Review

Natural Products from Octocorals of the Genus Dendronephthya (Family Nephtheidae)

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Abstract: In this review, 170 natural substances, including steroid, diterpenoid, sesquiterpenoid, peptide, prostaglandin, base, chlorolipid, bicyclolactone, amide, piperezine, polyketide, glycerol, benzoic acid, glycyrrhetin amino acid, hexitol, pentanoic acid, aminoethyl ester, octadecanone, alkaloid, and a 53-kD allergenic component from octocorals belonging to genus Dendronephthya, were listed. Some of these compounds displayed potential bioactivities.

Keywords: octocoral; Dendronephthya; steroid; natural compound

1. Introduction

Octocorals of the genus Dendronephthya (phylum Cnidaria, class Anthozoa, subclass Octocorallia, order Alcyonacea, suborder Alcyoniina, family Nephtheidae) [1], distributed in the Indo-Pacific Ocean, have been investigated. Since the initial study in 1999 discovered four antifouling seco-steroids, isogosterones A–D (1–4), from an octocoral Dendronethphya sp. collected off the Izu Peninsula, Japan [2]...
(Figure 1), subsequent studies over the past two decades have yielded a series of interesting secondary metabolites, particularly steroid metabolites. In this article, different types of compounds isolated from Dendronephthya spp., were summarized.

2. Dendronephthya gigantea (Verrill, 1864)

The Dendronephthya genus includes one common species, D. gigantea. Yoshikawa and colleagues isolated five polyhydroxylated sterols, including two new metabolites, dendronesterols A (5) and B (6), along with three known analogues, (22E,24S)-24-methyl-cholesta-7,22-diene-3β,5α,6β,9α-tetrol (7) [3], (22E)-cholesta-7,22-diene-3β,5α,6β,9α-tetrol (8) [3], and (22E)-24-norcholesta-7,22-diene-3β,5α,6β-triol (9) [4,5] (Figure 2), from D. gigantea collected off the coast of Tokushima, Japan [6]. The study also established the structures of new sterols 5 and 6 by spectroscopic methods. A cytotoxic assay showed that sterol 6 had an IC₅₀ value of 5.2 µg/mL in the treatment of L1210 (mouse lymphocytic leukemia) cells [6].

In 2004, three new steroids, dendronesterones A–C (10–12), along with a known steroid, cholest-1-ene-3,22-dione (13) [7], were isolated from D. gigantea, collected at Green Island, off Taiwan [8] (Figure 3). Structures of steroids 10–13 were established by spectroscopic methods, and the ¹H and ¹³C chemical shifts at C-23 and C-24 in steroid 13 were revised in this study. In the cytotoxic testing, steroids 10 and 13 had ED₅₀ values of 9.84 and 8.93 µM, respectively, in the treatment of P-388
(mouse lymphoma) cells, and 13 was cytotoxic toward HT-29 (human colorectal adenocarcinoma) cells with an ED_{50} value of 9.03 µM [8].

Furthermore, two known metabolites, including a monoalkyl glycerol ether (±)-1-nondecylxyloxy-2,3-propanediol (14) [9], a ceramide, (2S,3R,4E,8E)-N-hexadecanoyl-2-amino-4,8-octadecadiene-1,3-diol (15) [10–14], as well as two bases, thymine (16) and uracil (17), (Figure 4), were isolated from the organic extract of *D. gigantea*, collected in the area of Jeju Island, Korea [15]. The structures of metabolites 14–17 were established by spectroscopic methods and by comparison of their physical and spectral data with those of literature values and glycerol 14 was found to be cytotoxic toward A549 (human lung epithelial carcinoma), HT-29, HT-1080 (human connective tissue epithelial fibrosarcoma), and SNU-638 (human gastric adenocarcinoma) cells with IC_{50} values of 15.1, 14.5, 13.7, and 15.5 µg/mL, respectively [15]. Glycerol 14 was not optically active ([α]_{D}^25 0.00 (c 0.134, MeOH)), indicating that this compound is a racemic mixture. Thus, the stereogenic center C-2 in 14 was not determined [15]. Sphingolipid 15 showed cytotoxicity against human peripheral blood mononuclear cells (PBMC) with an ED_{50} of 20 µg/mL [13].

Eight well known secondary metabolites, including (2S,3R,4E,8E)-N-hexadecanoyl-2-amino-4,8-octadecadiene-1,3-diol (15) [10–14] (Figure 4), (2S,3R,4E)-N-hexadecanoyl-2-amino-4-octadecane-1,3-
diol (18) [10,16], N-phenethylacetamide (19) [17–21], cyclo-(Leu-Pro) (20), cyclo-(Ala-Pro) (21), cyclo-(Val-Pro) (22) [22], 2,4-dichlorobenzonic acid (23) [23], thymidine (24) [24–32], 2'-deoxyuridine (25) [27–30,32,33], and cholesterol (26) [30] (Figure 5), were isolated from D. gigantea, collected from the South China Sea [34]. The structures of compounds 15 and 18–26 were elucidated by spectral data and by comparison with the spectral and physical data of other known compounds [34].

In 2012, six steroids, including three new compounds, 3-oxocholest-1,22-dien-12β-ol (27), 3-oxocholest-1,4-dien-20β-ol (28), 3-oxocholest-1,4-dien-12β-ol (29), along with three known analogues, (20S)-20-hydroxyergosta-1,4,24-trien-3-one (30) [35], 5α,8α-epidioxycholesta-6,22-dien-3β-ol (31) [36], and 5-cholestene-3β,12β-diol (32) [37] (Figure 6), were isolated from D. gigantea, collected near Geo-Je Island, South Korea [38]. The structures for steroids 27–32 were established by spectroscopic methods. Steroids 27–31 displayed inhibitory activity against farnesoid X-activated receptor (FXR) with IC₅₀ values of 13.59 and 29.41 µM, respectively, and were not cytotoxic toward the CV-1 cells ([37], 2012). In lipopolysaccharides (LPS)-stimulated RAW cells, this mixture inhibited nitric oxide (NO) and prostaglandin E₂ (PGE₂) production via the downregulation of inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) inflammatory mediators. This sterol-rich mixture also suppressed the expression of proinflammatory cytokines, including tumor necrosis factor-α (TNF-α), interleukin 1β (IL-1β), and interleukin 6 (IL-6). The anti-inflammatory effects of this sterol-rich mixture was confirmed in an LPS-stimulated in vivo zebrafish model by the downregulation of iNOS and COX-2 expression, inhibition of NO and reactive oxygen species (ROS) levels, and increased cytoprotective effects against LPS-induced toxicity [50]. Furthermore, this sterol-rich fraction was found to exhibit cytotoxicity toward HL-60 (human acute promyelocytic leukemia) and MCF-7 (Michigan Cancer Foundation-7, human invasive ductal carcinoma) cells with IC₅₀ values of 13.59 and 29.41 µg/mL [51], and one of the mixtures, stigmasta-5-en-3β-ol (39), displayed cytotoxicity on HL-60 and MCF-7 cells with IC₅₀ values of 37.82 and 45.17 µg/mL, respectively [52].
Fifteen steroids, including four new compounds, 7-dehydroerectasteroid F (41), 11α-acetoxyarmatinol A (42), 22,23-didehydroarmatinol A (43), and 3-O-acetylhyrtiosterol (44), as well as 11 known steroids, 24-methylene-5-cholesten-3β,7β-diol (45) [53], 24-methylene-5-cholesten-3β,19-diol (= litosterol) (46) [54], 24-methylene-5-cholesten-3β,19-diol-7β-monoacetate (47) [55], 5,6-epoxylitosterol (48) [54], armatinol A (49) [56], hyrtiosterol (50) [57,58], (2β,3β,4α,5α,8β,11β)-4-
methylergost-24-ene-2,3,8,11-tetrol (51) [58], and erectasteroids C–F (52–55) [59] (Figure 8), were isolated from *D. gigantea*, collected from the inner coral reef of Meishan, Hainan Province, China [60]. The structures of new steroids 41–43 were elucidated by comprehensive spectroscopic analysis and steroid 41 was found to show protection against hydrogen-peroxide (H$_2$O$_2$)-induced oxidative damage in neuron-like PC-12 (rat adrenal gland pheochromocytoma) cells by promoting nuclear translocation of nuclear factor erythroid 2-related factor 2 (Nrf2) and enhancing the expression of heme oxygenase-1 (HO-1) [60].

