1 and carbon-2, a carboxylic acid at carbon-12 and an epoxide moiety at carbon-7 and carbon-8. Moreover, the authors mentioned that both ehrenberoixides B and C 160–161 raised from the exact precursor with a 7,8-epoxide through a transannular cleavage of the 7,8-epoxide by both ends of an 11,12-diol, while compound 160 has a unique oxepane ring, which was not detected previously in cembranoid [63] and from S. infiniduliforme diterpenoids cembrene C 163, sarcophytol B 164, sarcophytol E 165, and sarcophytol H 166, (−)-marasol 167 were reported [64].

A cembreane diterpene identified as 2R,7R,8R-dihydroxysarcophine 168 was isolated from S. glaucum [65], and three compounds were reported from its ethyl acetate fraction, of which two were peroxide diterpenes identified as 11(S)-hydroperoxysarcoph-12(20)-ene 169, 12(S)-hydroperoxysarcoph-10-ene 170, and 8-epi-sarcophinone 171. All structures were investigated by spectral data, and their relative configuration was assigned by X-ray diffraction [66].

Methyl sarcotroate A and B 172 and 173 two diterpenes, along with sarcophytololide M 174, a precursor for the former two compounds, were isolated from S. trocheliophorum, and their biogenetic pathways were proposed, in which isomaration, cycloaddition followed by oxidation of compound 174 led to the formation of both compounds 172 and 173. The authors also studied the absolute configuration of methyl sarcotroate B 173 through TDDFT ECD calculations, helping in determining the absolute configurations for methyl sarcotroate A 172 and sarcophytololide M 174 by a biogenetic relationship and ECD comparison, respectively [67].
Cembranoid diterpene, identified as (1S,2E,4R,6E,8S,11R,12S)-8,11-epoxy-4,12-epoxy-2,6-cembradiene 175, (1S,2E,4R,6E,8R,11S,12R)-8,11-epoxy-2,6-cembradiene-4,11-diol 176, and (1S,4R,13S)-cembra-2E,7E,11E-trien-4,13-diol 177, were reported from nature for the first time, from *S. glaucum* [68].

From an acetone extract of *S. ehrenbergii*, three cembranoids were isolated. Through full NMR data, the existence of α, β unsaturated ethyl ester and α, β unsaturated methyl ester of both (+)-12-ethoxycarbonyl-11Z-sarcophine; ehrenbergol A and B 178–180 were confirmed. Ehrenbergol B 179 showed a trisubstituted epoxide and two trisubstituted olefins. [69].

Fifteen cembrane-type diterpenoids were isolated from *S. elegans*, sarcophyolides B–E 181–184, along with sarcophytol L 185, 13α-hydroxysarcophytol L 186, sarcophyloide A 187, sarcophinone 188, 7α-hydroxy-Δ8(19)-deepoxysarcophine 189, 4β-hydroxy-Δ2(3)-sarcophine 190, 1,15β epoxy-2-epi-16-deoxysarcophine 191, sarcophytol Q 192, and lobocrasol 193. A detailed structural elucidation was determined by spectral data and reported data. The absolute configurations of sarcophyolides B–E 181–184 were approved by single-crystal X-ray diffraction assay, using Flack’s assay [22], and the structure of lobocrasol 193 was further studied [70].

From the ethyl acetate extract of *S. ehrenbergii* two diterpenes were isolated, acetyl ehrenberoxide B 194 and ehrenbergol C 195. Ehrenbergol C 195 shared a structure similar to lobocrasol 193, isolated from *Lobophytum crassum* [71]. Yet, relative stereochemistry of carbon-7 and carbon-8 in ehrenbergol C 195 differed from lobocrasol 193 in hydroxy group and a conjugated enone evidenced by the IR spectrum at 3444 and 1696 cm⁻¹, respectively [72].

An oxygenated cembranoid diterpene, sarcophytol W 196, together with (2E,7E)-4,11-dihydroxy-1,12-oxidocembre-2,7-dien 197, were isolated before from *S. infundibuliforme* and *S. glaucum*, (+)-11,12-epoxy-11,12-dihydrocembrene-C 198, (+)-11,12-epoxysarcophytol A 199 and sarcolactone A 200, previously known, were reported from *Sarcophytos* sp. Structures were determined through spectral data and comparing the reported data. The absolute configuration of sarcophytol W 196 was elucidated based on the modified Mosher’s assay [73].

Two diterpenes were isolated from *S. tortuoseA*, identified as tortuocenes A and B 201 and 202. Structural elucidation of compounds 201 and 202 were investigated by spectral data. The absolute configuration of tortuone A 201 was investigated using TDDFT ECD method. Moreover, the authors proposed a biosynthetic pathway for tortuocenes A and B 201 and 202 from the assumed cembranoidal precursor; (1Z, 3Z, 7E, 11E)-4-isopropyl-1,7,11-trimethylcyclooctadeca-1,3,7,11-tetaene, by oxidation of carbon-20 and the carbon-7-carbon-8 double bond was epoxidize, forming aldehydocembreane, a structure related to embide [81]. The resulting aldehydocembreane additionally formed a cycle from carbon-2 to carbon-20 by acid-catalyzed attacking the carbon-1/carbon-2 double bond of the carbonyl moiety [74].

2-epi-sarcophine 203 and (1R,2E,4S,6E,8R,11R,12R)-2,6-cembradiene-4,8,11,12-tetrol 204, two diterpenes were isolated from *S. auritum* [75]. An extensive chemical investigation of *Sarcophytos* sp. extract yielded four cembranoids, sarcophytins A–D 205–208, along with cembranoids, 2-[(E,E,E)-7,8′-epoxy-4′,8′,12′-trimethylcyclooctadeca-1′,3′,11- trienyl]propan-2-ol 209, (1E,3E,7R*,8R*,11E)-1-(2-methoxy-propan-2-yl)-4,8,12-trimethylxacyclo[12.1.0]-pentadeca-1,3,11-triene 210, crassomol 211, and laevigatol A 212. [76]. Two unique pyrane-based cembranoids, sarcotrochelol acetate and sarcotrochelol 213 and 214 were isolated from *S. trocheliophorum* [77]. Investigation of *S. glaucum* organic extract resulted in the isolation of sarcophinediol 215, previously processed semi-synthetically [78].

Cembranoid diterpenes, 7-keto-8α-hydroxy-deepoxysarcophine 216 similar to compound 13, in which the carbon at carbon-3 and carbon-11 were presumed to be in E configuration established on compound 13 derivatives; this was established through spectral data. 7β-chloro-8α-hydroxy-12acetoxysarkophine 217 was close to 7-keto-8α-hydroxy-deepoxysarkophine 216 except for the disappearance of ketone signal at C-7 which co-exists with the presence of an up fielded signal at δ62.9 (C-7), a downfield of C-20 and the presence of carbonyl and methyl group at 170 and 22.2, respectively, were isolated from *S. ehrenbergii*. [79].
From *S. trocheliophorum*, sarsolenane diterpenes and capnosane diterpenes were obtained. Sarsolenane diterpenes are uncommon in nature, symbolized only by sarsolenone isolated from *S. solidum*. Two sarsolenane diterpenes, dihydrosarsolenone 218, methyl dihydrosarsolenonate 219, and two capnosane diterpenes, sarsolidines B and C 220 and 221, together with sarsolidile A 222 were isolated. Dihydrosarsolenone 218 resulting from sarsolenone 223 by terminal double bond Δ18 reduction followed by the oxidation of C-18 gave methyl dihydrosarsolenonate 219. Capnosane diterpenes were first isolated from *S. solidum* and *S. trocheliophorum*. The only example reported with α, β-unsaturated ε-lactone subunit was sarsolidile A 222, from *S. solidum*, in which, the hydration of the exomethylene group provided carbon-10 epimers, sarsolidiles B and C 220 and 221 [80].

Ethyl acetate extract of *S. trocheliophorum* yielded twenty-three isolates, of which nineteen were cembranoids with unique capnosane skeleton identified as trocheliohols A–S 224–242 and two analogues, 4-epi-sarcophytol L 243 and sarcophydoglide C 182. The structures were investigated by a full spectral data, and their absolute configurations were established through modified Mosher's assay, CD and X-ray diffraction. Trocheliohols C 226, E 228, F 229, and M 236 all possessed a structure similar to sarcophytolide C 176, while, trocheliophol Q 240 was identified as the C-8 methoxylated model of trochelioholf F 229. However, trocheliophol R 241 possessed a similar structure to trocheliophol F 229 but it differed in the presence of the methoxy group [81].

Chemical determination of *S. elegans* CHCl3/MeOH extract resulted in isolation of four cembranoids identified as sarcophelegans A–D 244–247. Sarcophelegan A 244 was found to be the 11,12-epoxy derivative of sarcophytogen C 246. Through X-ray crystallographic examination using anomalous scattering of Cu Kα radiation, sarcophelegan A 244 structure was verified. Moreover, sarcophytogen C 246 was found to be the 7-hydrogenated derivative of sarcophelegan B 245 [18].

Five polyoxygenated cembranoids were identified as polyoxygenated cembranoids, (+)-1,15-epoxy-2-methoxy-12methoxyethylcarbonyl-11E-sarcophytoxide 248, (+)-2-epi-12-methoxyethylcarbonyl-11E-sarcophytoxide 249, 3,4-epoxyehrenberoxide A 250, ehrenbergold D 251 and ehrenbergold E 252 in *S. ehrenbergii*. The authors proposed that (+)-1,15-epoxy-2-methoxy-12methoxyethylcarbonyl-11E-sarcophytoxide 248 was the 1,15 epoxy-2-methoxylated equivalent of lobophynin C 162. Through investigating the spectral data and X-ray crystallization of (+)-2-epi-12-methoxyethylcarbonyl-11E-sarcophytoxide 249 it was found that it differed in the alignment of the α, β-unsaturated γ-lactone ring attached to C-2 of the 14-membered ring [63]. 3,4-epoxyehrenberoxide A 250; an analogue to ehrenberoxide A 159 where the epoxide in ehrenberoxide A 159 was substituted by a double bond at C3 and C4 [82].

Eight metabolites were isolated from *S. solidum*, three sarsolenanes, 7-deacetyl-sarsolenone 253, sarsolenone 223, and methyl dihydro-sarsolenonate 219 together with, sarsolidile B 220. All 7-deacetyl-sarsolenone 253, sarsolenone 223, sarsolidile B 220, could be used as a chemotaxonomic marker for this species [83].

Three isolates; trocheliane 254, tetracyclic bisembrane and two cembranoid diterpenes, sarcotrocheldiols A and B 255 and 256, were isolated from *S. trocheliophorum*. Their relative configuration and structure of the isolates were investigated by spectral data [84].

From *Sarcophytton* sp., one cembrane diterpene, 16-hydroxycembre-1,3,7,11-tetraene 257, besides, 15-hydroxycembre-1,3,7,11-tetraene 258 were reported. Structures were investigated by spectral data [85].

Three cembranoids from *S. trocheliophorum*, sarcophytols D–F 259–261 highly oxidative compounds, besides, 11,12-epoxy-1(E),3(E), 7(E)-cembratrien-15-ol 262 and sinugibberol 263 were isolated. All structures were investigated by a full spectral data and by comparing with previous stated data [86]. Another six cembranoids, sarcophytols G–L 264–269 together with crassumol A 270, were isolated from *S. trocheliophorum* [87]. Additionally, another nine cembranoids, sarcophytols M–U 271–279, were also reported. Their structures were interpreted with extensive spectral analysis and chemical conversion and the absolute configuration for sarcophytols M–S 271–277 were investigated by the modified Mosher's assay. Sarcophytols R and S 276 and 277 revealed a unique decaryl skeleton with an uncommon C12/C15 cyclization [88]. Another cembranoid, trocheliolide B 280 from
**S. trocheliophorum** was isolated [89]. Chemical determination of *S. trocheliophorum* organic extract, yielded pyrane-based diterpene, 9-Hydroxy-10,11-dehydro-sarcotrochelinol 281 [90]. From *S. ehrenbergi* eight cembranoids, sarcophytonoxides A–E 282–286 were identified. Sarcophytonoxide A 282, a cembrane diterpene with epoxide, dihydrofuran, acetyl group and three olefin bonds were confirmed by spectral data analysis while sarcophytonoxide D 285 was the deacetylated form of sarcophytonoxide C 284 which has a structure similar to sarcophytonoxide A 282. However, sarcophytonoxide C 283 differed in the chemical shift of C-19, C-6, C-7, and C-9 because of the 7,8-double bond configuration or chiral center of C-6. However, sarcophytonoxide E 286 differed in the position of acetyl group and the exocyclic double bond. [91]. From *S. trocheliophorum* a sarsolane diterpene, secodihydrosarsolenone 287 was identified [92].

The chemical investigation of both diethyl ether and dichloromethane extracts of *S. stellatum* yielded the isolation of three cembranoid diterpenes and enantiomer, (+)-(1E,3E,11E)-7,8-epoxyembra-1,3,11,15-tetraene 288, (+)-(7R,8R,14S,1Z,3E,11E)-14-acetoxy-7,8-epoxyembra-1,3,11-triene 289 [93].

Five isoprenoids from *S. glaucum*, 3,4,8,16-tetra-epi-lobocarol, 1,15β-epoxy-deoxysarcophine, 3,4-dihydro-4α,7β,8α-trihydroxy-Δ2-sarcophine, ent-sarcophyolide E 290–293, together with, 3,4-dihydro-4α-hydroxy-Δ2-sarcophine, 3,4-dihydro-4β-hydroxy-Δ2-sarcophine 294 and 295 and kylflaccicembranol F 296 were reported and their structures were elucidated by spectral data. [70]. Moreover, five cembranoids, sarelengans C–G 297–301 from *S. elegans* were also stated. Isolates structures were established by spectral data, and absolute configuration of sarelengans D–F 298–300 were investigated through single crystal X-ray diffraction [94].

Isolation of seven diterpenes were reported from *S. ehrenbergi* and identified as sarcoehrenbergilids A–C 302–304 together with sinulolides A and B 305 and 306. The absolute configuration of sarcoehrenbergilid A 301 was investigated by scattering of CaKα radiation with the flack parameter [95]. Moreover, sarcoehrenbergilid D–F 307–309, diterpenes isolated from *S. ehrenbergi* were isolated and their absolute configurations were investigated by experimental and TDDFT-simulated ECD spectra. Sarcoehrenbergilid D 307 was found to differ from compound 301 only in stereochemistry [96]. Furthermore, five cembranes diterpenes, Sarcoehrenolides A–E 310–314 were isolated from *S. ehrenbergi*. Their chemical structures were determined through extensive spectral data. All isolates were related to ehrenbergil D 251 in structure, having an α,β-unsaturated-γ-lactone group at carbon-6 to carbon-19, however, they differ in migration of double bonds and/or oxidative configurations. Additionally, the absolute configuration of sarcoehrenolide A 310 was investigated by a single-crystal X-ray diffraction assay by Cu Kα radiation, and the absolute configurations of sarcoehrenolides B 311 and D 313 by TDDFT/ECD calculations [97].