![Figure 8. Structures of 7-dehydroerectasteroid F (41), 11α-acetoxyarmatinol A (42), 22,23-di-dehydroarmatinol A (43), 3-O-acetylhyrtiosterol (44), 24-methylene-5-cholesten-3β,7β-diol (45), 24-methylene-5-cholesten-3β,19-diol (46), 24-methylene-5-cholesten-3β,19-diol-7β-monoacetate (47), 5,6-epoxylitosterol (48), armatinol A (49), hyrtiosterol (50), (2β,3β,4α,5α,8β,11β)-4-methylergost-24(28)-ene-2,3,8,11-tetrol (51), and erectasteroids C–F (52–55).](image-url)
3. *Dendronephthya griffini* (Roxas, 1933)

Ten new steroids, griffinisterones A–I (56–64) and griffinipregnone (65) (Figure 9), were obtained from *D. griffini* specimens collected by a bottom trawl net at depths from 200 to 100 m at Taiwan Straight in December 2004 [61,62]. The structures of steroids 56–65 were determined by spectroscopic methods and the configuration of griffinisterone A (56) was further confirmed by a single-crystal X-ray diffraction analysis [61,62]. The absolute stereochemistry of griffinisterone E (60) was determined by the application of a modified phenylglycine methyl ester (PGME) method [61]. Anti-inflammatory assays revealed that griffinisterones A–D (56–59), F–H (61–63), and griffinipregnone (65), reduced the levels of iNOS protein to 49.7, 48.9, 8.1, 29.8, 13.4, 6.5, 15.4, and 59.6%, respectively, at a concentration of 10 µM [61,62]. At the same concentration, griffinisterones F (61), G (62), and griffinipregnone (65), reduced the levels of COX-2 protein to 61.7, 31.5, and 52.3%, respectively [62].

**Figure 9.** Structures of griffinisterones A–I (56–64) and griffinipregnone (65).

Furthermore, two new interesting polychlorolipids, (2R,3S,4R,5S,6S,7R)-2,3,5,6,7-pentachloropentadec-14-en-4-yl hydrogen sulfate (66), (2R,3S,4R,5S,6S,7R)-2,3,5,6,7-pentachloropentadec-14-en-4-ol (67), and a new natural substance, (2R,3S,4R,5S,6S,7R,E)-2,3,5,6,7,15-hexachloropentadec-
14-en-4-ol (68) [63,64], along with a known analogue, chlorosulfolipid (69) [63,64] (Figure 10), were obtained from *D. griffini* [65]. The structures of chlorolipids 66–69 were determined by extensive spectroscopic analysis and by comparison of the NMR data with those of known compounds. It was found that chlorolipid 68 has been prepared from the hydrolysis of 69 [63] and by a total synthesis of racemic 68 [64]. Chlorolipid 68 was isolated for the first time from a natural source and the compounds of this type was isolated for the first time from the soft corals [65].

![Structures of polychlorolipids 66–69.](image)

**Figure 10.** Structures of polychlorolipids 66–69.

### 4. *Dendronephthya hemprichi* (Klunzinger, 1877)

Chemical investigation of the extract of *D. hemprichi*, collected from the Red Sea, Egypt, delivered a novel glycyrrhetin amino acid, dendrophen (70), a new sterol, dendrotriol (71), along with the well-known metabolites, cholesterol (26) [30] (Figure 4) and hexitol (72) [66]. The structures of new compounds 70 and 71 were established by spectroscopic methods, although the stereochemistry for C-24 stereogenic center in 71 was not determined [66]. Furthermore, chromatography separation of the low-polarity components of *D. hemprichi* extract afforded 4-oxo-pentanoic acid (73), 2-methyl-acrylic acid 2-diethylaminoethyl ester (74), juniper camphor (75), and 2-octadecanone (76) (Figure 11) [66].

![Structures of dendrophen (70), dendrotriol (71), hexitol (72), 4-oxo-pentanoic acid (73), 2-methyl-acrylic acid 2-diethylaminoethyl ester (74), juniper camphor (75), and 2-octadecanone (76).](image)

**Figure 11.** Structures of dendrophen (70), dendrotriol (71), hexitol (72), 4-oxo-pentanoic acid (73), 2-methyl-acrylic acid 2-diethylaminoethyl ester (74), juniper camphor (75), and 2-octadecanone (76).
5. *Dendronephthya mucronata* (Pütter, 1900)

A new pregnane-type steroid 5α-pregnan-20-en-3,6-dione (77), along with five known steroids, 5α-pregnan-20-en-3β-ol (78) [67–69], 1,4,20-pregnatrien-3-one (79) [70–74], 15β-acetoxypregna-1,4,20-trien-3-one (80) [75,76], 5α-cholestan-3,6-dione (81) [76–78], and 5α-cholest-22-en-3,6-dione (82) [79], (Figure 12), were isolated from *D. mucronata* collected from waters off Phu Quoc Islands, Kien Giang, Vietnam in 2018 [80]. The structure of new steroid 77 was elucidated by spectroscopic method. Steroids 78 and 81 showed moderate inhibitory effects on LPS-induced NO formation in RAW264.7 murine macrophage cells with IC₅₀ values of 30.15 and 35.97 µM, respectively.

![Figure 12. Structures of 5α-pregnan-20-en-3,6-dione (77), 5α-pregnan-20-en-3β-ol (78), 1,4,20-pregnatrien-3-one (79), 15β-acetoxypregna-1,4,20-trien-3-one (80), 5α-cholestan-3,6-dione (81), and 5α-cholest-22-en-3,6-dione (82).](image)

Furthermore, three new bicyclo lactones, dendronephthyones A–C (83–85), along with a known analogue, suberosanone B (86) [81] (Figure 13), were isolated from the methanol extract of the same target material *D. mucronata* [82]. Structures of lactones 83–86 were established by spectroscopic methods and these four compounds exhibited cytotoxicity toward HeLa (human papillomavirus-related endocervical adenocarcinoma) cells with IC₅₀ values of 32.48, 30.12, 35.45, and 14.45 µM, respectively [82].

![Figure 13. Structures of dendronephthyones A–C (83–85) and suberosanone B (86).](image)

6. *Dendronephthya nipponica* (Utinomi, 1952)

A red soft-coral *D. nipponica* cause spiny lobster fisherman living along the coast of Miyazaki Prefecture, Japan to develop occupational allergies. In order to understand the allergic mechanism, a new 53-kD allergenic component (Den n 1) (87) was purified and the N-terminal amino of this allergen component was determined and identified as Asp-Asp-Ile-Asn-Arg-Tyr-Ala-Phe-Asp-Asn-Lys-Ile-Asn-Asp-Lys-Leu-Phe-Asp-His-Trp-Gln-Ser [83].
7. Dendronephthya puetteri (Kükenthal, 1905)

In 2018, Jeon’s group reported the isolation of a 3β-hydroxy-Δ5-steroidal congener, consisting of six sterols, cholesterol (26) [30] (Figure 4), cholesta-5,22-dien-3β-ol (34) [40], ergosta-5,22-dien-3β-ol (36) [41], stigmastera-5-en-3β-ol (39) [48], 22,23-methylencholesterol (40) [49] (Figure 7), and cholesta-5,24-dien-3β-ol (88) [84] (Figure 14), from D. puetteri, collected from the Jeju Island, South Korea [85]. The structures for all sterols 26, 34, 36, 39, 40, and 88 were determined by GC-MS/MS analysis [85]. In lipopolysaccharides (LPS)-stimulated RAW264.7 cells, this mixture inhibited nitric oxide (NO) production with an IC₅₀ value of 6.54 µg/mL. Moreover, this congener reduced the level of PGE₂, TNF-α, IL-1β, and IL-6. The anti-inflammatory effects of this sterol-rich mixture was confirmed in an LPS-stimulated in vivo zebrafish model by the downregulation of NO, iNOS, COX-2, ROS production and cell death [85,86], and this sterol rich congener showed cytotoxicity toward HL-60 and MCF-7 cells with IC₅₀ values of 25.27 and 22.81 µg/mL, respectively [87].

8. Dendronephthya rubeola (Henderson, 1909)

Four new acetoxycapnellenes, 2α,8β,13-triacetoxycapnell-9-ene-10α-ol (89), 3α,8β,14-triacetoxy-capnell-9-ene-10α-ol (90), 3α,14-diacetoxy-capnell-9-ene-8β,10α-diol (91), 3α,8β-diacetoxy-capnell-9-ene-10α-ol (92), and the first epoxyacapnellenes, 3α,4α-epoxyacapnell-10-ene (93), as well as two known analogues, capnell-9-ene-8β,10α-diol (94) [88,89] and 8β-acetoxy-capnell-9-ene-10α-ol (95) [88,90] (Figure 15), were obtained from D. rubeola, collected from the waters near Bali, Indonesia [91]. Structures of 89–95 were established by spectroscopic methods. Compounds 94 and 95 displayed antiproliferative activity against L-929 (murine connective tissue fibroblasts) (GI₅₀ = 6.8, 20.9 µM) [91]. 94 displayed cytotoxicity toward HL-60, K-562 (human chronic myelogenous leukemia), G-402 (human renal leiomyoblastoma), MCF-7, HT-115 (human colon carcinoma), and A-2780 (human ovarian endometrioid adenocarcinoma) cells with IC₅₀ values of 51, 0.7, 42–51, 93, 63, and 9.7 µM, respectively [89]. Compounds 94 and 95 also showed cytotoxicity toward HeLa cells (CC₅₀ = 7.6, 9.4 µM) [91]. It is interesting to note that compound 94 (capnell-9-ene-8β,10α-diol) inhibited the interaction of oncogenic transcription factor Myc (a family of regulator genes and proto-oncogenes that code for transcription factors) with its partner protein Max (inhibition = 77%) in yeast [91].
9. Dendronephthya studeri (Ridley, 1884)

Eleven steroids, including eight new metabolites, (22E)-19-norcholesta-1,3,5,22-tetraen-3-ol (96), (22E)-19,24-dinorcholesta-1,3,5,22-tetraen-3-ol (97), (22E)-24,26-cyclo-19-norcholesta-1,3,5 (10),22-tetraen-3-ol (98), 24-methylene-19-norcholesta-1,3,5,22-tetraen-3-ol (99), (22E,24S)-24-methyl-19-norcholesta-1,3,5,22-tetraen-3-ol (100), (22E,24R)-24-methyl-19-norcholesta-1,3,5, 22-tetraen-3-ol (101), 24-methylenecoelheosta-1,4,22-trien-3-one (102), and (22E)-24-cholesta-1,4,22-trien-3-one (103), which all were found to be characterized by either the presence of an aromatic ring or a cross-conjugated dienone system in ring A, as well as three known steroids, methyl spongoate (104) [92], 19-norcholesta-1,3,5-trien-3-ol (105) [93,94], and dendronestosterone C (12) (Figure 3) [8], were obtained from D. studeri, collected off the coast of Xiaodong Sea, Hainan Province, China [95] (Figure 16). Structures of isolates 12 and 96–105 were established by spectroscopic analysis and by comparison of their NMR data with those reported in the literature. Steroid 104 exhibited cytotoxicity against BEL-7402 (human papillomavirus-related endocervical adenocarcinoma), A-549, HT-29, and P-388 cells with IC_{50} values of 0.14, 5, 5, and 3.8 µg/mL [92].

Figure 16. Structures of (22E)-19-norcholesta-1,3,5,22-tetraen-3-ol (96), (22E)-19,24-dinor-cholesta-1,3,5,22-tetraen-3-ol (97), (22E)-24,26-cyclo-19-norcholesta-1,3,5,22-tetraen-3-ol (98), 24-methylene-19-norcholesta-1,3,5,22-tetraen-3-ol (99), (22E,24S)-24-methyl-19-norcholesta-1,3,5 (10),22-tetraen-3-ol (100), (22E,24R)-24-methyl-19-norcholesta-1,3,5,22-tetraen-3-ol (101), 24- methylenecoelheosta-1,4,22-trien-3-one (102), (22E)-24-cholesta-1,4,22-trien-3-one (103), methyl spongoate (104), and 19-norcholesta-1,3,5-trien-3-ol (105).
10. Dendronephthya spp.

*Dendronephthya* is a genus of octocoral belonging to the family Nephtheidae and there are over 250 described species in this genus. In 1990, Katrich and colleagues identified the correlation between the number of particular phospholipids (PhLs) and prostaglandins (PGs) that influenced the prostaglandin-like activities of the extracts from (1) *Dendronephthya* sp., collected in the region of the Great Barrier Reef, Australia and (2) *Dendronephthya* sp., collected in Vietnam [96].

An acetone extract from *Dendronephthya* sp., collected in 1990, off the Chichi-jima and Haha-jima Islands in the Ogasawara Islands, Japan, showed a high level of antifouling activity against the blue mussel *Mytilus edulis* [97]. Purification of the extract gave mixtures of sterols and fatty acids as active components. In the sterol mixture, there are several sterols, (24S)-24-methylcholesta-5(\(\E\))-22-dien-3β-ol (= pincsterol) or (24R)-24-methylcholesta-5(\(\E\))-22-dien-3β-ol (= brassicasterol) (106) [98], cholesterol (26) [30] (Figure 5), \(\beta\)-sitosterol (stigmasta-5-en-3\(\beta\)-ol) (39) [48], and \(\beta\)-cholesterol (5α-cholestan-3\(\beta\)-ol) (107) [99] were identified and sterol 39 in this study [97] was found to contain 35% of a 24S epimer (clionasterol) (108) [100,101] (Figure 17). Sterol 39 had the highest antifouling activity among sterols 26, 39, and 107 [97]. Moreover, a fatty acid mixture, showing the presence of saturated and unsaturated fatty acids with a chain length of C\(_{12}\) to C\(_{22}\), being rich in C\(_{16}\) and C\(_{18}\) acids as active constituents in antifouling activity [97].

![Figure 17. Structures of pincsterol (24S), brassicasterol (24R) (106), \(\beta\)-cholesterol (107), \(\beta\)-sitosterol (39), and clionasterol (108).](image)

Kawamata et al. isolated an antifouling substance, trigonelline (109) (Figure 18), from *Dendronephthya* sp. collected at Chichijima Island in the Ogasawara Islands [102]. The structure of 109 was elucidated by spectroscopic methods and this compound showed the same level of settling-inhibitory activity against the acorn barnacle *Balanus amphitrite* larvae as CuSO\(_{4}\) [102,103].

![Figure 18. Structure of trigonelline (109).](image)
In 1999, the ethanol extract of two soft coral specimens *Dendronephthya* (Roxasia) sp. and *Dendronephthya* (Morcellana) sp., collected off the Gopalpur coast, Bay of Bengal, were found to display attachment inhibitory activity at the settlement of cyprids of barnacle *Balanus amphitrite* [104], and the extract was claimed to contain natural non-toxic antifouling agents, although no natural products was reported to be active components.

Research by a group in Japan identified four new antifouling seco-steroids, isogosterones A–D (1–4) (Figure 1) from an octocoral identified as *Dendronephthya* sp. collected off the Izu Peninsula, Japan [2], and their structures were elucidated on the basis of spectroscopic data. This is the first time to isolate naturally occurring 13,17-secosteroids. It is interesting to note that seco-steroids 3 and 4 were interconvertible in CHCl₃ and 3 was detected as the hydrolyzed product of 4 [2]. These four seco-steroids displayed activity to inhibit the settlement of *B. amphitrite* cyprid larvae with an EC₅₀ values of 2.2 µg/mL.

Furthermore, a new steroid, methyl 3-oxochola-4,22-dien-24-oate (110) (Figure 19) [105], from *Dendronephthya* sp. collected off the Kii Peninsula, Japan, and determined its structure using spectroscopic methods [105]. Steroid 110 was lethal to cyprids of *B. amphitrite* at 100 µg/mL (LD₁₀₀) but did not inhibit larval settlement of *B. amphitrite* [105].

![Figure 19. Structure of methyl 3-oxochola-4,22-dien-24-oate (110).](image-url)

Four new brominated oxylipins, (4S,5E,7Z,12R,14Z,17Z)-4-hydroxy-17,18-didehydrobromovulone-3 (111), (4S,5E,7Z,12R,14Z,17Z)-4-(α-D-glucopyranosyloxy)-17,18-didehydrobromovulone-3 (112), (4R,5E,7Z,12R,14Z,17Z)-4-hydroxy-17,18-didehydrobromovulone-3 (113), and (4R,5E,7Z,12R,14Z,17Z)-4-(β-D-glucopyranosyloxy)-17,18-didehydrobromovulone-3 (114), (Figure 20) were isolated from *Dendronephthya* spp. (red variety—for compounds 111 and 112; yellow variety—for compounds 113 and 114) collected in the Gulf of Aqaba in the Red Sea (Eilat, Israel) [106]. The structures, including the absolute configurations of oxylipins 111–114, were determined by spectroscopic and chemical methods. All the isolates showed significant inhibition of the growth of crown gall tumors on potato disks inoculated with *Agrobacterium tumefaciens* and gave positive responses in a brine shrimp toxicity toward *Artemia salina*; these compounds showed antibacterial activity against the Gram-(+) bacteria *Staphylococcus aureus* and *Bacillus subtilis* [106].