From *S. infundibuliforme* two nitrogenous diterpenoids with unusual tricycle [6.3.1.01,5] dodecane skeleton named, sarinfacetamides A and B 315 and 316 and a known compound; nanolobatin B 317 were reported. Their structures were clarified by a thorough spectral data, TDDFT-ECD calculation and the absolute configuration of sarinfacetamide A 315 was investigated. The authors proposed a probable biosynthetic pathway for sarinfacetamides A and B 315 and 316, in which, the development of the carbon-12–carbon-4 bond together with epoxide ring opening of nanolobatin B 317 created an intermediary carbon cation molecule which reacted with the nitrogen lone pair electrons attacking carbon-9 followed by the opening of carbon-1/carbon-9 bond and generation of carbon-1/carbon-8 bond offering sarinfacetamides skeleton, of which acetylation of carbon -4/carbon -8 or carbon -4/carbon -8/carbon -16 yielded sarinfacetamides B 316 and A 315, respectively [98]. From genus *sarcophytion*, (1S,2E,4R,6E,8S,11S,12S)-11,12-epoxy-8-hydroperoxy-4-hydroxy-2,6-cembradiene 318 was reported. Its structure was fully determined through a complete spectroscopic analysis [99].

Sarcomililatos A, B and sarcomililate A 319–321, which possessed tricyclic [11.3.0.02,16] hexadecane skeleton, along with diterpenoids sarcophytol M 322, were isolated from *S. mililatensis*. Absolute configuration for sarcomililato A 319 and sarcomililate A 321 were elucidated by combination of residual dipolar coupling-based NMR analysis, Snatzke’s assay and TDDFT-ECD calculation and anomalous X-ray diffraction with sarcomililato A 319. The authors also proposed a
biogenetic pathway relationship for sarcomilatols A, B and sarcomilate A 319–321. Based on structural resemblance between the three compounds, acetylation of sarcomilatol B 320 gave sarcomilatol A 319, and with dehydration under acid, isomerization and intramolecular [4 + 2] cycloaddition, sarcomilate A 321 was formed [100]. A pyrane-cembranoid diterpenes, 9-hydroxy-7,8-dehydro-sarcotrocheliol and 8,9-expoy-sarcotrocheliol acetate 323 and 324 were isolated from S. trocheliophorum [101]. Figure 4 summarizes diterpenes isolated from Sacrophyton sp.
2.2. Biscembranes

Four biscembranes, bisglaucumlides A–D 325–328 were isolated from S. glaucum. Spectral data showed that bisglaucumlide A 325 possessed a biscembranoid skeleton. Bisglaucumlide B 326 was confirmed to be 32-acetyl-bisglaucumlide A by the positive Cotton effect in the CD spectrum. As for bisglaucumlide C 327 it was found to be the geometrical isomer of bisglaucumlide B 326 while considering the geometry of the C-4 olefin. Bisglaucumlide D 328 was an isomer to bisglaucumlide C 327, its absolute configuration indicated an anticlockwise relation among the enone chromopores revealing a negative Cotton effect CD spectrum [102]. Moreover, chemical investigation of S. glaucum extract yielded two biscembranes with an uncommon α, β-unsaturated ε-lactone, Glaucomicolides A and B 329–330 [103].

Ximaolides A–G 331–337, seven biscembranoid, together with methyl tortusolate A 338 where isolated from S. tortuosum. Their structures were elucidated through spectral analysis and Ximaoide A 331 and E 335 relative stereochemistry were investigated using X-ray diffraction method. The
authors demonstrated that methyl tortuosoate A 338 could be the biogenetic precursor for all isolated metabolites since their upper parts were closely related to compound 338 [104].

A cembranolide diterpene identified as isosarcophytolide D 339, an isomer to the previously isolated compound 41 from S. tortuosum, along with two biscembranes, bislatumlides A and B 340–341, were isolated from S. latum. A detailed spectral analysis revealed that the structure of bislatumlide B 341 matched that of bislatumlide A 340. However, 13C NMR data revealed a significant difference from compound 340 in the chemical shifts of carbon-19 and carbon-10 demonstrating the Z nature of Δ11 olefin in compound 340. Thus, compound 340 was found to be the 11Z isomer of bislatumlide B 341. Interestingly the authors have proposed a biosynthetic pathway for bislatumlides A and B 340–341 in which isosarcophytolide D 339 was found to be one of the precursors for bislatumlide A 340. Moreover, the authors investigated the effect of long-term storage in CDCl3, where it showed isomerization of bislatumlide A 340 to bislatumlide B 341 at Δ11 [105].

Methyl tetrahydrosarcoate and methyl tetrahydroisosarcoate 342 and 343, two cembranoids isolated from S. elegans, along with four biscembranoids, nyalolide, desacetylnyalolide, diepoxynyalolide, and dioxanyalolide 344–347. The authors proposed that diepoxynyalolide 346 could be a precursor for both compound nyalolide 344 and dioxanyalolide 347 [106].

Investigation on S. elegans extract led to the isolation of six biscembranoids identified as sarcophytolides G–L 348–353, together with biscembranoids, lobophytone H, Q, K, W, U 354–358. Isolates structure were determined by spectroscopic analysis. Absolute configuration of the compound sarcophytolide G 348 was determined using Mosher reaction [22,107]. From the methanol extract of S. pauciplicatum, sarcophytolides M and N 359 and 360, along with lobophytone O 361, were isolated [108].

Two biscembranoids, sarelengans A and B 362 and 363, were reported from S. elegans. Their chemical structures were investigated by spectral and chemical methods, and the absolute configuration of sarelengans A determined by single crystal X-ray diffraction. Sarelengans A and B 362 and 363 possessed a conjuncted trans-fused A/B-ring between two cembranoid entities. The authors mentioned that this structure feature led to an uncommon biosynthetic pathway including a cembranoid-Δ8 instead of cembranoid-Δ11 unit in endo-Diels-Alder cycloaddition [94]. Figure 5 summarizes biscembranes isolated from Sacrophyton sp.
Figure 5. Biscembranes reported from *Sarcophyton* sp.
2.3. Sesquiterpenes

Investigation of the methylene chloride extract of *S. acutangulum* yielded tetracyclic terpenoid hydrocarbon (+)-alloaromadendrene 364 which showed similar spectral data as that of (−)-alloaromadendrene but with different optical rotation [RJ] +25.8° (−)-alloaromadendrene and cyclosinularane 365 [109].

Two guaiane sesquiterpenes 4α-ethoxy-10α-hydroxyguai-6-ene and 10α-hydroxy-4α-methoxyguai-6-ene 366 and 367 were isolated from *S. butenidijki* and their structures were elucidated through 1 and 2D NMR [110]. One 1,2-dioxolane sesquiterpene alcohol named, dioxosarcoguaiacol 368, was isolated from *S. glaucum* [111].

Trocheliophorin 369 was isolated from *S. trocheliophorum* ethyl acetate extract. Through spectral data, its structure was elucidated, revealing that it could be the result of aromatization with dehydration of ring B of sarcophythin which co-exist in the extract, and removal of ring C and the ring junction methyl and breakage of ring A [112]. In addition, aromadendrene sesquiterpenoid, palustrol 370 from *S. trocheliophorum* was reported [77]. Moreover, sesquiterpene guajacophine 371 and 1,4-peroxymurol-5-ene 372 from *S. ehrenbergii* were stated. [62]. Continuing the abovementioned isolation from *S. glaucum* sesquiterpenoid, 6-oxo-germacra-4(15),8,11-triene 373 was also reported [78]. Figure 6 summarizes sesquiterpenes isolated from *Sarcophyton* sp.

![Figure 6](image)

Figure 6. Sesquiterpenes reported from *Sarcophyton* sp.

2.4. Polyhydroxysterol and Steroids

One polyhydroxysetrol, 23,24-dimethylcholeste-16(17)-E-en-3β,5α,6β,20(S)-tetaol 374, along with 24-methylcholeste-3β,5α,6β,25-tetraol-25-monoacetate 375 and gosteren-5(E)-3β-ol 376, were reported from *S. trocheliophorum*. Interpretation using 1 and 2D NMR analysis pointed out the existence of 23,24-dimethyl cholesterol derivatives which were further approved by the mass fragmentation pattern [29]. The isolation of (24S)-24methylcholeste-3β,5α,6β-triol 377 from *S. crassocaule* were also reported [28].

Sardisterol 378 was isolated from *S. digitatun* Moser. The carbon NMR matched that of (22R)-methylcholeste-5-en-3β, 22,25,28-tetraol-3,22,28-triacetate 379 indicating that sardisterol 378 has the same steroidal nucleus as (22R)-methylcholeste-5-en-3β, 22,25,28-tetraol-3,22,28-triacetate 378 but the OH groups in carbon 22 and 28 were replaced by acetoxy groups [113].

(24S)-24methylcholeste-3β,5α,6β,25γ,26-pentol-25,26-diacetate 380 and (24S)-24methylcholeste-3β,5α,6β,25γ,26-pentol-26-n-decanoate 381, was isolated from *S. trocheliophorum*, while, (24S)-24methylcholeste-3β,5α,6β,25γ-tetrol 382 and (24S)-24methylcholeste-3β,5α,6β,25γ-pentol-25-monoacetate 383 were reported from *S. glaucum* [114].

Fourteen polyoxygenated steroids with 3β,5α,6β-hydroxy group, showing ergostane, cholestan, gorgostane and 23,24-dimethyl cholesterol carbon skeletons were reported from *Sarcophyton* sp., 11α-acetoxy-cholesta-24-en-3β,5α,6β-triol 384, (22E,24S)-11α-acetoxy-ergostane-22,25-dien-3β,5α,6β-triol 385, (24S)-ergostane-1α,3β,5α,6β,11α-pentaol 386, (24S)-23,24-dimethylcholesta-22-en-3β,5α,6β,11α-tetrol 387, (23R,24R)-23,24-dimethylcholesta-17(20)-en-3β,5α,6β-triol 388, 11α-acetoxy-gorgostane-3β,5α,6β,12α-tetraol 389 and 12α-acetoxy-gorgostane-
3β,5α,6β,11α-tetraol 390, sarcoaldoster A 391, (24S)-ergostane-3β,5α,6β-triol 392, (24S)-ergostane-3β,5α,6β,11α-tetraol 393, (24S)-ergostane-7-en-3β,5α,6β-triol 394, 11α-acetoxy-gorgostane-3β,5α,6β-triol 395, sarcoaldoster B 396 and gorgostane-1α,3β,5α,6β,11α-pentaol 397. Structural elucidation for all isolates were done based on spectral analysis and comparing with reported literature [115].

Six polyhydroxy steroids, (24S)-ergostan-3β,5α,6β,25-tetraol-25-monoacetate 398, (24S)-24-methylcholestan-3β,6β,25-triol-25-O-acetate 399, (24S)-methylcholestan-3β,5α,6β,25-tetraol-25-diacetate 400, (24S)-24-methylcholestan-3β,5α,6β,25-pentaol-25-monoacetate 401 and (24S)-methylcholestan-3β,5α,6β,12β,25-pentaol-25-O-acetate 402, were reported from Sarcophyton sp., one was reported as 18-oxygenated polyhydroxy steroid, (24S)-ergostan-3β,5α,6β,18,25-pentaol 18,25-diacetate 403. The structure of this compound was determined through spectroscopic data, and its absolute configuration was elucidated by the modified Mosher’s assay [116].

Chemical investigation of the polar fraction of S. trocheliophorum, yielded two poly-hydroxy steroids, identified through extensive spectral analysis as zahramycins A and B 404 and 405. Zahramycin A 404 was characterized by the existence of oxirane ring at carbon-5 and carbon-6, while zahramycin B 405 possessed a keto-hydroxy sterol structure [117].

Ten polyhydroxylated steroids were isolated from Sarcophyton sp., (23R,24R,17Z)-11α-acetoxy-16β-methoxy-23,24-dimethylcholestan-17(20)-en-3β,5α,6β-triol 406, (24R)-gorgost-25-en-3β,5α,6β,11α-tetraol 407 and 11α-acetoxycholestan-24-en-1α,3β,5α,6β-tetraol 408, (24R)-methylcholestan-7-en-3β,5α,6β-triol 409, 11α-acetoxy-cholestan-24-en-3β,5α,6β-triol 410, (22E,24S)-11α-acetoxy-ergostan-22,25-dien-3β,5α,6β-triol 411, (24S)-11α-acetoxy-ergostan-3β,5α,6β-triol 412, (24R)-11α-acetoxy-gorgostane-3β,5α,6β-triol 413, (24S)-ergostan-3β,5α,6β,11α-tetraol 414, and (24S)-23,24-dimethylcholestan-22-en-3β,5α,6β,11α-tetraol 415. Their structural elucidation was based on spectral data, and it was found that all isolated compounds have a distinguishable 3β,5α,6β-trihydroxy group; however, they differ in side chains and substitutions. These steroids could be alienated structurally into four categories including, cholesterol, ergosterol, gorgostere and 23,24-dimethyl cholesterol. (23R,24R,17Z)-11α-acetoxy-16β-methoxy-23,24-dimethylcholestan-17(20)-en-3β,5α,6β-triol 406 has a distinctive 17(20)-en-23,24-dimethyl side chain, while (24R)-gorgost-25-en-3β,5α,6β,11α-tetraol 407 was a gorgostere having a 25-ene side chain [118].

Ethanol-soluble fraction of the acetone extract of S. trocheliophorum yielded 9,11-seco steroid named, 25(26)-dehydroxasarcomsterol 416 and three polyhydroxylated steroids, 7α-hydroxocassarossterol A 417, 11α-acetoxy-7α-Hydroxocassarossterol A 418, sarcomsterol 419, 3β,6α,11-trihydroxy-9,11-seco-5α-cholestan-7-ene-9-one 420 and 3β,6α,11-trihydroxy-24-methylene-9,11-seco-5α-cholestan-7-ene-9-one 421. The 9,11-seco steroids nucleus can be described as the chemotaxonomic indicators for genus Sarcophyton [119].

Beside the abovementioned isoprenoids obtained from S. glaucum, 16-deacetylhalicrasterol B 422, together with sarcoeilsterol B 396, sarglaucsterol 423 were isolated too and their structures were elucidated by spectral data [70]. Furthermore, from S. ehrenbergi the isolation of two formerly isolated hippurin 424 and 425 [120] alongside pregnenolone 426 were reported [121]. Figure 7 summarizes polyhydroxylated sterols isolated from Sarcophyton sp.
2.5. Miscellaneous

From *S. trocheliophorum*, tetradecyl octadecenoate 427, 2,3-dihydroxypropyl-octadecyl ether 428 and tetradecyl-9-Z-octadecenoate 429 were identified [29]. In addition, purification of the total lipid extract of *S. trocheliophorum* provided four butenolides 430–433 with different chain substitutions and saturation together with three fatty acids, arachidonic acid, eicosapentaenoic and docosahexaenoic methyl esters 434–436 and prostaglandin PGB2 437 [122].

An infrequent prostaglandin was isolated from *S. crassocaule*, (5Z)-9,15-dioxoprosta-5,8(12)-dien-1-oate 438 based on spectral analysis. This was the first time to report a prostaglandin with a C-15 keto group from natural origin [123]. Furthermore, from the ethyl acetate and n-butanol fractions of *S. crassocaule*, two isolated metabolites identified as sarcophytonone 439 a tetra-substituted quinone, and sarcophytonamine 440 a quaternary amine were reported. It might be valuable to know that these quinone derivatives are scarce in marine organisms and only sarcophytonone 439 was identified in *S. mayi* [124].