![Figure 20. Structures of oxylipins 112–114.](image-url)

Fifteen steroids, including five new compounds, (22E)-3-O-β-formylcholest-5,22-diene (115), (22E)-3-O-β-formyl-24-methyl-cholest-5,22-diene (116), 2-ethoxycarbonyl-2-β-hydroxy-A-nor-
The structures of steroids were elucidated by spectroscopic methods and by comparison of their spectroscopic data with those reported previously. However, the configuration of Me-28 at stereogenic center C-24 in steroids, as well as nine known steroids, 3β,7β-dihydroxycholest-5-ene (121) [108,109], (22E)-3β,7α-dihydroxycholest-5,22-diene (122) [110], 3β,7α-dihydroxy-24-methylenecholest-5-ene (123) [109], 3β,7α-dihydroxy-24-methylcholest-5,22-diene (124) [110], 3β,7α-dihydroxycholest-5-ene (125) [110–112], cholest-4-ene-3-one (126) [113–115], 24-methylenecholest-4-ene-3-one (127) [116,117], (22E)-cholest-4,22-dien-3-one (128) [116], and (22E)-24-methylcholest-4,22-dien-3-one (129) [118] (Figure 21), were isolated from the soft coral *Dendronephthya* sp. collected off coral reef in Sanya, Hainan Province, South China Sea of People’s Republic of China [119].

The structures of steroids 115–129 were elucidated by spectroscopic methods and by comparison of their spectroscopic data with those reported previously. However, the configuration of Me-28 at stereogenic center C-24 in steroids 116, 119, 124, and 129 were not determined in this study. Steroids 115, 116, and 120 belonging to 3-O-formylated cholesterol analogues and steroids 117–119 are unique ring A-contracted steroids [119].

Figure 21. Structures of (22E)-3-O-β-formylcholest-5,22-diene (115), (22E)-3-O-β-formyl-24-methylcholest-5,22-diene (116), 2-ethoxycarbonyl-2-β-hydroxy-A-nor-cholest-5-ene-4-one (117), (22E)-2-ethoxycarbonyl-2-β-hydroxy-A-nor-cholest-5,22-diene-4-one (118), (22E)-2-ethoxycarbonyl-2-β-hydroxy-24-methyl-A-nor-cholest-5,22-diene-4-one (119), 3-β-formylcholest-5-ene (120), 3β,7β-dihydroxycholest-5-ene (121), (22E)-3β,7α-dihydroxycholest-5,22-diene (122), 3β,7α-dihydroxy-24-methylenecholest-5-ene (123), 3β,7α-dihydroxy-24-methylcholest-5,22-diene (124), 3β,7α-dihydroxycholest-5-ene (125), cholest-4-ene-3-one (126), 24-methylenecholest-4-ene-3-one (127), (22E)-cholest-4,22-dien-3-one (128), and (22E)-24-methylcholest-4,22-dien-3-one (129).
A chemical examination of a soft coral identified as *Dendronephthya* sp., collected from the inner coral reef in Sanya Bay, Hainan Island of China, resulted in the isolation of 20 cembrane-type diterpenoids [120], including 15 new metabolites, dendronpholides C–F (130–133), I–R (134–143), and (−)-sandensolide (144) (an enantiomer of sandensolide) [120–124], along with five known compounds, 11-episinulariolide (145) [125–130], and sinulaflexiolides E, F, J, K (146–149) [128] (Figure 22). The structures of all isolates 130–149 were determined through spectroscopic methods and by comparison with those reported in literature [120]. Cembranoid dendronpholides C (130), J (135), and sinulaflexiolide E (146) showed cytotoxicity toward BGC-823 (human papillomavirus-related endocervical adenocarcinoma) cells with IC50 values of 0.05, 0.20, 0.02 µg/mL, respectively, whereas the other compounds were not active. A comparison of the cytotoxic data between 130 and 144 revealed that the methyl ester functionality plays a crucial role in the inhibition of BGC-823 cells compared to the ε-lactone functionality. This is the first report of cembrane-type diterpenoids from the soft corals belonging to the genus *Dendronephthya* [120].

![Figure 22. Structures of dendronpholides C–F (130–133), I–R (134–143), (−)-sandensolide (144), 11-episinulariolide (145) and sinulaflexiolides E, F, J, K (146–149).](image-url)
In 2010, two tetrahydroxylated sterols, including a new compound, 23-nor-ergost-24-ene-
3β,6α,9α,19β-tetrol (150) and a known analogue, ergost-24-ene-3β,6β,9α,19β-tetrol (151) [131],
were isolated from Dendronephthya sp. collected from Naozhou Islands of the South China Sea [132]
(Figure 23). The structures of sterols 150 and 151 were identified by spectroscopic methods [132].
Sterol 150 showed cytotoxicity toward the BEL-7402, MCG (human plasma cell myeloma), MCF,
LoVo (human colorectal adenocarcinoma), and Hep G2 (human hepatocellular carcinoma) cells with
IC₅₀ values of 32.2, 20.5, 2.0, 5.5, and 18.6 µg/mL, respectively, and sterol 151 was cytotoxic against
MCG and LoVo cells (IC₅₀ = 22.0, 13.8 µg/mL), respectively [132].

![Figure 23. Structures of 23-nor-ergost-24-ene-3β,6α,9α,19β-tetrol (150) and ergost-24-ene-3β,
6β,9α,19-tetrol (151).](image)

Three new ylangene-type sesquiterpenoids, dendronephthols A–C (152–154) (Figure 24),
together with two known steroids, dendronesterone A (10) [8] (Figure 3) and cholesterol (26) [30]
(Figure 5), were isolated from a Red Sea soft coral Dendronephthya sp., collected near the coast
of Hurghada, Egypt [133]. The structures of new sesquiterpenoids 152–154 were established by
spectroscopic methods and 152 and 154 were found to be cytotoxic against L5178Y (mouse lymphoma)
cells with ED₅₀ values of 8.4 and 6.8 µg/mL, respectively [133].

![Figure 24. Structures of dendronephthols A–C (152–154).](image)

Furthermore, two new steroids, dendronesterones D (155) and E (156), featuring with
1,4-dienone moiety, together with three known steroids, methyl 3-oxochola-4,22-dien-24-oate
(110) [105] (Figure 19), 5α,8α-epidioxy-24(S)-methylcholesta-6,22-dien-3β-ol (157), and 5α,8α-epidioxy-
24(S)-methylcholesta-6,9,22-trien-3β-ol (158) [36,134], were isolated from an octocoral Dendronephthya
sp., collected off the northeast coast of Taiwan [135] (Figure 25). The structures of new steroids
155 and 156 were elucidated by using spectroscopic methods and 155 was found to suppress the
expression of inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) to 24.2 and 70.4%
at a concentration of 10 µM [135].
Two new 2,5-piperazinedione derivatives, janthinolides A (159) and B (160), as well as a new natural product, deoxymycelianamide (161) [136,137], and two known metabolites, griseofulvin (162) [138–142], and dechlorogriseofulvin (163) [142–144], were isolated from the fermentation broths of the endophytic fungus *Penicillium janthinellum*, isolated from a soft coral identified as *Dendronephthya* sp., collected in the South China Sea [145]. The structures of metabolites 159–163 were determined by spectroscopic data analysis and compound 162 displayed inhibitory concentration at 2.75 and 20 µg/mL against the fungal pathogen *Alternaria solani* and ascomycetous pathogen *Pyricularia oryzae*, respectively [145] (Figure 26).

Moreover, seven isoechinulin-type alkaloids, neoechinulin A (164) [146–154], preechinulin (165) [155,156], isoechinulin A (166) [149,157], tardioxopiperazine A (167) [158], variecolorin L (168) [159], dihydroxyisoechinulin A (169) [160], and L-alanyl-L-tryptophan anhydride (170) [161] (Figure 27), were isolated from the fermentation broths of an endophytic fungus *Nigrospora oryzae* isolated from a soft coral identified as *Dendronephthya* sp. collected in the South China Sea [162]. The structures of 164–170 were determined by their spectroscopic data and by comparison with those reported in the literature. In the antifouling activity against the larval settlement of barnacle *Balanus amphitrite*, compound 166 showed activity with an IC$_{50}$ value of 5.92 µg/mL [162].
11. Conclusions

Ever since the seco-steroids, isogosterones A–D (1–4) were obtained from a specimen of the octocoral *Dendronephthya* collected off the Izu Peninsula, Japan [2], 170 interesting secondary metabolites, including 96 steroids (56.47%), 20 cembranes (11.76%), 11 sesquiterpenoids (6.47%), 11 amides (6.47%), 4 chlorolipids (2.35%), 4 bicyclic lactones (2.35%), 4 prostaglandins (2.35%), 4 bases (2.35%), 3 peptides (1.76%), 2 polyketides (1.18%), 2 ceramides (1.18%), 1 glycerol (0.59%), 1 glycyrrhetinic acid (0.59%), 1 benzoic acid (0.59%), 1 trigonelline (0.59%), 1 hexitol (0.59%), 1 pentanoic acid (0.59%), 1 octadecanone (0.59%), 1 aminoethyl ester (0.59%), and a 53-KD allergenic component (0.59%), were produced by *Dendronephthya* spp., and extensive biomedical activities, especially in cytotoxicity and anti-inflammatory activity, were related to these natural substances (Figure 28).