Five compounds were isolated from *S. infundibuliforme*, three were reported O-glycosylglycerol known as sargoglycosides A–C 441–443 and chimyl alcohol and hexadecanol 444 and 445.
Sarcoglycoside A 441 was the first glyco(2020, 18, 41)
glycerolipid to be isolated from soft coral, while sarcoglycosides B and C 442 and 443 were rare marine isolates, composed of a lyxose residue and chymyl alcohol moiety [125]. Moreover, one α-tocopheryl quinone derivative, 3,5,6-trimethyl-2-14S-3,11,14-trihydroxy-3,7,11,15-tetramethylhexadecyclohexa-2,5-diene-1,4-dione 446, was isolated [64].

Purification of ethyl acetate extract of S. ehrenbergi yielded ten prostaglandins, sarcoehrendin A–J 447–456 together with five correlated compounds 457–461. Sarcoehrendin A 447 was found to be the acetylated derivative of arachidonic acid ethyl; previously isolated from Lobophyton depressum [126,127]. Another six prostaglandins 462–467, were reported from S. ehrenbergi, three were reported to be of marine origin [121]. From S. ehrenbergi extract, 2-methyl-1-octanol ester of (E)-3-(4methoxyphenyl) propenoic acid 468 was reported. The authors mentioned that stereochemical structure of 2-methyl-1-octanol ester of (E)-3-(4methoxyphenyl) propenoic acid 468 was ensured via synthesis of two possible isomers (S)-1 and (R)-1 which was recognized by an asymmetric synthesis using 4-benzyl-2-oxazolidinone chiral auxiliaries from octanoic acid [128]. From S. ehrenbergi ceramids 469 was reported alongside two cerebrosides, sarcoehrenosides A and B 470 and 471. A detailed spectral analysis revealed the occurrence of an amide linkage, a long chain, and a sugar, dependable with the C-9 methyl cerebroside nature of sarcoehrenoside A 470 [129].

Three carotenoids, peridinin, peridininol and peridininol-5,8-furanoxide 472–474 were reported for the first time from S. elegans. Chemical structures were interpreted by using spectral data and reported data [130]. Additionally, from Sacrophyton sp. another carotenoid, all-trans-(9′Z,11′Z)-(3R,3′S,5′R,6′R)-pyrrhoxanthin 475 was isolated [76].

Methyl tortuolate A and methyl tortuolate B 476 and 477, two tetracyclic tetraterpenoids, together with methyl sartortuolate 478 and methyl isoamortuolate 479, were reported from S. tortuosum. Methyl tortuolate A 476 was similar to methyl sartortuolate 478 in structure, except for the presence of secondary hydroxyl group in methyl tortuolate A 476 and absence of one tertiary hydroxyl functional group and conjugated diene. As for, methyl tortuolate B 477, it was found to be similar to methyl isosartortuolate 479 in structure, but with no hydroxyl group at C-27 [131]. Tetraterpenoid, methyl tortuolate C 480 after further investigation of the same ethanolic extract of S. tortuosum was isolated and a full spectral data was done to investigate its structure [132]. Another tetracyclic tetraterpenoid; methyl tortuolate D 481, was also reported from S. tortuosum and was identified using direct infusion electrospray ionization mass spectrometry [133]. Figure 8 summarizes miscellaneous isolated from Sacrophyton sp.
Figure 8. Miscellaneous isolated from Sacrophyton sp.

3. Biological Activities

3.1. Cytotoxic Activity

The capability of 13- Acetoxysarcosarcolide 9 was investigated, as a cytotoxic agent against gastric carcinoma using MTT method, colony formation method, cell morphology assessments, and wound-healing method. It suppressed the development and migration of gastric cancer cells in a dose-dependent manner and initiated both early and late cell death examined by flow cytometer assay [134]. The authors mentioned that there was a relationship between the structure of sarcosarin A, B, D, and E 76, 77, 79, and 80, and embilde 81, and its activity, showing that loss of acetoxy group as in crassocolide C 84 led to loss of activity against all tested cell lines. While, acetylation at 4-OH position in crassocolide B 83 resulted in a decrease in activity cytotoxicity. However, the existence of
two hydroxy moiety present at carbon-3 and carbon-4 and no oxidation at carbon-13 as in crassocolide D 85 showed potent activity against MCF-7 and A549 cell lines. While, crassocolide A 82 and F 87 exhibited potent activity toward Hep G2, MCF-7, MDA-MB-231 and A549, because of the 5-O-acetyl group [46]. Furthermore, crassocolide H and L 90 and 94, from S. crascaule, showed strong activity toward KB, Hela, and Daoy cell lines owing to the presence of Cl atom at C-11 instead of OH group in crassocolide H 90 [47].

Sarocrassocolides A–D 137–140, showed potent activity toward MCF-7, WiDr, HEP-2 and Daoy cell lines [58]. The authors maintained that the existence of acetoxy group at C-13 was important for activity. Sarocrasscolides F–I 143–146, showed cytotoxicity toward all or part cell lines. However, sarocrasscolide I 146 was most potent toward Daoy, HEP-2, MCF-7 and WiDr cell lines while sarocrasscolide J and L 147 and 149 13-deacetoxy derivatives, were least potent against all tested cell lines with ED₅₀ > 20 μM. Furthermore, hydroxy moiety at carbon-8 improve the cytotoxic activity in contrast with carbon-8 hydroperoxy-bearing correspondents sarocrasscolide F and H 143 and 145 were most potent toward MCF-7 [59].

Owing to the α, β -unsaturated ε -lactone ring in glaucolvides A and B 329 and 330 both exhibited strong cytotoxicity toward HL-60 and CCRF-CEM cell [103]. The authors specified that the absence of oxygen present the more immunosuppressive activity, yalongene A 71 was the most potent even better than the positive control Cyclosporin A [100]. (24S)-24-methylcholestan-3β,5α,6β,25-tetrol-25-monoacetate 375 exhibited potent activity toward P-388, A549, and HT-29 cell lines [114]. The authors reported that there was a structure activity relationship in which the presence of an extra free hydroxyl group at C-20 position in 23,24-dimethylcholest-16(17)-E-ene-3β,5α,6β,20(8S)-tetraol 374 and acetyl group at C-25 position in 24-methylcholestan-3β,5α,6β,25-tetraol-25-monoacetate 375 led to strong cytotoxicity toward human MI14, HL60, and MCF7 cells with a dose-dependent manner [29]. The occurrence of OAc moiety at carbon-11 was important for cytotoxic activity, as in (23R,24R,17Z)-11α-acetoxy-16β-methoxy-23,24-dimethylcholeste-17(20)-en-3β,5α,6β-tetraol 406, (22E,24S)-11α-acetoxy-ergost-22, 25-dien-3β,5α,6β-tetraol 411 and (24S)-11α-acetoxy-gorgost-3β,5α,6β-tetraol 413 showed a strong cytotoxicity toward K562, HL-60, HeLa cell lines, while, 11α-acetoxycholeste-24-en-1α,3β,5α,6β-tetraol 408, 11α-acetoxy-choleste-24-en-3β,5α,6β-tetraol 410 and (24S)-11α-acetoxy-ergost-3β,5α,6β-tetraol 412 exhibited a potent activity toward K562 and HL-60 [118].

3.2. Anti-Inflammatory Activity

Sarocrasscolide M 150 could be a leading anti-inflammatory. Sarocrasscolides M–O 150–152 might be beneficial anti-inflammatory agents because of the structure relationship and the existence of β-hydroperoxy moiety at carbon-7 [60]. Sarocrasscolides F–L 137–143 activity was attributed to the ring-opening of the α,β-unsaturated-β-ether ketone group leading to an increase in the enzyme inhibitory activity [58]. Sarcoehrenolide A, B, and D 310, 311, and 313 and ehrenbergo D 251 showed significant TNF-α inhibition in which sarcoehrenolide B 311 was most active due to the existence of acetoxy at carbon-18. A structure activity relationship was demonstrated in which the keto moiety at carbon-13 and hydroxyl group at carbon-18 could be responsible for the slight increase in activity. However, the presence of carbomethoxy moiety at carbon-18 led to a reduction in activity [97].

3.3. Antidiabetic Activity

Methyl sarcoelement B 173 has strong inhibitory activity toward PTP1B because of the hydroperoxide group which binds to the active site of the Cys residue [67]. Potency of sarcophytololide N 50 and sarcassin E 80 may be because of the existence of methyl ester moiety at carbon-18, which significantly increases the enzyme inhibitory activity toward human PTP1B enzyme [39].
3.4. Antimicrobial Activity

Sarcophytolide 32 showed a strong antibacterial activity toward methicillin-sensitive S. aureus Newman strain because of the diene at C-1/C-3 [41]. The crude extract exhibited antimicrobial activity toward most of the examined bacteria, yeasts, and fungi. [77]. Trocheliophols H, I, L, N, O, and R 231, 232, 235, 237, 238, and 241, 4-epi-sarcophytol L 243 showed antibacterial activity toward Xanthomonas vesicatoria, Agrobacterium tumefaciens, Pseudomonas lachrymans, Bacillus subtilis, and Staphylococcus aureus. The authors mentioned that the structure activity relationship and the existence of exomethylene group at C-8 add to the antibacterial activity, while H-3β orientation, which was present only in compound trocheliophol S 242, gave the most potent activity against the selected bacteria [81]. The toxicity of the novel γ-lactones compounds butenolides 430–433 were evaluated by using shrimp bioassay, and bioactivity was shown. Additionally, they showed activity against Gram-positive bacteria only [122].

Because of the structure activity relationship, 11α-acetoxy-cholesta-24-en-3β,5α,6β-triol 384, (22E,24S)-11α-acetoxy-ergostane-22,25-dien-3β,5α,6β-triol 385, 11α-acetoxy-gorgostane-3β,5α,6β,12α-tetraol 389, 12α-acetoxy-gorgostane-3β,5α,6β,11α-tetraol 390, and sarcoaldosterol A 391 were more potent toward antibacterial activity toward Escherichia coli and Bacillus megaterium, and antifungal activity toward Microbotryum violaceum and Septoria tritici fungi, because of the 11α-acetoxy group, cyclopropane side chain and terminal-double bond [115].

3.5. Miscellaneous

Anticonvulsant activity of ceramide 469, measured in vivo by the pentylentetrazole (PTZ)-induced seizure assay, has successfully opposed the lethality of pentylenetetrazole in mice. It showed also a significant anxiolytic activity when used in the light–dark transition box. This could be caused possibly by GABA and serotonin receptors modulation [135]. Table 1 summarizes the main biological activities of secondary metabolites from genus Sacrophyton.
### Table 1. The main biological activities of secondary metabolites isolated from genus *Sacrophyton*.

| Compound Name (Number) | Soft Coral | Chemical Class | Biological Activities | Geographical Area of Collection |
|------------------------|------------|----------------|-----------------------|--------------------------------|
| Crassolide 7           |            |                | Potent cytotoxic activity against A549, HT-29, KB with IC₅₀ range of 7.55 to 9.15 and most active against P-388 cell line with ED₅₀ = 0.16 μg/mL [28]. | Green Island, Taiwan |
| Sarcocrassolide A 8    | *S. crassocaule* |                | Potent cytotoxic activity against A549, HT-29, KB with IC₅₀ range of 4.29 to 8.35 and most active against P-388 cell line with ED₅₀ = 0.14 μg/mL. Significantly decreased iNOS protein levels and COX-2 expression to 1.1 ± 0.9% and 3.9 ± 2.3%, respectively, could be a promising anti-inflammatory agent [32,58]. | Green Island, Taiwan. Xisha Islands, South Sea, China. Dongsha coast, Taiwan |
| 13-Acetoxy sarcocrassolide 9 |          | Diterpene | Potent cytotoxic activity against A549, HT-29, KB with IC₅₀ range of 4.66 to 7.39 and most active against P-388 cell line with ED₅₀ = 0.38 μg/mL and gastric carcinoma [32,58]. | Green Island, Taiwan |
| Denticulatolide 10     | *S. crassocaule* |            | Potent cytotoxic activity against A549, HT-29, KB with IC₅₀ range of 5.78 to 6.46 and most active against P-388 cell line with ED₅₀ = 0.15 μg/mL. Inhibited the colony formation of Chinese hamster V79 at ED₅₀ = 3.6 μM, respectively and decreased the TNFα-production at 3.0–10.0 μM [28,54]. | Green Island, Taiwan. Manado, North Sulawesi |
| Sarcophytol A 15       | *S. infundibuliforme* |            | Significantly decrease the viability of melanoma cells and does not show toxic effect on CV-1 cells and decrease de novo DNA synthesis and PARP activity. Exhibited cytotoxic activity toward A2780 cell line with IC₅₀ > 10 μg/mL. Significant increase in ALP activity and collagen synthesis [75,136]. | Xidao Island, Hainan, China. Baycanh Island, Condao District, Baria-Vungtau province, Vietnam |
| Sarcophytol A acetate 16 |          |            | Strong anti fouling activity toward the larval settlement of barnacle *Balanus Amphitrite* (EC₅₀ = 2.25 μg/mL) [64]. | Wenchang coral reef in the South China Sea |
| 13-Dehydroxy sarcoglaucol 23 | *S. cherbonnieri* | Diterpene | Potent cytotoxic activity against hepatocellular carcinoma, gastric adenocarcinoma, and breast adenocarcinoma cell lines against cell lines with IC₅₀ = 6.6, 5.4, 1.7 μg/mL, respectively [33]. | Ra-Ra Reef, Fiji Islands, and Stanley Reef, Australia |
| Sarcoglaucol-16-one 25  | *S. cherbonnieri* |            | Potent cytotoxic activity against hepatocellular carcinoma, gastric adenocarcinoma, and breast adenocarcinoma cell lines against cell lines with IC₅₀ = 6.6, 5.4, 1.7 μg/mL, respectively [33]. | Ra-Ra Reef, Fiji Islands, and Stanley Reef, Australia |
### Table of Potency of Compounds against Various Cancer Cell Lines

| Compound欢喜 | Source | Activity Against | Details |
|--------------|--------|------------------|---------|
| Decaryiol 29 | S. cherbonnieri | Potent cytotoxic activity | against hepatocellular carcinoma, gastric adenocarcinoma, and breast adenocarcinoma cell lines with IC₅₀ = 2.0, 7.1, 0.19 μg/mL, respectively [33]. |
| Sarcophytolide 32 | S. glaucum, S. trocheliophorum | Cytotoxic activity at 500 μM concentration | toward mouse melanoma B16F10 cells. Good antiadibiotic activity with IC₅₀ = 15.4 μM. Strong antibacterial activity toward methicillin-sensitive S. aureus Newman strain with MIC = 125 μg/mL [40,41,68]. |
| (4Z,8S,9R,12E,14E)-9-Hydroxy-1-isopropyl-8,12-dimethyloxabicyclo[9.3.2]-hexadeca-4,12,14-trien-18-one 33 | Sarcophyton new sp. | Potent cytotoxicity | toward breast adenocarcinoma cell line with IC₅₀ = 6.5 μg/mL [35]. |
| Decaryiol 35 | S. glaucum | Potent activity | against HepG2 with IC₅₀ = 20 ± 0.032 μM [34]. |
| Sarcophytolide B 36 | S. glaucum | Potent activity | toward MCF-7 with IC₅₀ = 25.0 ± 0.160 μM [34]. |
| Sarcophytolide C 37 | S. glaucum | Potent activity against HepG2 with IC₅₀ = 20 ± 0.153 μM [34]. |
| Sarcophytolinolide J 47 | S. infundibuliforme | Strong antifouling activity | toward the larval settlement of barnacle Balanus Amphitrite (EC₅₀ = 7.50 μg/mL) [64]. |
| Sarcophytolinolide N 50 | S. trocheliophorum | Strong antidiabetic activity | with IC₅₀ = 5.95 μM [39]. |
| Ketoemblide 55 | S. elegans | Significant cytotoxicity | toward breast cancer MDA-MB-231 migration in a time dependent manner. Mild antidiabetic activity with IC₅₀ = 27.2 μM [18,39]. |
| Yalongene A 71 | S. mililatensis | Most potent immunosuppressant | with IC₅₀ = 4.8 μM and selective index = 7.2. Strong cytoprotective activity on SH-SY5Y cell injury caused by hydrogen peroxide in vitro [42,100]. |
| Sarcassin A 76 | S. crassocaule | Potent cytotoxic activity | toward KB cell lines with IC₅₀ = 19.0 μg/mL [44]. |
| Sarcassin B 77 | S. crassocaule | Potent cytotoxic activity | toward KB cell lines with IC₅₀ = 5.0 μg/mL [44]. |
| Sarcassin D 79 | S. crassocaule | Potent cytotoxicity | toward KB cell lines with IC₅₀ = 4.0 μg/mL [44]. |
| Compound         | Source                          | Activity Description                                                                 | Location                                    |
|------------------|---------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------|
| Sarcassin E 80   | S. crassocaule, S. trocheliophorum | Potent cytotoxic activity toward KB cell lines with IC₅₀ = 13.0 µg/mL. Strong antidiabetic activity with IC₅₀ = 6.33 µM [39]. | Sanya Bay, Hainan Island, China. Lanyu Island Coast, Taiwan |
| Emblide 81       | S. crassocaule, S. tortuosum     | Potent cytotoxic activity toward KB cell lines with IC₅₀ = 5.0 µg/ml. Mild inhibition of the elastase release 29.2 ± 6.1% [44,74]. | Kenting Coast, Taiwan. Dongsha Coast, Taiwan |
| Crassocolide A 82| S. crassocaule                   | Potent cytotoxic activity toward Hep G2, MCF-7, MDA-MB-231, A549 DLD-1, and CCRF-CEM cell lines (IC₅₀ = 3.1, 8.9, 8.6, and 11.9 µg/mL, 5.7 and 6.3 µM, respectively). Strongly decreased iNOS protein levels and COX-2 expression to 3.5% ± 0.9% and 59.4% ± 21.4%, respectively [46,61]. | Kenting Coast, Taiwan. Dongsha Coast, Taiwan |
| Crassocolide B 83|                                 | Decrease cytotoxic activity against Liver, breast, lung, DLD-1, CCRF-CEM, and HL-60 cancer cells (IC₅₀ = 13.1, 10.3, 12.1 11.9 µg/mL, 28.1, 8.7 and 11.1 µM, respectively). Strongly decreased iNOS protein levels to 3.2% ± 0.7% [46,61]. | Kenting Coast, Taiwan. Dongsha Coast, Taiwan |
| Crassocolide D 85|                                 | Potent cytotoxic activity toward MCF-7, A549, and DLD-1 cell lines with IC₅₀ = 15.3, 12.5 µg/mL and 27.7 µM, respectively. Strongly decreased iNOS protein levels to 3.2% ± 0.6% [46,61]. | Kenting Coast, Taiwan. Dongsha Coast, Taiwan |
| Crassocolide E 86|                                 | Potent cytotoxicity toward DLD-1, CCRF-CEM, and HL-60 cancer cells with IC₅₀ = 8.7, 7.3, and 8.4 µM, respectively. Strongly decreased iNOS protein and COX-2 expression levels to 1.4% ± 0.4% and 32.0% ± 15.3%, respectively [46,61]. | Dongsha Coast, Taiwan |
| Crassocolide F 87|                                 | Potent cytotoxic activity toward Hep G2, MCF-7, MDA-MB-231, and A549 with IC₅₀ = 2.1, 7.4, 8.8, and 3.2 µg/mL, respectively [46]. | Kenting Coast, Taiwan. Dongsha Coast, Taiwan |
| Crassocolide H 90| S. crassocaule                   | Strong cytotoxic activity toward KB, Hela, and Daoy cell lines with IC₅₀ = 5.3, 14.9, and 3.8 20 µg/mL, respectively [47]. | Kenting Coast, Taiwan |
| Crassocolide I 91|                                 | Potent cytotoxic activity toward Daoy cell line with IC₅₀ = 0.8 µg/mL [47]. | Kenting Coast, Taiwan |
| Crassocolide J 92|                                 | Potent cytotoxic activity toward Daoy cell line with IC₅₀ = 2.8 µg/mL [47]. | Kenting Coast, Taiwan |
| Crassocolide K 93|                                 | Potent cytotoxic activity toward Daoy cell line with IC₅₀ = 2.5 µg/mL [47]. | Kenting Coast, Taiwan |
| Crassocolide L 94|                                 | Strong cytotoxic activity toward KB, Hela, and Daoy cell lines with IC₅₀ = 12.2, 8.0, and 4.1 µg/mL [47]. | Kenting Coast, Taiwan |
| Crassocolide M 95|                                 | Potent cytotoxic activity toward Daoy cell line with IC₅₀ = 1.1 µg/mL [47]. | Kenting Coast, Taiwan |
| Substance | Source | Activity | Notes |
|-----------|--------|----------|-------|
| Crassocolide N 96 | Dongsha Atoll, Taiwan | Potent cytotoxic activity against KB, HeLa, and Daoy cells (IC<sub>50</sub> = 4.7, 4.7, and 2.8 μg/mL, respectively) [47]. | |
| Crassocolide O 97 | Dongsha Atoll, Taiwan | Potent cytotoxicity against Daoy cells IC<sub>50</sub> = 4.5 μg/mL [47]. | |
| Crassocolide P 98 | S. cresscoraule | Potent and selective cytotoxicity against Daoy cells growth IC<sub>50</sub> = 1.9 μg/mL [47]. | |
| Sarcostolide A 102 | Dongsha Atoll, Taiwan | Potent cytotoxic activity toward HeLa and WiDr cell lines with IC<sub>50</sub> = 22.26 and 19.97 μg/mL, respectively [50]. | |
| Sarcostolide B 103 | | Potent cytotoxic activity toward WiDr with IC<sub>50</sub> = 8.31 μg/mL and HeLa and cell lines with IC<sub>50</sub> = 5.88 μg/mL [50]. | |
| Sarcostolide C 104 | | Most potent cytotoxic activity toward HeLa cell lines with IC<sub>50</sub> = 1.65 μg/mL and WiDr with IC<sub>50</sub> = 19.35 μg/mL [50]. | |
| Sarcostolide D 105 | S. stolidotum | Potent cytotoxic activity toward HeLa and WiDr cell lines with IC<sub>50</sub> = 11.05 and 29.09 μg/mL, respectively [50]. | Kenting, off the southern coast, Taiwan |
| Sarcostolide E 106 | | Potent cytotoxic activity toward HeLa and WiDr cell lines with IC<sub>50</sub> = 16.75 and 27.48 μg/mL, respectively, and Daoy with IC<sub>50</sub> = 5.5 μg/mL [50]. | |
| Sarcostolide F 107 | | Potent cytotoxic activity toward HeLa and WiDr cell lines with IC<sub>50</sub> = 7.32 and 28.84 μg/mL, respectively [50]. | |
| Sarcostolide G 108 | | Potent cytotoxic activity toward HeLa and WiDr cell lines with IC<sub>50</sub> = 18.45 and 20.06 μg/mL, respectively. | |
| (-)-7β-Hydroxy-8α-methoxy-deepoxy-sarcophytolide 110 | S. mililatensis | Significant increase in the ALP activity collagen synthesis [51]. | Baycanh Island, Condao District, Baria-Vungtau Province, Vietnam |
| (+)-7β,8β-Dihydroxy-deepoxy-sarcophytolide 111 | S. mililatensis | | |
| (-)-17-Hydroxysarcophytol A 112 | S. mililatensis | | |
| Sarcophytol V 113 | | | |
| Sarcophytolide 114 | S. mililatensis | | |
| S. glaucum | | | |
| Sarcophyton sp. | | | |
| S. trocheloporum | | | |
| Diterpene | | | |
| 7β-Acetoxy-8α-hydroxy-deepoxy-sarcophine 116 | S. glaucum | | |
| S. elegans | | | |
| S. auritum | | | |
| S. glaucum | | | |
| Diterpene | | | |
| 7α,8β-Dihydroxy-deepoxysarcophine 117 | | | |
| S. elegans | | Cytotoxic activity toward A2780 cell line with IC<sub>50</sub> > 10 μg/mL and against both breast and liver cancer cell lines with IC<sub>50</sub> = 18.4 ± 0.16, 11 ± 0.22 μg/mL, respectively. | Xidao Island, Hainan, China. |
| S. auritum | | | |
| S. glaucum | | | |
| Natural Product | Format | Biological Activity | Biological Activity Details |
|-----------------|--------|----------------------|-----------------------------|
| Ent-sarcophine | 122    | *S. glaucum*         | Potent suppression of the phase I enzyme cytochrome P450 1A activity with IC₅₀ = 3.4 μM [66]. | Xidao Island, Hainan, China |
| Lobohedleolide | 125    | *Sarcophyton sp.*    | Most potent, inhibited the colony formation of Chinese hamster V79 at ED₅₀ = 4.6 μM and decreased the TNFα-production at 3.0–10.0 μM [54]. | Safaga Red Sea, Egypt |
| (7Z)- Lobohedleolide | 126 | *Sarcophyton sp.*    | Most potent, inhibited the colony formation of Chinese hamster V79 at ED₅₀ = 4.6 μM and decreased the TNFα-production at 3.0–10.0 μM [54]. | Yalong Bay, Hainan Province, China |
| 7-Acetyl-8-epi-sinumaximol G | 131 | *S. ehrenbergi*     | Cytotoxic activity against MCF-7 with IC₅₀ range 22.39 to 27.12 μg/mL [56]. | Hurghada, Red Sea, Egypt |
| 8-Epi- sinumaximol G | 132 | *S. ehrenbergi*    | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, 2.0, and 4.1 μg/mL, respectively. Decreased the levels of iNOS protein to 13.7 ± 5.2% at a concentration of 10 μM [58]. | Taiwán |
| 12-Acetyl-7, 12-epi- sinumaximol G | 133 | *S. ehrenbergi*     | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, 1.2, and 1.8 μg/mL, respectively. Significantly decreased the levels of iNOS protein to 3.3 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| 12-Hydroxysarcoph-10-ene | 134 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 6.2, 4.5, 2.6, and 4.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 4.6 ± 1.3% at a concentration of 10 μM [58]. | Diterpene |
| 8-Hydroxy-epi-sarcophinone | 135 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 8.8, 5.6, 3.2, and 5.4 μg/mL, respectively. Decrease significantly iNOS protein levels to 7.0 ± 3.1% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sinumaximol G | 136 | *S. ehrenbergi*     | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sarcocrassocolide A | 137 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sarcocrassocolide B | 138 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sarcocrassocolide C | 139 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sarcocrassocolide D | 140 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |
| Sarcocrassocolide F | 143 | *S. crassocaule* | Potent cytotoxic activity toward MCF-7, WiDr, HEP-2, and Daoy cancer with IC₅₀ = 4.2, 3.2, and 2.0 μg/mL, respectively. Decrease significantly iNOS protein levels to 3.8 ± 5.0% at a concentration of 10 μM [58]. | Dongsha Coast, Taiwan |