Figure 27. Structures of neoechinulin A (164), preechinulin (165), isoechinulin A (166), tardioxopiperazine A (167), variecolorin L (168), dihydroxyisoechinulin A (169), and L-alanyl-L-tryptophan anhydride (170).

Figure 28. Biomedical activities of natural products from *Dendronephthya* spp.

All the secondary metabolites from *Dendronephthya* spp., reported between 1999 and 2019 were obtained from the octocorals distributed in the Indo-Pacific Ocean and Red Sea. As more than 56% of the compounds obtained from the *Dendronephthya* genus are steroids, based on above findings, these results suggest that continued investigation of new steroid analogues with the potential bioactivities from this marine organism are worthwhile for further development. The octocoral *Dendronephthya* sp. had been transplanted to culturing tanks located in the National Museum of Marine
Biology and Aquarium, Taiwan, for the extraction of additional natural products to establish a stable supply of bioactive material.

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**References**

1. Dai, C.-F.; Chin, C.-H. Octocoral Fauna of Kenting National Park, 1st ed.; Kenting National Park Headquaters: Kenting Pingtung, Taiwan, 2019; pp. 54, 382–405.
2. Tomono, Y.; Hirota, H.; Fusetani, N. Isogosterones A–D, antifouling 13,17-seco steroids from an octocoral *Dendronephthya* sp. *J. Org. Chem.* 1999, 64, 2272–2275. [CrossRef]
3. Migliuolo, A.; Notaro, G.; Piccialli, V.; Sica, D. New tetrahydroxylated sterols from the marine sponge *Spongia officinalis*. *J. Nat. Prod.* 1990, 53, 1414–1424. [CrossRef]
4. Piccialli, V.; Sica, D. Four new trihydroxylated sterols from the sponge *Spongionella gracilis*. *J. Nat. Prod.* 1987, 50, 915–920. [CrossRef]
5. Cafieri, F.; Fattorusso, E.; Gavagnin, M.; Santacroce, C. 3β,5α,6β-Trihydroxysterols from the Mediterranean bryozoan *Myriapora truncata*. *J. Nat. Prod.* 1985, 48, 944–947. [CrossRef]
6. Yoshikawa, K.; Kanekuni, S.; Hanahusa, M.; Arihara, S.; Ohta, T. Polyhydroxylated sterols from the octocoral *Dendronephthya gigantea*. *J. Nat. Prod.* 2000, 63, 670–672. [CrossRef]
7. Seo, Y.; Jung, J.H.; Rho, J.-R.; Shin, J.; Song, J.-I. Isolation of novel bioactive steroids from the soft coral *Aclyonium gracilimum*. *Tetrahedron* 1995, 51, 2497–2506. [CrossRef]
8. Subrahmanyam, C.; Kulatheeswaran, R.; Venkateswara Rao, C. New spingosines from two soft corals of the Andaman & Nicobar Islands. *Indian J. Chem.* 1996, 35B, 578–580.
9. Muralidhar, P.; Kumar, M.M.; Krishna, N.; Rao, C.B.; Rao, D.V. New sphingolipids and a sterol from a *Lobophytum* species of the Indian Ocean. *Chem. Pharm. Bull.* 2005, 53, 168–171. [CrossRef] [PubMed]
10. Zhou, G.-X.; Huang, M.-Y.; Shi, J.-G. Ceramides and cerebrosides from *Bugula neritina*. *Chin. J. Mar. Drugs* 2005, 24, 37–40. [CrossRef]
11. Han, A.-R.; Song, J.-I.; Jang, D.S.; Min, H.-Y.; Lee, S.K.; Seo, E.-K. Cytotoxic constituents of the octocoral *Dendronephthya gigantea*. *Chem. Biodivers.* 2007, 4, 899–904. [CrossRef]
20. Han, W.-J.; Lu, X.-L.; Xu, Q.-Z.; Liu, X.-Y.; Jiao, B.-H. Isolation, identification and biological characterization of secondary metabolites produced by a marine Bacillus subtilis. *Acad. J. Second Mil. Med. Univ.* 2008, 29, 1234–1238. [CrossRef]

21. Wu, H.-H.; Tian, L.; Chen, G.; Xu, N.; Wang, Y.-N.; Sun, S.; Pei, Y.-H. Six compounds from marine fungus Y26-02. *J. Asian Nat. Prod. Res.* 2009, 11, 748–751. [CrossRef]

22. Gautschi, M.; Schmid, J.P.; Peppard, T.L.; Ryan, T.P.; Tuorto, R.M.; Yang, X. Chemical characterization of diketopiperazines in beer. *J. Agric. Food Chem.* 1997, 45, 3183–3189. [CrossRef]

23. Wright, A.D.; Papendorf, O.; König, G.M. Ambigol C and 2,4-dichlorobenzoic acid, natural products produced by the terrestrial cyanobacterium *Fischcherella ambigua*. *J. Nat. Prod.* 2005, 68, 459–461. [CrossRef] [PubMed]

24. Levene, P.A.; Tipson, R. Stuart. The ring structure of thymidine. *Science* 1935, 81, 98. [CrossRef] [PubMed]

25. Ericson, L.-E.; Widoff, E.; Bänhidi, Z.G. Studies of growth factors for *Streptococcus faecalis* occurring in marine algae. *Acta Chem. Scand.* 1953, 7, 974–979. [CrossRef]

26. Jones, A.J.; Grant, D.M.; Winkley, M.W.; Robins, R.K. Carbon-13 magnetic resonance. XVII. Pyrimidine and purine nucleosides. *J. Am. Chem. Soc.* 1970, 92, 4079–4087. [CrossRef] [PubMed]

27. Komori, T.; Sanechika, Y.; Ito, Y.; Matsuo, J.; Nohara, T.; Kawasaki, T. Biologically active glycosides from Asteroidae, I.-Structures of a new cerebroside mixture and of two nucleosides from the starfish *Acanthaster planci*. *Liebigs Ann. Chem.* 1980, 1980, 653–666. [CrossRef]

28. Deng, S.; Wu, J.; Li, F.; Peng, S.; Chen, J.; Liu, X.; Zhong, H. Studies on the activity constituent of sponge from South China Sea *Gellides spinosella* Thiele (I). *Guangzhou Chem.* 1993, 1, 37–41.

29. Xiao, D.; Deng, S.; Wu, H. A study on chemical constituents of the South China Sea marine sponge *Pachychalina* sp. *Nat. Prod. Res. Dev.* 1997, 9, 1–4.

30. Shao, Z.-Y.; Guo, Y.-W.; Yu, J.-L.; Zhu, D.-Y. Studied on chemical constitution of *Dysidea* sp. from *South China Sea*. *Nat. Prod. Res. Dev.* 2004, 16, 19–22.

31. Wang, B.; Dong, J.; Zhou, X.; Lee, K.J.; Huang, R.; Zhang, S.; Liu, Y. Nucleosides from the marine sponge *Haliclona* sp. *Z. Naturforsch.* C 2009, 64, 143–148. [CrossRef]

32. Huang, R.-M.; Chen, Y.-N.; Zeng, Z.; Gao, C.-H.; Su, X.; Peng, Y. Marine nucleosides: Structure, bioactivity, synthesis and biosynthesis. *Mar. Drugs* 2014, 12, 5817–5838. [CrossRef]

33. Huang, R.; Zhou, X.; Peng, Y.; Yang, X.; Xu, T.; Liu, Y. Nucleosides from the marine sponge *Callyspongia* sp. *Chem. Nat. Comp.* 2011, 46, 1010–1014. [CrossRef]

34. Wang, Y.-L.; Liao, X.-J.; Xu, S.-H. Study on chemical constituents of soft coral *Dendronephthya gigantea* from the South China Sea. *Chem. Nat. Comp.* 2009, 46, 3860–3866. [CrossRef]

35. Mellado, G.G.; Zubía, E.; Ortega, M.J.; López-González, P.J. Steroids from the Antarctic octocoral *Anthomastus bathyphterus*. *J. Nat. Prod.* 2005, 68, 1111–1115. [CrossRef] [PubMed]

36. Gunati, A.A.; Gopichand, Y.; Schmitz, F.J.; Djerassi, C. Minor and trace sterols in marine invertebrates. 26. Isolation and structure elucidation of nine new 5α,8α-epidioxy sterols from four marine organisms. *J. Org. Chem.* 1981, 46, 3860–3866. [CrossRef]

37. Swell, L.; Gustafsson, J.; Schwartz, C.C.; Halloran, L.G.; Danielsson, H.; Vlahcevic, Z.R. An in vivo evaluation of the quantitative significance of several potential pathways to cholic and chenodeoxycholic acids from cholesterol in man. *J. Lipid Res.* 1980, 21, 455–466.