Significantly decrease the viability of melanoma cells at 500 (72 hr) treatment, does not show toxic effect CV-1 cells and decrease de novo DNA synthesis and PARP activity [75,136].
| Compound                  | Activity                                                                                           |
|--------------------------|----------------------------------------------------------------------------------------------------|
| Sarcocrassocolide G 144  | Potent toward Daoy, HEp-2 and WiDr cells with ED_{50} = 8.3 ± 1.4, 16.5 ± 1.7 and 18.9 ± 1.9 μM, respectively. Decreased iNOS protein levels [59]. |
| Sarcocrassocolide H 145  | Most potent toward MCF-7 ED_{50} = 9.4 ± 2.5 μM. Significantly suppressed both iNOS and COX-2 proteins expression [59]. |
| Sarcocrassocolide I 146  | Most potent toward Daoy, HEp-2, MCF-7, and WiDr cell lines with ED_{50} = 5.1 ± 1.2, 5.8 ± 0.5, 8.4 ± 1.5, and 6.4 ± 2.0 μM. Decreased iNOS protein levels [59]. |
| Sarcocrassocolide J 147  | Least potent toward Daoy, HEp-2, MCF-7, and WiDr cell lines with ED_{50} = >20 μM. Decreased iNOS protein levels [59]. |
| Sarcocrassocolide L 149  | Least potent toward Daoy, HEp-2, MCF-7, and WiDr cell lines with IC_{50} = 5.1 ± 1.2, 12.3 ± 1.6, and 12.4 ± 2.1 μM. Reduced iNOS protein levels [59]. |
| Sarcocrassocolide M 150  | Potent cytotoxicity toward Daoy, HEp-2, MCF-7, and WiDr with IC_{50} = 6.6 ± 0.8, 5.2 ± 0.6, and 5.0 ± 0.7 μM, respectively. Significantly decreased iNOS protein levels and COX-2 expression to 4.2 ± 1.6% and 62.8 ± 22.4%, respectively [60]. |
| Sarcocrassocolide N 151  | Potent cytotoxicity toward Daoy, HEp-2, MCF-7, and WiDr with IC_{50} = 10.4 ± 1.1, 12.3 ± 1.6, and 12.4 ± 2.1 μM, respectively. Significantly decreased iNOS protein levels to 52.9 ± 12.8% [60]. |
| Sarcocrassocolide O 152  | Potent cytotoxicity toward Daoy, HEp-2, MCF-7, and WiDr with IC_{50} = 10.6 ± 0.5, 10.1 ± 2.3, and 6.4 ± 0.5 μM, respectively. Significantly decreased the levels of iNOS protein to 22.7 ± 2.8% [60]. |
| Sarcocrassocolide P 153  | Potent cytotoxic against DLD-1 and HL-6 (IC_{50} = 21.8 and 24.9 μM, respectively. Strongly reduced iNOS protein levels with 1.3% ± 0.3% [61]. |
| Sarcocrassocolide Q 154  | Potent cytotoxic against DLD-1, CCRF-CEM, and HL-60 cancer cells (IC_{50} = 10.0, 3.8, and 7.9 μM, respectively). Strongly reduced iNOS protein levels to 1.2% ± 0.3% [61]. |
| Sarcocrassocolide R 155  | Potent cytotoxicity toward DLD-1, CCRF-CEM, and HL-60 cancer cells (IC_{50} = 18.6 μM). Decreased iNOS protein levels and COX-2 expression with 2.4% ± 0.4% and 58.3% ± 20.5, respectively [61]. |
| (+)-12-Carboxy-11Z-sarcophytoxide 157 | Antiviral activity toward HCMV with IC_{50} = 180.7 μM [63]. |
| (+)-12-Methoxycarbonyl-11Z-sarcophine 158 | Antiviral activity toward HCMV with IC_{50} = 5.8, 24.2, 24.8, 4.7, and 16.1 μM, respectively [63]. |
| Compound                | Source/Remarks                                      |
|------------------------|----------------------------------------------------|
| Ehrenberoxide A 159    |                                                    |
| Ehrenberoxide B 160    |                                                    |
| Ehrenberoxide C 161    |                                                    |
| Lobophynin C 162       |                                                    |
| Cembrone C 163         | *S. trocheliophorum*                               |
| Sarcophytol B 164      | *Sarcophyton sp.*                                  |
| Sarcophytol H 166      | *S. infundibuliforme*                              |
| (−)-Marasol 167        | *S. infundibuliforme*                              |
| 12(S)-Hydroperoxylsarcoph-10-ene 170 | *S. glaucum*                                         |
| 8-Epi-sarcophinone 171 |                                                    |
| Methyl sarcotroate B 173 | *S. trocheliophorum*                              |
| (1S,2E,4R,6E,8S,11R,12S)-8,11-Epoxy-4,12-epoxy-2,6-cembradiene 175 | *S. glaucum*                                         |
| (1S,4R,13S)-Cembra-2E,7E,11E-trien-4,13-diol 177 |                                                    |
| Ehrenbergol B 179      | *S. ehrenbergi*                                    |
| Sarcophyolide B 181    |                                                    |
| Sarcophyolide C 182    |                                                    |
| Sarcophyolide D 183    |                                                    |
| Sarcophyolide E 184    |                                                    |
| Sarcophytol L 185      |                                                    |
| 13α-Hydroxysarcophytol L 186 |                                                    |
|                        |                                                    |
| Mild antidiabetic activity with IC₅₀ = 26.6 μM. Antifungal activity toward *Aspergillus flavus* and *Candida albicans* (MIC = 0.68 μM) [39,77]. | Yalong Bay, Hainan Province, China. Red Sea, Jeddah, Saudi Arabia |
| Potent antibacterial activity toward *Bacillus cereus*, *Staphylococcus albus*, and *Vibrio parahaemolyticus* (MIC = 3.13, 1.56, and 0.50 μM, respectively) [73]. | Xuwen Coral Reef Area, Guangdong Province, China |
| Strong antifouling activity toward the larval settlement of barnacle *Balanus Amphitrite* (EC₅₀ = 8.13 μg/mL) [64]. | Wenchang Coral Reef in the South China Sea |
| Antifouling activity on larval adherence of the barnacle *Balanus Amphitrite* at concentration of 10.0 μg/mL [73]. | Xuwen Coral Reef, Guangdong Province, China |
| Potent suppression of the phase I enzyme cytochrome P450 1A activity with IC₅₀ = 2.7 μM [66]. | Yalong Bay, Hainan Province, China |
| Potent suppression of the phase I enzyme cytochrome P450 1A activity with IC₅₀ = 3.7 μM [66]. |                                                    |
| Strong inhibitory activity toward PTP1B with IC₅₀ = 6.97 μM [67]. |                                                    |
| Cytotoxic activity at 500 μM concentration toward mouse melanoma B16F10 cells [68]. | Red Sea |
| Strong antiviral activity with IC₅₀ = 5 μg/mL [69]. | San-Hsian-Tai, Taichung County, Taiwan |
| Most potent cytotoxic activity toward A2780 with IC₅₀ = 2.92 μM [22]. | Xidao Island, Hainan, China |
| Cytotoxic activity toward A2780 cell line with IC₅₀ > 10 μg/mL [22]. |                                                    |
| Chemical Name                        | Compound Identification | Activity                                                                                   | Location                        |
|-------------------------------------|-------------------------|--------------------------------------------------------------------------------------------|---------------------------------|
| Sarcophyolide A 187                 |                         | Most potent cytotoxic activity toward A2780 cell line with IC\(_50\) = 3.37 \(\mu\)M [22]. | San-Hsian-Tai, Taitong County, Taiwan |
| Sarcophinone 188                    |                         | Antiviral activity toward HCMV with IC\(_50\) = 8 \(\mu\)g/ml [72].                     |                                 |
| 7\(\alpha\)-Hydroxy-\(\Delta^{20}\)-deepoxysarcophine 189 |                         | Antiviral activity toward HCMV with IC\(_50\) = 20 \(\mu\)g/ml [72].                    |                                 |
| 4\(\beta\)-Hydroxy-\(\Delta^{20}\)-sarcophine 190  |                         | Potent inhibition 56.0 ± 3.1% against FMLP/CB-induced superoxide anion generation [74].  | Lanyu Coast Island of Taiwan    |
| 1,15\(\beta\)-Epoxy-2\(\beta\)-epi-16-deoxysarcophine 191 |                         | Strong activity against HepG2 and MCF-7 cells with IC\(_50\) = 19.9 ± 0.02 and 2.4 ± 0.04 \(\mu\)M, respectively. Strong antibacterial activity with inhibition zones range (12 to 18 mm) and MICs between 1.53 to 4.34 \(\mu\)M, toward \(S.\) \emph{tortuosum} [77,78]. | Red Sea, Jeddah, Saudi Arabia |
| Sarcophytol Q 192                   |                         | Strong antibacterial activity with inhibition zones range from 12 to 18 mm and MICs between 1.53 and 4.34 \(\mu\)M, toward \(S.\) \emph{tropaeolum} sp., and MRSA [77,78]. |                                 |
| Lobocrasol 193                      |                         | Strong activity against HepG2 and HCT116 with IC\(_50\) = 18.8 ± 0.07 and 19.4 ± 0.02 \(\mu\)M, respectively [78]. |                                 |
| Acetyl ehrenberoxide B 194          | \(S.\) \emph{ehrenbergi} | Mild inhibition more than 10% at a concentration of 20 \(\mu\)M toward the MCF-7 cell line [76]. | Dongshan island, China          |
| Ehrenbergol C 195                   |                         | Inhibited protein tyrosine phosphatase 1B IC\(_50\) = 6.8 ± 0.9 \(\mu\)M [80].             |                                 |
| Tortuosene A 201                    | \(S.\) \emph{tortuosum} | Inhibited protein tyrosine phosphatase 1B IC\(_50\) = 27.1 ± 2.6 \(\mu\)M [81].             |                                 |
| Tortuosene B 202                    |                         | Strong activity toward HepG2 and MCF-7 cells with IC\(_50\) = 3.2 ± 0.02 \(\mu\)M, respectively [77,78]. |                                 |
| Sarcotrocheliol acetate 213         | \(S.\) \emph{glaucum}  | Strong activity against HepG2 and MCF-7 cells with IC\(_50\) = 19.9 ± 0.02 and 2.4 ± 0.04 \(\mu\)M, respectively. Strong antibacterial activity with inhibition zones range (12 to 18 mm) and MICs between 1.53 to 4.34 \(\mu\)M, toward \(S.\) \emph{tortuosum} [77,78]. |                                 |
| Sarcotrocheliol 214                 | \(S.\) \emph{glaucum}  | Strong activity against HepG2 and MCF-7 cells with IC\(_50\) = 3.2 ± 0.02 \(\mu\)M, respectively [77,78]. |                                 |
| Sarcopinediol 215                   |                         | Strong antibacterial activity with inhibition zones range from 12 to 18 mm and MICs between 1.53 and 4.34 \(\mu\)M, toward \(S.\) \emph{tropaeolum} sp., and MRSA [77,78]. |                                 |
| 2-\{(E,E,E)\}-7,8'-Epoxy-4',8',12'-trimethylcycloheptadeca-1',3',11'-tri-enyl|propan-2-ol 209 | Sarcophyton sp. |                                 |
| Crassumol C 211                     |                         | Diterpene                                                                                   |                                 |
| Laevigatol A 212                    |                         | Inhibited protein tyrosine phosphatase 1B IC\(_50\) = 6.8 ± 0.9 \(\mu\)M [80].             |                                 |
| Sarsolilide B 220                   | \(S.\) \emph{tropaeolum} | Inhibited protein tyrosine phosphatase 1B IC\(_50\) = 27.1 ± 2.6 \(\mu\)M [81].             |                                 |
| Sarsolilide C 221                   |                         | Strong activity against HepG2 and MCF-7 cells with IC\(_50\) = 3.2 ± 0.02 \(\mu\)M, respectively [77,78]. |                                 |
| Trocheliophol E 228 | Mild inhibition toward inflammation-related NF-kB by 11% [81]. |
|---|---|
| Trocheliophol F 229 | Mild inhibition toward inflammation-related NF-kB by 29% [81]. |
| Trocheliophol H 231 | Antibacterial activity toward *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus*, with MIC = 8 to 32 μg/mL [81]. |
| Trocheliophol I 232 | Antibacterial activity toward *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus*, with MIC = 8 to 32 μg/mL [81]. |
| Trocheliophol L 235 | Mild inhibition toward inflammation-related NF-kB by 14% [81]. |
| Trocheliophol M 236 | Antibacterial activity toward *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus*, with MIC = 8 to 32 μg/mL [81]. |
| Trocheliophol N 237 | Antibacterial activity toward *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus*, with MIC = 8 to 32 μg/mL [81]. |
| Trocheliophol O 238 | Antibacterial activity toward *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus*, with MIC = 8 to 32 μg/mL [81]. |
| Trocheliophol R 241 | Most potent antibacterial activity against *Xanthomonas vesicatoria*, *Agrobacterium tumefaciens*, *Pseudomonas lachrymans*, *Bacillus subtilis*, and *Staphylococcus aureus* [81]. |
| Trocheliophol S 242 | S. trocheliophorum |
| 4-Epi-sarcophytol L 243 | Diterpene |
| Sarcophelegan B 245 | S. elegans |
| Ehrenbergol D 251 | S. ehrenbergi |
| Ehrenbergol E 252 | Potent cytotoxic activity P-388 cell line with EC₅₀ = 2.0 μM. Significant TNF-α inhibition IC₅₀ = 24.2 μM [82,97]. |
| Secodihydrosarsolenone 287 | S. trocheliophorum |
| Secodihydrosarsolenone 287 | S. trocheliophorum |

Weizhou Island, Southwestern China

Xisha Islands, South China Sea

San-Hsian-Tai Island (Taitong)