38. Shin, K.; Chin, J.; Hahn, D.; Lee, J.; Hwang, H.; Won, D.H.; Ham, J.; Choi, H.; Kang, E.; Kim, H.; et al. Sterols from a soft coral, *Dendronephthya gigantea* as farnesoid X-activated receptor antagonists. *Steroids* 2012, 77, 355–359. [CrossRef]

39. Smith, A.G.; Goad, L.J. Sterol biosynthesis by the sea urchin *Echinus esculentus*. *Biochem. J.* 1974, 142, 421–427. [CrossRef]

40. Idler, D.R.; Wiseman, P. Identification of 22-cis-cholesta-5,22-dien-3β-ol and other scallop sterols by gas-liquid chromatography and mass spectrometry. *Comp. Biochem. Physiol.* 1971, 38A, 581–590. [CrossRef]

41. Byju, K.; Anuradha, V.; Vasundhara, G.; Nair, S.M.; Kumar, N.C. In vitro and in silico studies on the anticancer and apoptosis-inducing activities of the sterols identified from the soft coral, *Subergorgia reticulata*. *Pharmacogn. Mag.* 2014, 10, S65–S71.

42. Heilbron, I.M.; Phipers, R.F.; Wright, H.R. Chemistry of the brown algae. *Nature* 1934, 133, 419. [CrossRef]

43. Heilbron, I.; Phipers, R.F.; Wright, H.R. The chemistry of the the algae. Part I. The algae sterol fucosterol. *J. Chem. Soc.* 1934, 1572–1576. [CrossRef]
44. Nes, W.R.; Castle, M.; McClanahan, J.L.; Settine, J.M. Confirmation of the structure of fucosterol by nuclear magnetic resonance spectroscopy (1). *Steroids* **1966**, *8*, 655–657. [CrossRef]

45. Patterson, G.W. The distribution of sterols in algae. *Lipids* **1971**, *6*, 120–127. [CrossRef]

46. Sheu, J.-H.; Sung, P.-J. Isolation of 24-hydroperoxy-24-vinylcholesterol and fucosterol from the brown alga *Turbinaria conoides*. *J. Chin. Chem. Soc.* **1991**, *38*, 501–503. [CrossRef]

47. Sheu, J.-H.; Wang, G.-H.; Sung, P.-J.; Chiu, Y.-H.; Duh, C.-Y. Cytotoxic sterols from the Formosan brown alga *Turbinaria ornata*. *Planta Med.* **1997**, *63*, 571–572. [CrossRef]

48. Ribeiro, S.M.; Cassiano, K.M.; Cavalcanti, D.N.; Teixeira, V.L.; Pereira, R.C. Isolated and synergistic effects of chemical and structural defenses of two species of *Tethya* (Porifera: Demospongiae). *J. Sea Res.* **2012**, *68*, 57–62. [CrossRef]

49. Padhan, S.K.; Mishra, P.M.; Baliarsingh, S.; Sree, A.; Panigrahi, M. Fatty acid profile and sterol composition of the marine sponge *Petrosia testudinaria*. *Chem. Nat. Comp.* **2015**, *51*, 323–325. [CrossRef]

50. Shanura Fernando, I.P.; Asanka Sanjeewa, K.K.; Kim, H.-S.; Kim, S.-Y.; Lee, S.-H.; Lee, W.W.; Jeon, Y.-J. Identification of sterols from the soft coral *Dendronephthya gigantea* and their anti-inflammatory potential. *Environ. Toxicol. Pharmacol.* **2017**, *55*, 37–43. [CrossRef]

51. Shanura Fernando, I.P.; Asanka Sanjeewa, K.K.; Kim, H.-S.; Wang, L.; Lee, W.W.; Jeon, Y.-J. Apoptotic and antiproliferative properties of 3β-hydroxy-Δ5-steroidal congeners from a partially purified column fraction of *Dendronephthya gigantea* against HL-60 and MCF-7 cancer cells. *J. Appl. Toxicol.* **2018**, *38*, 527–536. [CrossRef]

52. Shanura Fernando, I.P.; Asanka Sanjeewa, K.K.; Ann, Y.-S.; Ko, C.-I.; Lee, S.-H.; Lee, W.W.; Jeon, Y.-J. Apoptotic and antiproliferative properties of stigmast-5-en-3-ol from *Dendronephthya gigantea* against HL-60 and human breast cancer MCF-7 cells. *Toxicol. in Vitro* **2018**, *52*, 297–305. [CrossRef] [PubMed]

53. Findlay, J.A.; Patil, A.D. Novel sterols from the finger sponge *Litophyton virids*. *Can. J. Chem.* **1985**, *63*, 2406–2410. [CrossRef]

54. Ighchi, K.; Saitoh, S.; Yamada, Y. Novel 19-oxygenated steroids from the Okinawan soft coral *Litophyton viridis*. *Chem. Pharm. Bull.* **1989**, *37*, 2535–2534. [CrossRef]

55. Bortolotto, M.; Braekman, J.C.; Daloze, D.; Losman, D.; Tursch, B. Chemical studies of marine invertebrates. XXIII. A novel polyhydroxylated sterol from the soft coral *Litophyton viridis* (Coelenterata, Octocorallia, Alcyonacea). *Steroids* **1976**, *28*, 461–466. [CrossRef]

56. El-Gamal, A.A.H.; Wang, S.-K.; Dai, C.-F.; Duh, C.-Y. New nardosinanes and 19-oxygenated ergosteroids from the soft coral *Nephthea armata* collected in Taiwan. *J. Nat. Prod.* **2004**, *67*, 1455–1458. [CrossRef]

57. Youssif, D.T.A.; Singab, A.N.B.; van Soest, R.W.M.; Fusetani, N. Hyrtiosenolides A and B, two new sesquiterpenes γ-methoxybutenolides and a new sterol from a Red Sea sponge *Hyrtios* species. *J. Nat. Prod.* **2004**, *67*, 1736–1739. [CrossRef]

58. Jia, R.; Guo, Y.-W.; Mollo, E.; Gavagnin, M.; Cimino, G. Two new polyhydroxylated steroids from the Hainan soft coral *Simularia sp*. *Helv. Chim. Acta* **2006**, *89*, 1330–1336. [CrossRef]

59. Cheng, S.-Y.; Dai, C.-F.; Duh, C.-Y. New 4-methylated and 19-oxygenated steroids from the Formosan soft coral *Nephthea erecta*. *Steroids* **2007**, *72*, 653–659. [CrossRef]

60. Wu, J.; Xi, Y.; Huang, L.; Li, G.; Mao, Q.; Fang, C.; Shan, T.; Jiang, W.; Zhao, M.; He, W.; et al. A steroid-type antioxidant targeting the Keap1/Nrf2/ARE signaling pathway from the soft coral *Dendronephthya gigantea*. *J. Nat. Prod.* **2018**, *81*, 2567–2575. [CrossRef]

61. Chao, C.-H.; Wen, Z.-H.; Chen, I.-M.; Su, J.-H.; Huang, H.-C.; Chiang, M.Y.; Sheu, J.-H. Anti-inflammatory steroids from the octocoral *Dendronephthya griffini*. *Tetrahedron* **2008**, *64*, 3554–3560. [CrossRef]

62. Chao, C.-H.; Wen, Z.-H.; Su, J.-H.; Chen, I.-M.; Huang, H.-C.; Dai, C.-F.; Sheu, J.-H. Further study on anti-inflammatory oxygenated steroids from the octocoral *Dendronephthya griffini*. *Steroids* **2008**, *73*, 1353–1358. [CrossRef] [PubMed]

63. Ciminiello, P.; Fattorusso, E.; Forino, M.; Di Rosa, M.; Ianaro, A.; Poletti, R. Structural elucidation of a new cytotoxin isolated from mussels of the Adriatic Sea. *J. Org. Chem.* **2001**, *66*, 578–582. [CrossRef] [PubMed]

64. Nilewski, C.; Geisser, R.W.; Carreira, E.M. Total synthesis of a chlorosulpholipid cytotoxin associated with seafood poisoning. *Nature* **2009**, *457*, 573–577. [CrossRef] [PubMed]

65. Chao, C.-H.; Huang, H.-C.; Wang, G.-H.; Wen, Z.-H.; Wang, W.-H.; Chen, I.-M.; Sheu, J.-H. Chlorosulfolipids and the corresponding alcohols from the octocoral *Dendronephthya griffini*. *Chem. Pharm. Bull.* **2010**, *58*, 944–946. [CrossRef]
66. Shaaban, M.; Shaaban, K.A.; Abd-Alla, H.I.; Hanna, A.G.; Laatsch, H. Dendrophen, a novel glycyrrehyl amnon acid from Dendronephthya hemprichii. Z. Naturforsch. 2011, 66b, 425-432. [CrossRef]
67. Schow, S.R.; McMorris, T.C. Synthesis of 5α-pregna-1,20-dien-3-one. Steroids 1977, 30, 389-392. [CrossRef]
68. Lorenzo, M.; Cueto, M.; D’Croz, L.; Maté, J.L.; San-Martin, A.; Darias, J. Muriceanol, a 24-epoxide sterol link in the carbon flux toward side-chain dealkylation of sterols. Eur. J. Org. Chem. 2006, 2006, 582-585. [CrossRef]
69. Ioannou, E.; Abdel-Razik, A.F.; Alexi, X.; Vagias, C.; Alexis, M.N.; Roussis, V. Pregnanes with antiproliferative activity from the gorgonian Eunicella carolini. Tetrahedron 2008, 64, 11797–11801. [CrossRef]
70. Higgs, M.D.; Faulkner, D.J. 5α-Pregna-1,20-dien-3-one and related compounds from a soft coral. Steroids 1977, 30, 379–388. [CrossRef]
71. Kingston, J.F.; Gregory, B.; Fallis, A.G. Pregna-1,4,20-triene-3-one, a novel marine steroid from the sea sponge Gersemia rubiformis. Tetrahedron Lett. 1977, 18, 4261–4264. [CrossRef]
72. Kingston, J.F.; Gregory, B.; Fallis, A.G. Marine natural products. Novel Cα α-pregna-1,20-dien-3-one. J. Chem. Soc. Perkin Trans. 1 1979, 2064–2068. [CrossRef]
73. Ciavatta, M.L.; Lopez Gresa, M.P.; Manzo, E.; Gavagnin, M.; Wahidulla, S.; Cimino, G. New Cα α-pregna-1,20-dien-3-one, inhibitors of mitochondrial respiratory chain, from Indopacific octocoral Carijoa sp. Tetrahedron Lett. 2004, 45, 7745–7748. [CrossRef]
74. Yan, X.-H.; Jia, R.; Shen, X.; Guo, Y.-W. A new dolabellane diterpenoid from the Hainan soft coral Sponges sp. Nat. Prod. Res. 2007, 21, 897–902. [PubMed]
75. Nam, N.H.; Huong, N.T.; Hanh, T.T.H.; Thanh, N.V.; Cuong, N.X.; Thung, D.C.; Kiem, P.V.; Minh, C.V. Pregnane steroids from the Vietnamese octocoral Carijoa riisei. Nat. Prod. Res. 2017, 31, 2435–2440. [CrossRef]
76. Nussim, M.; Mazur, Y.; Sondheimer, F. The hydration of unsaturated steroids by the Brown Hydroboration reaction. I. Monounsaturated steroids. J. Org. Chem. 1964, 29, 1120–1131. [CrossRef]
77. Wahidulla, S.; D’Souza, L.; Patel, J. 5α-Cholesterol-3,6-dione from the red alga Acantophora spicifera. Phytochemistry 1987, 26, 2864–2865. [CrossRef]
78. Wijnberg, J.B.P.A.; de Groot, A. Synthesis and 13C-NMR analysis of 5α- and 5β-cholestan-3,6-dione. Steroids 1989, 54, 333–344. [CrossRef]
79. Gosavi, K.; Moses Babu, J.; Mathur, H.H.; Bhdhbdh, M. Isolation and X-ray structure of a new 3,6-diketo steroid from red alga Hypnea musciformis. Chem. Lett. 1995, 24, 519–520. [CrossRef]
80. Ngoc, N.T.; Hanh, T.T.H.; Cuong, N.X.; Nam, N.H.; Thung, D.C.; Ivanchina, N.V.; Dang, N.H.; Kicha, A.A.; Kiem, P.V.; Minh, C.V. Steroids from Dendronephthya mucronata and their inhibitory effects on lipopolysaccharide-induced NO formation in RAW264.7 cells. Chem. Nat. Comp. 2019, 55, 1090–1093. [CrossRef]
81. Zhang, J.; Liang, Y.; Li, L.-C.; Xu, S.-H. Suberosanones A–C, new metabolites possessing cyclopentenone system from the South China Sea gorgonian coral Subergorgia suberosa. Helv. Chim. Acta 2014, 97, 128–136. [CrossRef]
82. Ngoc, N.T.; Hanh, T.T.H.; Nguyen, H.D.; Quang, T.H.; Cuong, N.X.; Nam, N.H.; Thung, D.C.; Ngai, N.D.; Kiem, P.V.; Minh, C.V. Bicyclic lactones from the octocoral Dendronephthya mucronata. Nat. Prod. Res. 2019, 1–5. [CrossRef] [PubMed]
83. Onizuka, R.; Kamiya, H.; Muramoto, K.; Goto, R.; Inoue, K.; Kumamoto, K.; Nakajima, Y.; Iida, S.; Ishigami, F. Purification of the major allergen of red soft coral (Dendronephthya nipponica). Int. Arch. Allergy Immunol. 2001, 125, 135–143. [CrossRef] [PubMed]
84. Wilson, W.K.; Sumpter, R.M.; Warren, J.J.; Rogers, P.S.; Ruan, B.; Schroepfer, G.J., Jr. Analysis of unsaturated C27 sterols by nuclear magnetic resonance spectroscopy. J. Lipid Res. 1996, 37, 1529–1555. [PubMed]
85. Fernando, I.P.S.; Lee, W.W.; Jayawardena, T.U.; Kang, M.-C.; Ann, Y.-S.; Ko, C.-I.; Park, Y.J.; Jeon, Y.-J. 3β-Hydroxy-Δ5-steroidal congeners from a column fraction of Dendronephthya puetteri attenuate LPS-induced inflammatory responses in RAW 264.7 macrophages and zebrafish embryo model. RSC Adv. 2018, 8, 18626–18634. [CrossRef]
86. Kim, E.-A.; Ding, Y.; Yang, H.-W.; Heo, S.-J.; Lee, S.-H. Soft coral Dendronephthya puetteri extract ameliorates inflammations by suppressing inflammatory mediators and oxidative stress in LPS-stimulated zebrafish. Int. J. Mol. Sci. 2018, 19, 2695. [CrossRef]
87. Jayawardena, T.U.; Lee, W.W.; Fernando, I.P.S.; Sanjeeewa, K.K.A.; Wang, L.; Lee, T.-G.; Park, Y.J.; Ko, C.-I.; Jeon, Y.-J. Antiproliferative and apoptosis-inducing potential of 3β-hydroxy-Δ5-steroidal congeners purified from the soft coral Dendronephthya puetteri. J. Oceanol. Limnol. 2019, 37, 1382–1392. [CrossRef]
88. Sheikh, Y.M.; Singy, G.; Kaisin, M.; Eggert, H.; Djerassi, C.; Tursch, B.; Dalozé, D.; Braekman, J.C. Chemical studies of marine invertebrates–XIV. Four representatives of a novel sesquiterpene class–the capnellane skeleton. *Tetrahedron* 1976, 32, 1171–1178. [CrossRef]
89. Morris, L.A.; Jaspars, M.; Adamson, K.; Woods, S.; Wallace, H.M. The capnellenes revisited: New structures and new biological activity. *Tetrahedron* 1998, 54, 12953–12958. [CrossRef]
90. Kaisin, M.; Braekman, J.C.; Dalozé, D.; Tursch, B. Novel acetoxycapnellenes from the alcyonacean *Capnella imbricata*. *Tetrahedron* 1985, 41, 1067–1072. [CrossRef]
91. Grote, D.; Hänel, F.; Dahse, H.-M.; Seifert, K. Capnellenes from the soft coral *Dendronephthya rubeola*. *Chem. Biodivers.* 2007, 4, 1683–1693. [CrossRef]
92. Yan, X.-H.; Lin, L.-P.; Ding, J.; Guo, Y.-W. Methyl spongoate, a cytotoxic steroid from the Sanya soft coral *Sponges sp.* *Bioorg. Med. Chem. Lett.* 2007, 17, 2661–2663. [CrossRef] [PubMed]
93. Suginome, H.; Senboku, H.; Yamada, S. A new aromatization of ring-A of steroids. Synthesis of estrone. *Tetrahedron Lett.* 1988, 20, 79–80. [CrossRef]
94. Koˇ covský, P.; Baines, R.S. Stereoelectronically controlled, thallium(III)-mediated C-19 degradation of 19-hydroxy steroids. An expedient route to estrone and its congeners via 19-nor-10β-hydroxy intermediates. *J. Org. Chem.* 1994, 59, 5439–5444. [CrossRef]
95. Yan, X.-H.; Liu, H.-L.; Huang, H.; Li, X.-B.; Guo, Y.-W. Steroids with aromatic A-rings from the Hainan soft coral *Dendronephthya studeri*. *J. Nat. Prod.* 2011, 74, 175–180. [CrossRef] [PubMed]
96. Katrich, E.M.; Isaí, S.V.; Mishchenko, T.Y. Phospholipid composition of prostaglandin extracts of some marine invertebrates with different degrees of prostaglandin-like activity. *Chem. Nat. Comp.* 1990, 26, 264–267. [CrossRef]
97. Mizobuchi, S.; Shimizu, N.; Katsuoka, M.; Adachi, K.; Miki, W. Antifouling substances against the mussel in an octocoral *Dendronephthya sp.* *Nippon Suisan Gakk.* 1993, 59, 1195–1199. [CrossRef]
98. Matsumoto, T.; Shimizu, N.; Shigemoto, T.; Itoh, T.; Iida, T.; Nishioka, A. Isolation of 22-dehydro-campesterol from the seeds of *Brassica juncea*. *Phytochemistry* 1988, 23, 789–790. [CrossRef]
99. Weldon, P.J.; Flachsbartb, B.; Schulz, S. Natural products from the integument of nonavian reptiles. *Nat. Prod. Rep.* 2008, 25, 738–756. [CrossRef]
100. Dzeha, T.; Jaspars, M.; Tabudravu, J. Clionasterol, a triterpenoid from the Kenyan marine green macroalga *Halimeda macroloba*. *West. Indian Ocean J. Mar. Sci.* 2003, 2, 157–161.
101. Gallo, C.; Landi, S.; d’Ippolito, G.; Nuzzo, G.; Manzo, E.; Fontana, A. Diatoms synthesize sterols by inclusion of animal and fungal genes in the plant pathway. *Sci. Rep.* 2020, 10, 4204. [CrossRef]
102. Kawamata, M.; Kon-ya, K.; Miki, W. Trigonelline, an antifouling substance isolated from an octocoral *Dendronephthya rubeola*. *J. Org. Chem.* 1994, 60, 485–486. [CrossRef]
103. Miki, W.; Kon-ya, K.; Mizobuchi, S. Biofouling and marine biotechnology: New antifoulants from marine invertebrates. *J. Mar. Biotechnol.* 1996, 4, 117–120.
104. Wilsanand, V.; Wagh, A.B.; Bapuji, M. Antifouling activities of marine sedentary invertebrates on some macrofoulers. *Indian J. Mar. Sci.* 1999, 28, 280–284.
105. Tomono, Y.; Hirota, H.; Imahara, Y.; Fusetani, N. Four new steroids from two octocorals. *J. Nat. Prod.* 1999, 62, 1538–1541. [CrossRef] [PubMed]
106. Řezanka, T.; Dembitsky, V.M. Brominated oxylipins and oxylipin glycosides from Red Sea corals. *Eur. J. Org. Chem.* 2003, 309–316. [CrossRef]
107. Kang, B.K.; Chung, M.J.; Park, Y.J. The crystal and molecular structure of cholesteryl formate. *Bull. Korean Chem. Soc.* 1985, 6, 333–337.
108. Teng, J.I.; Kulig, M.J.; Smith, L.L.; Kan, G.; van Lier, J.E. Sterol metabolism. XX. Cholesterol 7β-hydroperoxide. *J. Org. Chem.* 1973, 38, 119–123. [CrossRef]
109. de Riccardis, F.; Minale, L.; Iorizzi, M.; Debitus, C.; Lévi, C. Marine sterols. Side-chain-oxygenated sterols, possibly of abiotic origin, from the New Caledonian sponge *Stelodoryx chlorophylla*. *J. Nat. Prod.* 1993, 56, 282–287. [CrossRef]
110. Notaro, G.; Picciali, V.; Sica, D. New steroidal hydroxyketones and closely related diols from the marine sponge *Cliona copiosa*. *J. Nat. Prod.* 1992, 55, 1588–1594. [CrossRef]
111. Shoppee, C.W.; Newman, B.C. Steroids. Part XXX. Some properties of the cholest-5-ene-3β,7ξ-diols and their esters. *J. Chem. Soc. (C)* 1968, 8, 981–983. [CrossRef]
112. Kumar, V.; Amann, A.; Ourisson, G.; Luu, B. Stereospecific syntheses of 7β- and 7α-hydroxycholesterols. Synth. Commun. 1987, 17, 1279–1286. [CrossRef]