The South China Sea Coral Reef
| Compound                          | Species            | Description                                                                                                                                                                                                 | Location                        |
|----------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Sarelengan C 297                 | *S. elegans*       | Significant inhibitory action on nitric oxide synthesis in RAW264.7 macrophages, with IC₅₀ = 32.5 μM [94].                                                                                                   | Yalong Bay, Hainan Province, China |
| Sarcoehrenbergilid D 307         |                    | Strong cytotoxicity against A549 cells with IC₅₀ = 23.3 μM [96].                                                                                                                                               | Hurghada, Red Sea, Egypt         |
| Sarcoehrenbergilid E 308         |                    | Strong cytotoxicity activity against A549 and HepG2 cells with IC₅₀ = 27.3 and 22.6 μM, respectively [96].                                                                                                     |                                 |
| Sarcoehrenbergilid F 309         | *S. ehenbergi*     | Strong cytotoxic activity against A549 cells with IC₅₀ = 25.4 μM [96].                                                                                                                                     |                                 |
| Sarcoehrenolide A 310            |                    | Significant TNF-α inhibition IC₅₀ = 28.5 μM [97].                                                                                                                                                           | Weizhou Island, Guangxi Province, China |
| Sarcoehrenolide B 311            |                    | Significant TNF-α inhibition IC₅₀ = 8.5 μM [97].                                                                                                                                                           |                                 |
| Sarcoehrenolide D 313            |                    | Significant TNF-α inhibition IC₅₀ = 27.3 μM [97].                                                                                                                                                           |                                 |
| Sarinfacetamide A 315            | *S. infundibiliforme* | Increase effects of the ConA-induced T lymphocytes with 6.18% and 36.32% proliferation rates, respectively [98].                                                                                       | Ximao Island, Hainan Province, China |
| Nanolobatin B 317                | (1S,2E,4R,6E,8S,11S,12S)-11,12-Epoxy-8-hydroperoxy-4-hydroxy-2,6-cembradiene 318 | Diterpene Potent antibacterial activity toward pathogens as *Alteromonas sp.*, *Cytophaga-Flavobacterium*, and *Vibrio* sp. from seaweed, with antibiosis index = 0.5, 1.25, and 1.75, respectively [99]. | Bohey Dulang, Semporna, Sabah |
| Glaucumolides A and B 329–330    | *S. glaucum*       | Potent cytotoxicity toward HL-60 and CCRF-CEM cancer cell lines with IC₅₀ = 6.6 ± 1.2, 3.8 ± 0.9, 5.3 ± 1.4, and 7.4 ± 1.5μg/mL, respectively. Strong inhibition against superoxide anion generation with IC₅₀ = 2.79 ± 0.66 μM and 2.79 ± 0.32 μM, respectively, and elastase release with IC₅₀ = 3.97 ± 0.10 μM for both compounds and in vitro anti-inflammatory activity both significantly prevent the accumulation nitric oxide synthase protein [103]. | From the wild and cultured in cultivation tank in the National Museum of Marine Biology and Aquarium, Taiwan |
| Bislatumlide A and B 340–341     | *S. latum*         | Potent activity against A549 and WiDr tumor cell with IC₅₀ = 7 μg/mL and murine lymphocytic leukemia with IC₅₀ = of 5.8 μg/mL [105].                                                                          | Ximao Island, Hainan Province, China |
| Methyl tetrahydroarsoate 342     |                    | Lethality bioassay exhibited IC₅₀ = 1.5 μM [106].                                                                                                                                                           | Kitangambwe, Kenya               |
| Dioxanyalolide 347               | *S. elegans*       | Antimicrobial activity toward *Escherichia coli*. Lethality bioassay exhibited IC₅₀ = 1.5 μM [106].                                                                                                             |                                 |
| Sarelengan B 363                 |                    | Significant inhibitory action on nitric oxide synthesis in RAW264.7 macrophages, with IC₅₀ = 18.2 μM [94].                                                                                                   | Yalong Bay, Hainan Province, China |
| (+)-alloaromadendrene 364        | *S. glaucum*       | Most potent with IC₅₀ = 20.0 ± 0.068, 20.0 ± 0.054, and 09.3 ± 0.164 μM toward HepG2, MCF-7, and PC-3, respectively. Significant inhibition to +SA mammary epithelial cell growth [34]. | North of Jeddah, Saudi Arabia, Red Sea |
| Compound Description                                                                 | Sterilin Name | Biological Activity                                                                 |
|-------------------------------------------------------------------------------------|---------------|-------------------------------------------------------------------------------------|
| Palustril 370                                                                        | S. trocheliophorum | Potent activity toward Lymphoma and Ehrlich cell lines with LD₅₀ range from 2.5 to 3.79 μM [77]. |
| 6-Oxo-germacra-4(15),8,11-triene 373                                                 | S. glaucum     | Strong activity against HCT116 with IC₅₀ = 25.8 ± 0.03 μM [78].                    |
| 23,24-Dimethylcholest-16(17)-E-ene-3β,5α,6β,20(S)-tetraol 374                       | S. trocheliophorum | Strong cytotoxicity toward human M14, HL60, and MCF7 cells (EC₅₀ = 4.3, 2.8, and 4.9 μg/ml, respectively), with a dose-dependent manner [28]. |
| 24-Methylcholestan-3β,5α,6β,25-tetraol-25-monoacetate 375                          | S. crassocaule | Potent activity toward the P-388, A549, and HT-29 cell lines with cell line with ED₅₀ = 3.96, 6.6, and 0.6 μg/ml, respectively. Strong cytotoxicity against M14, HL60, and MCF7 cells with EC₅₀ = 19.6, 13.2, and 34.5 μg/ml, respectively, with a dose-dependent manner [29]. |
| (24S)-24-Methylcholestan-3β,5α,6β-triol 377                                         | S. crassocaule | Potent activity toward the P-388 cell line with ED₅₀ = 0.14 μg/ml, respectively [28]. |
| 11α-Acetoxy-cholesta-24-en-3β,5α,6β-triol 384                                       | S. ehrenbergii | Potent activity against A-549 cell line with IC₅₀ = 27.3 μM [95].                  |
| (22E,24S)-11α-Acetoxy-ergostane-22,25-dien-3β,5α,6β-triol 385                      | Sterol                     | Potent toward antibacterial activity toward Escherichia coli and Bacillus megaterium, and antifungal activity toward Microbotryum violaceum and Septoria tritici fungi [115]. |
| 11α-Acetoxy-gorgostane-3β,5α,6β,12α-tetraol 389                                     | Sarcophyton sp. |                                                   |
| 12α-Acetoxy-gorgostane-3β,5α,6β,11α-tetraol 390                                     | Sarcophyton sp. |                                                   |
| Sarco aldosterone A 391                                                             | S. glaucum     |                                                   |
| (24S)-Ergostan-3β,5α,6β,25-tetraol-25-monoacetate 398                              | Sarcophyton sp. |                                                   |
| (24S)-24-methylcholestan-3β,6β,25-triol-25-O-acetate 399                            | Sarcophyton sp. |                                                   |
| (24S)-24-Methylcholestan-1β,3β,5α,6β,25-pentaol-25-monoacetate 401                  | Sarcophyton sp. |                                                   |
| Compound | Description | Source |
|----------|-------------|--------|
| (24S)-Methylcholestan-3β,5α,6β,12β,25-pentaol-25-O-acetate | Potent cytotoxic toward K562 with IC₅₀ = 4.10 μg/mL [116]. | Xuwen Coral Reef, South China Sea |
| (24S)-Ergostan-3β,5α,6β,18,25-pentaol 18,25-diacetate | Potent cytotoxic toward K562 with IC₅₀ = 5.25 μg/mL [116]. | Hurghada, Red Sea, Egypt |
| Zahramycin B | Potent antimicrobial (15 mm) and (12 mm) activity toward Staphylococcus aureus and Bacillus subtilis, respectively, and potent activity toward Pythium ultimum pathogenic fungus (12 mm) [117]. | |
| (23R,24R,17Z)-11α-Acetoxy-16β-methoxy-23,24-dimethylcholestan-17(20)-en-3β,5α,6β-tetraol | Strong cytotoxic activity against K562, HL-60, and HeLa cell lines with IC₅₀ range of 6.4 to 24.7 μM [118]. | South Sea, Weizhou Islands |
| 11α-Acetoxycholestan-24-en-1α,3β,5α,6β-tetraol | Potent activity toward K562 and HL-60 with IC₅₀ range of 9.1 to 17.2 μM [118]. | |
| (24R)-Methylcholestan-7-en-3β,5α,6β-tetraol | Potent activity toward K562 and HL-60 with IC₅₀ range of 9.1 to 17.2 μM [118]. | |
| 11α-Acetoxy-cholestan-24-en-3β,5α,6β-tetraol | Potent anti-H1N1 virus activity with IC₅₀ = 19.6 μg/mL [118]. | |
| (22E,24S)-11α-Acetoxy-ergostan-22,25-dien-3β,5α,6β-triol | Strong cytotoxicity against, K562, HL-60, HeLa cell lines with IC₅₀ range of 6.4 to 24.7 μM [118]. | |
| (24S)-11α-Acetoxy-ergostan-3β,5α,6β-triol | Potent activity toward K562 and HL-60 with IC₅₀ range of 9.1 to 17.2 μM [118]. | |
| (24R)-11α-Acetoxy-gorgostan-3β,5α,6β-triol | Strong cytotoxicity toward, K562, HL-60, HeLa cell lines with IC₅₀ range of 6.4 to 24.7 μM [118]. | |
| (24S)-Ergostan-3β,5α,6β,11α-tetraol | Potent anti-H1N1 virus activity with IC₅₀ = 36.7 μg/mL [118]. | |
| Sarcomilasterol | Cytotoxicity toward MDA-MB-231, MOLT-4, SUP-T, and U-937 cell lines with IC₅₀ = 13.8, 6.7, 10.5, and 17.7 μg/mL, respectively [70]. | Jihui Fishing Port Coast, Taitung County, Taiwan |
| Butenolides 430–433 | Active against gram positive bacteria only [122]. | Gulf of Aqaba, Tel Aviv |
| Sarcophytonamine | Protection against UV radiation for organism [124]. | Lingshui Bay, Hainan Province, China |
| 440 | Decreased iNOS to 46.9 ± 9.7% and COX-2 level to 77.2 ± 9.9%. Anticonvulsant activity, successfully opposed the lethality of pentylentetrazole in mice. Significant anxiolytic activity [129,135]. | Dongsha Islands, Taiwan Red Sea |
| S. crassocaule | Miscellaneous | |
| Compound                  | Strain                      | Activity                                                                 | Location                                      |
|--------------------------|-----------------------------|--------------------------------------------------------------------------|-----------------------------------------------|
| Methyl tortuolate A 476  | *S. tortuosum*              | Strong cytotoxic activity toward CNE-2 and P-388 cell lines with IC₅₀ = 22.7, 3.5, 24.7, and 5.0 μg/mL, respectively [131]. | Sanya Bay, Hainan Island, China               |
| Methyl tortuolate B 477  |                             | Strong cytotoxic activity toward CNE-2 and P-388 cell lines with IC₅₀ = 24.7 and 5.0 μg/mL, respectively [131].            |                                               |
| Methyl sartortuolate 478 | *S. pauciplicatum*          | Good cytotoxic activity toward HepG2, HL-60, KB, LNCaP, LU-1, MCF7, SK-Mel2, and SW480 cancer cells with IC₅₀ ranged from 7.93 ± 2.08 to 19.34 ± 0.72 μM [108]. | Hai Phong, Vietnam                           |
4. Conclusions

Based on reviewing the available current literature, a huge library of metabolites was isolated, and it possessed unique structures. Up to 481 compounds with different structures belonging to different chemical classes were reported from the Sarcophyton species. The chemical structures were classified as terpenoids (majority), bisbemaranes, polyhydroxylated sterols, sesquiterpenes (minority), and miscellaneous compounds. S. trocheliophorum gave the highest number of compounds. Members of genus Sarcophyton possessed valuable and interesting biological activities, such as antibacterial, cytotoxicity, antifungal, and antidiabetic.

Author Contributions: All authors have read and agree to the published version of the manuscript. Resources, Y.A.E. and M.M.B.; data curation, A.M.E. and O.M.S.; writing—original draft preparation, Y.A.E.; writing—review and editing, A.M.E., M.S.E., O.M.S., and M.M.B.; visualization, N.M.M. and E.M.K.; supervision, O.M.S. and A.N.B.S; project administration, O.M.S.; funding acquisition, all authors. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgment: We would like to thank M. El-Kalay, head of Department of English Postgraduate Studies (EPS) and International Exams (CELTA, OET, ILETS), Future University in Egypt, for her kind and valuable help with English language correction.

Conflicts of Interest: The authors declare no conflicts of interest.

References
1. Lewis, J.C.; Wallis, E.V. The function of surface sclerites in gorgonians (Coelenterata, Octocorallia). Biol. Bull. 1991, 181, 275–288.
2. Rajendra, S.; Raghunathan, C.; Chandra, K. New record of Sarcophyton cornispiculatum Verseveldt, 1971 (Octocorallia: Alcyonacea: Alcyoniidae) in India, from the Andaman Islands. Eur. Zool. J. 2017, 84, 167–171.
3. Verseveldt, J. A revision of the genus Sarcophyton Lesson (Octocorallia, Alcyonacea). Zool. Verhandel. 1982, 192, 1–91.
4. Alderslade, P. A redescription of Alcyonium agaricium Stimpson with a generic placement in Sarcophyton (Coelenterata: Octocorallia). Precious Corals Octocorals Res. 1993, 1, 20–29.
5. Alderslade, P.; Shirwaiker, P. New species of soft corals (Coelenterata: Octocorallia) from the Laccadive Archipelago. BeogJe 1991, 8, 189–233.
6. Benayahu, Y.; Perkol-Finkel, S. Soft corals (Octocorallia: Alcyonacea) from southern Taiwan. I. Sarcophyton nanwanensis sp. nov. (Octocorallia: Alcyonacea). Zool. Stud. 2004, 43, 537–543.
7. Benayahu, Y.; van Ofwegen, L.P. New species of Sarcophyton and Lobophyllum (Octocorallia: Alcyonacea) from Hong Kong. Zool. Meded. 2009, 83, 863–876.
8. Li, C. Studies on the Alcyonacea of the South China Sea II. Genera Lobophyllum and Sarcophyton from the Xisha Islands, Guangdong Province. J. Chin. Chem. Soc. 1984, 6, 103–119.
9. McFadden, C.S.; Alderslade, P.; Ofwegen, L.P.; Johnsen, H.; Rusmevichientong, A. Phylogenetic relationships within the tropical soft coral genera Sarcophyton and Lobophyllum (Anthozoa, Octocorallia). Invertebr. Biol. 2006, 125, 288–305.
10. Aratake, S.; Tomura, T.; Saitoh, S.; Yokokura, R.; Kawanishi, Y.; Shinjo, R.; Reimer, J.D.; Tanaka, J.; Maekawa, H. Soft coral Sarcophyton (Cnidaria: Anthozoa: Octocorallia) species diversity and chemotypes. PLoS ONE 2012, 7, e30410.
11. Dineson, Z. Patterns in the distribution of soft corals across the Central Great Barrier Reef. Coral Reefs 1983, 1, 229–236.
12. Mignk, C.A.; Davoust, D. Quantitative distribution of benthic macrofauna of the Dover Strait pebble community (English Channel, France). Oceanol. Acta 1997, 20, 453–460.
13. Benayahu, Y.; Loya, Y. Competition for space among coral reef sessile organisms at Eilat, Red Sea. Bull. Mar. Sci. 1981, 31, 514–522.
14. Ros, J.; Romero, J.; Ballesteros, E.; Gili, J. Diving in blue water. The benthos. In The Western Mediterranean; Pergamon Press: Oxford, UK, 1985; pp. 233–295.
15. Slattery, M.; McClintock, J.B. Population structure and feeding deterrence in three shallow-water antarctic soft corals. *Mar. Biol.* 1995, 122, 461–470.

16. Faulkner, D.J. Interesting aspects of marine natural products chemistry. *Tetrahedron* 1977, 33, 1421–1443.

17. Kobayashi, J.; Ohizumi, Y.; Nakamura, H.; Yamakado, T.; Matsuzaki, T.; Hirata, Y. Ca-antagonistic substance from soft coral of the genus *Sarcophyton*. *Experientia* 1983, 39, 67–69.

18. Liu, X.; Zhang, J.; Liu, Q.; Tang, G.; Wang, H.; Fan, C.; Yin, S. Bioactive cembranoids from the South China Sea soft coral *Sarcophyton elegans*. *Molecules* 2015, 20, 13324–13335.

19. Sawant, S.S.; Sylvester, P.W.; Avery, M.A.; Desai, P.; Youssef, D.T.A.; El Sayed, K.A. Bioactive Rearranged and Halogenated Semisynthetic Derivatives of the Marine Natural Product Sarcophyne. *J. Nat. Prod.* 2004, 67, 2017–2023.

20. Ibrahim, H.; Mohamed, S.Z.; Abu El-Regal, M.; Farhat, A.Z. Antibacterial activity of some Red Sea soft corals, Egypt. *Blue Biotechnol.* 2013, 1, 119–138.

21. Lai, K.; You, W.; Lin, C.; El-Shazly, M.; Liao, Z.; Su, J. Anti-Inflammatory Dembranoids from the Soft Coral *Lobophytum crassum*. *Mar. Drugs* 2017, 15, 327.

22. Xi, Z.; Bie, W.; Chen, W.; Liu, D.; Øvregen, L.; Proksch, P.; Lin, W. Sarcophyolides B–E, New Cembranoids from the Soft Coral *Sarcophyton elegans*. *Mar. Drugs* 2013, 11, 3186–3196.

23. Fujiki, H.; Suganuma, M.; Suguri, H.; Yoshizawa, S.; Takagi, K.; Kobayashi, M. Sarcophytols A and B inhibit tumor promotion by teleocidin in two-stage carcinogenesis in mouse skin. *J. Cancer Res. Clin. Oncol.* 1989, 115, 25–28.

24. Liang, L.F.; Guo, Y.W. Terpenes from the soft corals of the genus *Sarcophyton*: Chemistry and biological activities. *Chem. Biodivers.* 2013, 10, 2161–2196.

25. Rodrigues, I.G.; Miguel, M.G.; Mnif, W. A Brief Review on New Naturally Occurring Cembranoid Diterpene Derivatives from the Soft Corals of the Genera *Sarcophyton*, *Sinularia*, and *Lobophytum*. *Molecules* 2019, 24, 781.

26. Zubaira, M.S.; Al-Footy, K.O.; Ayyada, S.N.; Al-Lihaisib, S.S.; Alarifb, W.M. A review of steroids from *Sarcophyton* species. *Nat. Prod. Res.* 2015, 30, 869–879.

27. König, G.M.; Wright, A.D. New Cembranoid Diterpenes from the Soft Coral *Sarcophyton ehrenbergi*. *J. Nat. Prod.* 1998, 61, 494–496.

28. Duh, C.; Wang, S.; Chung, S.; Chou, G.; Dai, C. Cytotoxic Cembranolides and Steroids from the Formosan Soft Coral *Sarcophyton crassocaule*. *J. Nat. Prod.* 2000, 63, 1634–1637.

29. Dong, H.; Gou, Y.; Kini, R.M.; Xu, H.; Chen, S.; Teo, S.L.M.; But, P.P. A New Cytotoxic Polyhydroxysterol from Soft Coral *Sarcophyton trocheliophorum*. *Chem. Pharm. Bull.* 2000, 48, 1087–1089.

30. Mada, K.; Ooi, T.; Kusumi, T. NMR study of acutanol, a new cembrane alcohol, and sarcophytol A isolated from the soft coral *Sarcophyton acutangulum*. *J. Spectrosc.* 2001, 15, 177–182.

31. Pham, N.; Butler, M.; Quinn, R.J. Naturally Occurring Cembranes from an Australian *Sarcophyton* Species. *J. Nat. prod.* 2002, 65, 1147–1150.

32. Xu, X.; Kong, C.; Lin, C.; Wang, X.; Zhu, Y.; Yang, H. A Novel Diterpenoid from the Soft Coral *Sarcophyton crassocaule*. *Chin. J. Chem.* 2003, 21, 1506–1509.

33. Gross, H.; Kehraus, S.; Nett, M.; König, G.M.; Beil, W.; Wright, A.D. New cytotoxic cembrane based diterpenes from the soft corals *Sarcophyton ceburnieri* and *Nephthea* sp. *Org. Biomol. Chem.* 2003, 1, 944–949.

34. Al-Lihaisib, S.; Alarif, W.; Abdel-Latef, A.; Ayyad, S.; Abdel-Naim, A.; El-Senduny, F.; Badria, F. Three New Cembranoid-Type Diterpenes from Red Sea Soft Coral *Sarcophyton glauca*um: Isolation and Antiproliferative Activity against HepG2 Cells. *Eur. J. Med. Chem.* 2014, 81, 314–322.

35. Gross, H.; Wright, A.D.; Beil, W.; König, G.M. Two new bicyclic cembranolides from a new *Sarcophyton* species and determination of the absolute configuration of sarcoglaucol-16-one. *Org. Biomol. Chem.* 2004, 2, 1133–1138.

36. Jia, R.; Guo, Y.; Mollo, E.; Cimino, G. Sarcophytonolides AD, Four New Cembranolides from the Hainan Soft Coral *Sarcophyton* sp. *Helv. Chim. Acta* 2005, 88, 1028–1033.

37. Jia, R.; Guo, Y.; Mollo, E.; Gavagnin, M.; Cimino, G. Sarcophytonolides E–H, Cembranolides from the Hainan Soft Coral *Sarcophyton latum*. *J. Nat. prod.* 2006, 69, 819–822.

38. Yan, X.; Li, Z.; Guo, Y. Further New Cembranoid Diterpenes from the Hainan Soft Coral *Sarcophyton latum*. *Helv. Chim. Acta* 2007, 38, 1574–1580.
39. Liang, L.; Gao, L.; Li, J.; Tagliafate-Scafati, O.; Guo, Y. Cembrane diterpenoids from the soft coral *Sarcophyton trocheliophorum* Marenzeller as a new class of PTP1B inhibitors. *Bioorg. Med. Chem.* 2013, 21, 5076–5080.

40. Liang, L.; Kurtán, T.; Mándi, A.; Yao, L.; Li, J.; Lan, L.; Guo, Y. Structural, stereochemical, and bioactive studies of cembranoids from Chinese soft coral *Sarcophyton trocheliophorum*. *Tetrahedron* 2018, 74, 1933–1941.

41. Liang, L.; Lan, L.; Tagliafate-Scafati, O.; Guo, Y. Sartrrolides A–G and bissartrolide, new cembranoides from the South China Sea soft coral *Sarcophyton trocheliophorum* Marenzeller. *Tetrahedron* 2013, 69, 7381–7386.

42. Yao, L.; Zhang, H.; Liang, L.; Guo, X.; Mao, S.; Guo, Y. Yalongenes A and B, Two New Cembranoids with Cytoprotective Effects from the Hainan Soft Coral *Sarcophyton trocheliophorum* Marenzeller. *Helv. Chim. Acta* 2012, 95, 235–239.

43. Hegazy, M.E.; Mohamed, T.; Abdel-Latif, F.; Alsaied, M.; Shahat, A.; Pare, P. Trochelioi d A and B, new cembranoid diterpenes from the Red Sea soft coral *Sarcophyton trocheliophorum*. *Phytochem. Lett.* 2013, 6, 383–386.

44. Zhang, C.; Li, J.; Su, J.; Liang, Y.; Yang, X.; Zheng, K.; Zeng, L. Cytotoxic diterpenoids from the soft coral *Sarcophyton cembrace*. *J. Nat. Prod.* 2006, 69, 1476–1480.

45. Toth, J.A.; Burresson, B.J.; Scheuer, P.J.; Finer-Moore, J.; Claridy, J. Embilide, a new polyfunctional cembranolide from the soft coral *Sarcophyton glaucum*. *Tetrahedron* 1980, 36, 1307–1309.

46. Huang, H.; Ahmed, A.; Su, J.; Chao, C.; Wu, Y.; Chiang, M.; Sheu, J. Crassocollides A–F, Cembranoids with a trans- Fused Lactone from the Soft Coral *Sarcophyton cembrace*. *J. Nat. Prod.* 2006, 69, 1554–1559.

47. Huang, H.; Chao, C.; Kuo, Y.; Sheu, J. Crassocollides G–M, Cembranoids from the Formosan Soft Coral *Sarcophyton cembrace*. *Chem. Biodivers.* 2009, 6, 1232–1242.

48. Wang, G.; Huang, H.; Su, J.; Huang, C.; Hsu, C.; Kuo, Y.; Sheu, J. Crassocollides N–P, three cembranoids from the Formosan soft coral *Sarcophyton cembrace*. *Bioorg. Med. Chem. Lett.* 2011, 21, 7201–7204.

49. Bensembroun, J.; Rudi, A.; Bombarda, I.; Gaydou, E.M.; Kashman, Y.; Aknin, M. Flexusines A and B and Epimukulol from the Soft Coral *Sarcophyton flexuosum*. *J. Nat. Prod.* 2008, 71, 1262–1264.

50. Cheng, Y.; Shen, Y.; Kuo, Y.; Khalil, A.T. Cembrane Diterpenoids from the Taiwanese Soft Coral *Sarcophyton stolidum*. *J. Nat. Prod.* 2008, 71, 1141–1145.

51. Coung, N.X.; Tuan, T.A.; Kiem, P.V.; Minh, C.V.; Choi, E.M.; KIM, Y.H. New Cembranoid Diterpenes from the Vietnamese Soft Coral *Sarcophyton mililatensis* Stimulate Osteoblastic Differentiation in MC3T3-E1 Cells. *Chem. Pharm. Bull.* 2008, 56, 988–992.

52. Grote, D.; Shaker, K.; Soliman, H.; Hegazi, M.; Seifert, K. Cembranoid Diterpenes from the Soft Corals *Sarcophyton sp.* and *Glaucium*. *Nat. Prod. Commun.* 2008, 3, 1473–1478.

53. Yao, L.; Liu, H.; Guo, Y.; Mollo, E. New Cembranoids from the Hainan Soft Coral *Sarcophyton glaucum*. *Helv. Chim. Acta* 2009, 92, 1085–1091.

54. Magie, M.K.; Lee, J.; Oda, T.; Nakazawa, T.; Takahashi, O.; Ukai, K.; Mangindaan, R.; Rotinsulu, H.; Defny, S.W.; Sachiko, T.; et al. Two unprecedented cembrane-type terpenes from an Indonesian soft coral *Sarcophyton sp.* *Tetrahedron* 2010, 66, 641–645.

55. Chen, S.; Chen, B.; Dai, C.; Sung, P.; Wu, Y.; Sheu, J. Sarcophytonins F and G, New Dihydrofuranocembranoids from a Dongsha Atoll Soft Coral *Sarcophyton sp.* *Bull. Chem. Soc. Jpn.* 2012, 85, 920–922.

56. Hassan, M.H.; Rateb, E.M.; Hassan, H.M.; Sayed, M.A.; Shabana, S.; Raslan, M.; Amin, E.; Behery, A.F.; Ahmed, M.O.; Bin Muhsinah, A.; et al. New Antiproliferative Cembrane Diterpenes from the Red Sea *Sarcophyton Species*. *Mar. Drugs* 2019, 17, 411.

57. Rodriguez, A.D.; Soto, J.J.; Piña, I.C. Uprolides D–G, 2. A Rare Family of 4,7-Oxa-bridged Cembranolides from the Caribbean Gorgonian *Euencea mammosa*. *J. Nat. Prod.* 1995, 58, 1209–1216.

58. Lin, W.; Su, J.; Lu, Y.; Wen, Z.; Dai, C.; Kuo, Y.; Sheu, J. Cytotoxic and Anti-inflammatory cembranoids from the Dongsha Atoll soft coral *Sarcophyton cembrace*. *Bioorg. Med. Chem.* 2010, 18, 1936–1941.

59. Lin, W.; Lu, Y.; Su, J.; Wen, Z.; Dai, C.; Kuo, Y.; Sheu, J. Bioactive Cembranoids from the Dongsha Atoll Soft Coral *Sarcophyton cembrace*. *Mar. Drugs* 2011, 9, 994–1006.

60. Lin, W.; Lu, Y.; Chen, B.; Huang, C.A.; Su, J.; Wen, Z.; Dai, C.; Kuo, Y.; Sheu, J. Sarcocrossocollides M–O, Bioactive Cembranoids from the Dongsha Atoll Soft Coral *Sarcophyton cembrace*. *Mar. Drugs* 2012, 10, 617–626.
Lin, W.; Chen, B.; Huang, C.A.; Wen, Z.; Sung, P.; Su, J.; Dai, C.; Sheu, J. Bioactive Cembranoids, Sarcocassocolides P–R, from the Dongsha Atoll Soft Coral Sarcophyton crassocaule. Mar. Drugs 2014, 12, 840–850.

Shaker, K.; Müller, M.; Ghanı, M.; Dahse, H.; Seifert, K. Terpenes from the Soft Corals Litophyton arboreum and Sarcophyton ehrenbergi. Chem. Biodivers. 2010, 7, 2007–2015.

Cheng, S.; Wang, S.; Chiu, S.; Hsu, C.; Dai, C.; Chiang, M.Y.; Duh, C.Y. Cembranoids from the Octocoral Sarcophyton ehrenbergi. J. Nat. Prod. 2010, 73, 197–203.

Wang, C.; Chen, A.; Shao, C.; Li, L.; Xu, Y.; Qian, P. Chemical constituents of soft coral Sarcophyton infundibuliforme from the South China Sea. Biochem. Syst. Ecol. 2011, 39, 853–856.

Hegazy, M.; El-Beih, A.; Moustafa, A.; Ramadan, A.; Alhamady, M.; Selim, R.; Abdel-Rehim, M.; Pare, P. Cytotoxic Cembranoids from the Red Sea Soft Coral Sarcophyton glaucum. Nat. Prod. Commun. 2011, 6, 1809–1812.

Hegazy, M.E.; Gamal-Eldeen, A.; Shahat, A.; Abdel-Latif, F.; Mohamed, T.; R Whittlesey, B.; Pare, P. Bioactive Hydroperoxy Cembranoids from the Red Sea Soft Coral Sarcophyton glaucum. Mar. Drugs 2012, 10, 209–222.

Liang, L.; Kürten, T.; Mändi, A.; Yao, L.; Li, J.; Zhang, W.; Guo, Y. Unprecedented Diterpenoids as a PTP1B Inhibitor from the Hainan Soft Coral Sarcophyton trocheliophorum Marenzeller. Org. Lett. 2012, 15, 274–277.

Ross, S.; Abou El-Ezz, R.F.; Sa, A.; Radwan, M.; Ayoub, N.; Afifi, M.; Khalifa, S. Bioactive cembranoids from the Red Sea soft coral Sarcophyton glaucum. Planta Med. 2012, 78, 989–992.

Wang, S.; Hsieh, M.; Duh, C. Three new cembranoids from the Taiwanese soft coral Sarcophyton ehrenbergii. Mar. Drugs 2012, 10, 1433–1444.

Chao, C.H.; Li, W.L.; Huang, C.Y.; Ahmed, A.F.; Dai, C.F.; Wu, Y.C.; Lu, M.C.; Liaw, C.C.; Sheu, J.H. Isoprenoids from the Soft Coral Sarcophyton glaucum. Mar. Drugs 2017, 15, 202.

Lin, S.; Wang, S.; Cheng, S.; Duh, C. Lobocrasol, a New Diterpenoid from the Soft Coral Lobophytyum crassum. Org. Lett. 2009, 11, 3012–3014.

Wang, S.; Hsieh, M.; Duh, C. New diterpenoids from soft coral Sarcophyton ehrenbergii. Mar. Drugs 2013, 11, 4318–4327.

Cao, F.; Zhou, J.; Xu, K.; Zhang, M.; Wang, C.Y. New Cembranoid Diterpene from the South China Sea Soft Coral Sarcophyton sp. Nat. Prod. Commun. 2013, 8, 1675–1678.

Lin, K.; Tseng, Y.; Chen, B.; Hwang, T.; Chen, H.; Dai, C.; Sheu, J. Tortuosenes A and B, New Diterpenoid Metabolites from the Formosan Soft Coral Sarcophyton tortuosum. Org. Lett. 2014, 16, 1314–1317.

Elhawawy, N.A.; Ibrahim, A.; Radwan, M.; Elsohly, M.A.; Hassanean, H.A.; Ahmed, S.A. Cytotoxic Cembranoids from the Red Sea Soft Coral, Sarcophyton auritum. Tetrahedron Lett. 2014, 46, 3984–3988.

Cheng, Z.; Liao, Q.; Chen, Y.Y.; Fan, C.; Huang, Z.; Xu, X.; Yin, S. Four new cembranoids from the soft coral Sarcophyton sp. Magn. Reson. Chem. 2014, 52, 515–520.

Al-Footy, K.; Alarif, W.; Asiri, F.; Aly, M.; Ayyad, S. Rare pyrane-based cembranoids from the Red Sea soft coral Sarcophyton trocheliophorum as potential antimicrobial-antitumor agents. Med. Chem. Res. 2014, 24, 505–512.

Abdel-Latef, A.; Alarif, W.; Ayyad, S.; Al-Lahaib, S.; Basaif, S. New cytotoxic isoprenoid derivatives from the Red Sea soft coral Sarcophyton glaucum. Nat. Prod. Res. 2015, 29, 24–30.

Elkhatteeb, A.; El-Beih, A.; Gamal-Eldeen, A.; Alhammady, M.; Ohta, S.; Pare, P.; Hegazy, M.E. New Terpenes from the Egyptian Soft Coral Sarcophyton ehrenbergii. Mar. Drugs 2014, 12, 1977–1986.

Liang, T.K.; Mändi, A.; Gao, L.; Jia, L.; Zhang, W.; Guo, Y. Sarselenane and Capnosane Diterpenes from the Hainan Soft Coral Sarcophyton trocheliophorum Marenzeller as PTP1B Inhibitors. Eur. J. Org. Chem. 2014, 1841–1847.

Liu, Z.; Cheng, W.; Liu, D.; Ofwegwe, L.; Proksch, P.; Lin, W. Capnosane-Type Cembranoids from the Soft Coral Sarcophyton trocheliophorum with Antibacterial Effects. Tetrahedron 2014, 70, 8703–8713.

Cheng, S.; Wang, S.; Hsieh, M.; Duh, C. Polyoxynated cembranoid diterpenoids from the soft coral Sarcophyton ehrenbergii. Int. J. Mol. Sci. 2015, 16, 6140–6152.

Zhu, J.; Li, W.; Bao, J.; Zhang, J.; Yin, S.; Tang, G. Diterpenoids from the South China Sea soft coral Sarcophyton solidum. Biochem. Syst. Ecol. 2015, 62, 6–10.

Zubair, M.; Alarif, W.; Al-Footy, K.; P H, M.; Aly, M.; A Basaif, S.; Al-Lahaib, S.; Ayyad, S. New antimicrobial biscembrane hydrocarbon and cembranoid diterpenes from the soft coral Sarcophyton trocheliophorum. Turk. J. Chem. 2015, 40, 385–392.
85. Kamada, T.; Phan, C.S.; Tin, H.S.; Vairappan, C.S.; Muhammad, T.S.T. 16-Hydroxycembra-1,3,7,11-tetraene, a new Cembrane Diterpene from Malaysian Soft Coral Genus Sarcophyton. Nat. Prod. Commun. 2016, 11, 1077–1078.

86. Chen, W.; Liang, L.F.; Li, X.; Xiao, W.; Guo, Y.W. Further New Highly Oxidative Cembranoids from the Hainan Soft Coral Sarcophyton trocheiophorum. Nat. Prod. Bioprospect. 2016, 6, 97–102.

87. Liang, L.; Chen, W.; Mollo, E.; Yao, L.; Wang, H.; Xiao, W.; Guo, Y. Sarcophytols G–L, Novel Minor Metabolic Components from South China Sea Soft Coral Sarcophyton trocheiophorum Marenzeller. Chem. Biodivers. 2017, 14, e1700079.

88. Liang, L.; Chen, W.; Li, X.; Wang, H.; Guo, Y. New Bicyclic Cembranoids from the South China Sea Soft Coral Sarcophyton trocheiophorum. Sci. Rep. 2017, 7, 46584.

89. Liu, K.M.; Lan, Y.H.; Su, C.C.; Sung, P.J. Trocheliolide B, a New Cembranoidal Diterpene from the Octocoral Sarcophyton trocheiophorum. Nat. Prod. Commun. 2016, 11, 21–22.

90. Shaaban, M.; Ghani, M.A.; Shaaban, K. Unusual pyranosyl cembranoid diterpene from Sarcophyton trocheiophorum. Zeitschrift Für Naturforschung B 2016, 71, 1211–1217.

91. Tang, G.; Sun, Z.; Zou, Y.H.; Yin, S. New Cembrane-Type Diterpenoids from the South China Sea Soft Coral Sarcophyton ehrenbergi. Molecules 2016, 21, 587.

92. Liang, L.; Wang, J.; Shi, X.; Zhu, Y.; Li, J.; Zhu, W.; Wang, H.; Guo, Y. A Novel Sarsolenane Diterpene as a PTP1B Inhibitor from Hainan Soft Coral Sarcophyton trocheiophorum Marenzeller. Chin. J. Chem. 2017, 35, 1246–1250.

93. Rahelivao, M.P.; Lubken, T.; Gruner, M.; Kataeva, O.; Ralambondrabety, R.; Andriamanaantoaina, H.; Checinski, M.P.; Bauer, I.; Knolker, H.J. Isolation and structure elucidation of natural products of three soft corals and a sponge from the coast of Madagascar. Org. Biomol. Chem. 2017, 15, 2593–2608.

94. Li, W.; Zou, Y.H.; Ge, M.X.; Lou, L.L.; Xu, Y.S.; Ahmed, A.; Chen, Y.Y.; Zhang, J.S.; Tang, G.H.; Yin, S. Biscembranoids and Cembranoids from the Soft Coral Sarcophyton elegans. Mar. Drugs 2017, 15, 85.

95. Hegazy, M.F.; Elshamy, A.I.; Mohamed, T.A.; Hamed, A.R.; Ibrahim, M.A.A.; Ohta, S.; Paré, P.W. Cembrane Diterpenoids with Ether Linkages from Sarcophyton ehrenbergii: An Anti-Proliferation and Molecular-Docking Assessment. Mar. Drugs 2017, 15, 192.

96. Hegazy, M.F.; Mohamed, T.A.; Elshamy, A.I.; Hamed, A.R.; Ibrahim, M.A.A.; Ohta, S.; Umeyama, A.; Paré, P.W.; Effertth, T. Sarcoehrenbergigilides D–F: Cytotoxic cembrene diterpenoids from the soft coral Sarcophyton ehrenbergi. RSC Adv. 2019, 9, 27183–27189.

97. Li, G.; Li, H.; Zhang, Q.; Yang, M.; Gu, Y.; Liang, L.; Tang, W.; Guo, Y. Rare Cembranoids from Chinese Soft Coral Sarcophyton ehrenbergii: Structural and Stereochemical Studies. J. Org. Chem. 2019, 84, 5091–5098.

98. Ye, F.; Li, J.; Wu, Y.; Zhu, Z.D.; Mollo, E.; Gavagnin, M.; Gu, Y.C.; Zhu, W.L.; Li, X.W.; Guo, Y.W. Sarinfaceamides A and B, Nitrogenous Diterpenoids with Tricyclo[6.3.1.0(1,5)]dodecane Scaffold from the South China Sea Soft Coral Sarcophyton infundibuliforme. Org. Lett. 2018, 20, 2637–2640.

99. Kamada, T.; Zanil, I.I.; Phan, C.; Vairappan, C. A new cembrene, from soft coral genus Sarcophyton in Borneo. Nat. Prod. Commun. 2018, 13, 123–124.

100. Yang, M.; Li, X.L.; Wang, J.R.; Lei, X.; Tang, W.; Li, X.W.; Sun, H.; Guo, Y.W. Sarcomitilolinate A, an Unusual Diterpenoid with Tricyclo[11.3.0.0(2,16)]hexadecane Carbon Skeleton, and Its Potential Biogenetic Precursors from the Hainan Soft Coral Sarcophyton mililitans. J. Org. Chem. 2019, 84, 2568–2576.

101. Shaaban, M.; Issa, M.Y.; Ghani, M.A.; Hamed, A.; Abdelwahab, A.B. New pyranosyl cembranoid diterpenes from Sarcophyton trocheiophorum. Nat. Prod. Res. 2019, 33, 24–33.

102. Iwagawa, T.; Hashimoto, K.; Okamura, H.; Kurawaki, J.; Nakatani, M.; Hou, D.X.; Fujii, M.; Doe, M.; Morimoto, Y.; Takemura, K. Biscembranes from the soft coral Sarcophyton glaucum. J. Nat. Prod. 2006, 69, 1130–1133.

103. Huang, C.Y.; Sung, P.J.; Uvarani, C.; Su, J.H.; Lu, M.C.; Hwang, T.L.; Dai, C.F.; Wu, S.L.; Sheu, J.H. Glaucumolides A and B, Biscembranoids with New Structural Type from a Cultured Soft Coral Sarcophyton glaucum. Sci. Rep. 2015, 5, 15624.

104. Jia, R.; Guo, Y.; Chen, P.; Yang, Y.; Mollo, E.; Gavagnin, M.; Cimino, G. Biscembranoids and Their Probable Biogenetic Precursor from the Hainan Soft Coral Sarcophyton tortuosaum. J. Nat. Prod. 2007, 70, 1158–1166.

105. Yan, X.; Gavagnin, M.; Cimino, G.; Guo, Y. Two new biscembranes with unprecedented carbon skeleton and their probable biogenetic precursor from the Hainan soft coral Sarcophyton latum. Tetrahedron Lett. 2007, 48, 5313–5316.
106. Bishara, A.; Rudi, A.; Benayahu, Y.; Kashyan, Y. Three Biscembranoids and their Monomeric Counterpart Cembranoid, a Biogenetic Diels–Alder Precursor, from the Soft Coral Sarcophyton elegans. J. Nat. Prod. 2007, 70, 1951–1954.

107. Xi, Z.; Bie, W.; Chen, W.; Liu, D.; Ofwegen, L.; Chaidir, C.; Lin, W. Sarcophytolides G–L, New Biscembranoids from the Soft Coral Sarcophyton elegans. Helv. Chim. Acta 2013, 96, 2218–2227.

108. Nam, N.; The Tung, P.; Thi Ngoc, N.; Thi Hong Hanh, T.; Thao, N.; Van Thanh, N.; Cuong, N.; Thao, D.; Thu Huong, T.; Cong Thung, D.; et al. Cytotoxic Biscembranoids from the Soft Coral Sarcophyton pauciplicatum. Chem. Pharm. Bull. 2015, 63, 636–640.

109. Yasumoto, M.; Mada, K.; Ooi, T.; Kusumi, T. New Terpenoid Components from the Volatile Oils of the Soft Corals Clavularia viridis and Sarcophyton acutangulum. J. Nat. Prod. 2000, 63, 1534–1536.

110. Anjaneyulu, A.S.R.; Gowri, P.M. Two New Guaiane Sesquiterpenoids from the Soft Coral Sarcophyton buitendijki of the Andaman and Nicobar Island of the Indian Ocean. Indian J. Chem. 2001, 32, 773–778.

111. Sawant, S.S.; Youssef, D.; Sylvester, P.; Wali, V.; El Sayed, K. Antiproliferative Sesquiterpenes from the Red Sea Soft Coral Sarcophyton glaucum. Nat. Prod. Commun. 2007, 2, 117.

112. Anjaneyulu, A.S.R.; Rao, V.L.; Sastry, V.G.; Rao, D.V. Trocheliophorin: A novel rearranged sesquiterpenoid from the Indian Ocean soft coral Sarcophyton trocheliophorum. J. Asian Nat. Prod. Res. 2008, 10, 597–601.

113. Su, J.; Yang, R.; Zeng, L.; Sardisterol, A. New Polyhydroxylated Sterol from the Soft Coral Sarcophyton digitatum Moser. Chin. J. Chem. 2001, 19, 515–517.

114. Wang, G.; Su, J.; Chen, C.; Duh, C.; Dai, C.; Sheu, J. Novel Polyhydroxysteroids from the Formosan Soft Coral Sarcophyton glaucum. J. Chin. Chem. Soc. 2004, 51, 217–222.

115. Wang, Z.; Tang, H.; Wang, P.; Gong, W.; Xue, M.; Zhang, H.; Liu, T.; Liu, B.; Yi, Y.; Zhang, W. Bioactive Polyoxycarbonated Steroids from the South China Sea Soft Coral, Sarcophyton sp. Mar. Drugs 2013, 11, 775–787.

116. Sun, L.L.; Fu, X.M.; Li, X.B.; Xing, Q.; Wang, C.Y. New 18-oxygenated polyhydroxy steroid from a South China Sea soft coral Sarcophyton sp. Nat. Prod. Res. 2013, 27, 2006–2011.

117. Shaaban, M.; Ghani, M.A.; Shaaban, K. Zahramycins A–B, Two New Steroids from the Coral Sarcophyton trocheliophorum. Zeitschrift Für Naturforschung B 2013, 68, 939–945.

118. Gong, K.; Tang, X.; Zhang, G.; Cheng, C.; Zhang, X.; Pinglin, L.; Li, G. Polyhydroxylated Steroids from the South China Sea Soft Coral Sarcophyton sp and Their Cytotoxic and Antiviral Activities. Mar. Drugs 2013, 11, 4788–4798.

119. Chen, W.; Liu, H.; Yao, L.; Guo, Y. 9,11-Secosteroids and polyhydroxylated steroids from two South China Sea soft corals Sarcophyton trocheliophorum and Sinularia flexibilis. Steroids 2014, 92, 56–61.

120. Anjaneyulu, A.S.R.; Krishnamurthy, M.V.R.; Rao, G.V. Rare aromadendrane diterpenoids from a new soft coral species of Sinularia genus of the Indian Ocean. Tetrahedron 1997, 53, 9301–9312.

121. Sekhar, V.C.; Rao, C.B.; Ramana, H.; Rao, D.V. New Prostaglandins from the Soft Coral Sarcophyton ehrenbergi MarengeUller of Andaman and Nicobar Islands of Indian Ocean. Asian J. Chem. 2010, 22, 5353–5358.

122. Řezanka, T. and Dembitsky, V. γ-Lactones from the soft corals Sarcophyton trocheliophorum and Lithophyton arboreum. Tetrahedron 2001, 57, 8743–8749.

123. Anjaneyulu, A.S.R.; Krishna Murthy, M.V.R.; Gowri, P.M.; Venugopal, M.J.R.V.; Laatsch, H. A Rare Prostaglandin from the Soft Coral Sarcophyton crassicaule of the Indian Ocean. J. Nat. Prod. 2000, 63, 1425–1426.

124. Li, L.; Wang, C.; Shao, C.; Han, L.; Sun, X.; Zhao, J.; Guo, Y.; Huang, H.; Guan, H. Two new metabolites from the Hainan soft coral Sarcophyton crassicaule. J. Asian Nat. Prod. Res. 2009, 11, 851–855.

125. Li, L.; Wang, C.; Shao, C.; Guo, Y.; Li, G.; Sun, X.; Han, L.; Huang, H.; Guan, H. Sarcoglycosides A–C, New O-Glycosylglycerol Derivatives from the South China Sea Soft Coral Sarcophyton infusionbiumforme. Helv. Chim. Acta 2009, 92, 1495–1502.

126. Carmely, S.; Kashman, Y.; Loya, Y.; Benayahu, Y. New prostaglandin (PGF) derivatives from the soft coral Lobophyton depressum. Tetrahedron Lett. 1980, 21, 875–878.

127. Cheng, Z.; Deng, Y.; Fan, C.; Han, Q.; Lin, S.; Tang, G.; Luo, H.; Yin, S. Prostaglandin Derivatives: Nonaromatic Phosphodiesterase-4 Inhibitors from the Soft Coral Sarcophyton ehrenbergi. J. Nat. Prod. 2014, 77, 1928–1936.

128. Chitturi, B.R.; Dokuburra, C.B.; Tatipamula, V.B.; Dudem, S.; Kalivendi, S.V.; Tuniki, V.R.; Richard, A.B.; Yenamandra, V. Isolation, structural assignment and synthesis of (S E)-2-methyloctyl 3-(4-
methoxyphenyl) propenoate from the marine soft coral *Sarcophyton ehrenbergi*. Nat. Prod. Res. 2014, 29, 70–76.

129. Cheng, S.; Wen, Z.; Chiou, S.; Tsai, C.; Wang, S.; Hsu, C.; Dai, C.; Chiang, M.Y.; Wang, W.; Duh, C. Ceramide and Cerebrosides from the Octocoral *Sarcophyton ehrenbergi*. J. Nat. Prod. 2009, 72, 465–468.

130. Minh, C.V.; Kiem, P.V.; Nam, N.; Cuong, N.; Thao, N.; Dang, N.; Quang, T.; Đạt, N.; Thung, D.C.; Thuy, D. Carotenoids from the soft coral *Sarcophyton elegans*. Vietnam J. Chem. 2010, 48, 627–631.

131. Zeng, L.; Lan, W.; Su, J.; Zhang, G.; Feng, X.; Liang, Y.; Yang, X. Two New Cytotoxic Tetracyclic Tetraterpenoids from the Soft Coral *Sarcophyton tortuosum*. J. Nat. Prod. 2004, 67, 1915–1918.

132. Lan, W.; Wang, S.; Li, H. Additional New Tetracyclic Tetraterpenoid: Methyl Tortuoate D from Soft Coral *Sarcophyton tortuosum*. Nat. Prod. Commun. 2009, 4, 1193–1196.

133. Su, C.; Chen, J.Y.; Din, Z.; Su, J.; Yang, Z.; Chen, Y.; Wang, R.Y.; Wu, Y. 13-Acetoxy sarcocrassolide Induces Apoptosis on Human Gastric Carcinoma Cells Through Mitochondria-Related Apoptotic Pathways: p38/JNK Activation and PI3K/AKT Suppression. Mar. Drugs 2014, 12, 5295–5315.

134. Eltahawy, N.A.; Ibrahim, A.K.; Radwan, M.M.; Zaitone, S.A.; Gomaa, M.; ElSohly, M.A.; Hassanean, H.A.; Ahmed, S.A. Mechanism of action of antiepileptic ceramide from Red Sea soft coral *Sarcophyton auritum*. Bioorg. Med. Chem. Lett. 2015, 25, 5819–5824.

135. Szymanski, P.T.; Ahmed, S.A.; Radwan, M.; Khalifa, S.; Fahmy, H. Evaluation of the Anti-melanoma Activities of Sarcophine, (+)-7 alpha,8 beta-Dihydroxydeeepoxysarcophine and Sarcophytolide from the Red Sea Soft Coral *Sarcophyton glaucum*. Nat. Prod. Commun. 2014, 9, 151–154.

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).