113. Rizvi, S.Q.A.; Williams, J.R. Synthesis and carbon-13 nuclear magnetic resonance studies of Δ5 and saturated 4,4-disubstituted 3-ketosteroids. J. Org. Chem. 1981, 46, 1127–1132. [CrossRef]

114. Parish, E.J.; Honda, H.; Chitrakorn, S.; Livant, P. A facile chemical synthesis of cholest-4-en-3-one. Carbon-13 nuclear magnetic resonance spectral properties of cholest-4-en-3-one and cholest-5-en-3-one. Lipids 1991, 26, 675–677. [CrossRef]

115. Wu, K.; Li, W.; Song, J.; Li, T. Production, purification, and identification of cholest-4-en-3-one produced by cholesterol oxidase from Rhodococcus sp. in aqueous/organic biphasic system. Biochem. Insights 2015, 8(1), 1–8.

116. Sheikh, Y.M.; Djerassi, C. Steroids from sponges. Tetrahedron 1974, 30, 4095–4103. [CrossRef]

117. Guella, G.; Mancini, I.; Pietra, F. Isolation of ergosta-4,24-dien-3-one from both Astrophorida demosponges and Subantarctic hexactinellides. Comp. Biochem. Physiol. 1988, 90B, 113–115. [CrossRef]

118. Wright, J.L.C.; McInnes, A.G.; Shimizu, S.; Smith, D.G.; Walter, J.A.; Idler, D.; Khalil, W. Identification of C-24 alkyl epimers of marine sterols by 13C nuclear magnetic resonance spectroscopy. Can. J. Chem. 1978, 56, 1898–1903.

119. Li, G.; Deng, Z.; Guan, H.; van Ofwegen, L.; Proksch, P.; Lin, W. Steroids from the soft coral Dendronephthya sp. Steroids 2005, 70, 13–18. [CrossRef]

120. Ma, A.; Deng, Z.; van Ofwegen, L.; Bayer, M.; Proksch, P.; Lin, W. Dendropholinides A–R, cembranoid diterpenoids from the Chinese soft coral Dendronephthya sp. J. Nat. Prod. 2008, 71, 1152–1160, (Correction in J. Nat. Prod. 2010, 73, 1026). [CrossRef]

121. Anjaneyulu, A.S.R.; Rao, G.V.; Sagar, K.S.; Kumar, K.R.; Mohan, K.C. Sandensolide: A new dihydroxyccembranolide from the soft coral, Sinularia sandensis Verseveldt of the Indian Ocean. Nat. Prod. Lett. 1995, 7, 183–190. [CrossRef]

122. Anjaneyulu, A.S.R.; Sagar, K.S.; Rao, G.V. New cembranoid lactones from the Indian Ocean soft coral Sinularia flexibilis. J. Nat. Prod. 1997, 60, 9–12. [CrossRef]

123. Hu, L.-C.; Su, J.-H.; Chiang, M.Y.-N.; Lu, M.-C.; Hwang, T.-L.; Chen, Y.-H.; Hu, W.-P.; Lin, N.-C.; Wang, W.-H.; Fang, L.-S.; et al. Flexibilins A–C, new cembre-type diterpenoids from the Formosan soft coral, Sinularia flexibilis. Mar. Drugs 2013, 11, 1999–2012. [CrossRef]

124. Chen, C.-T.; Kao, C.L.; Li, H.-T.; Chen, C.-Y. Chemical constituents of cultured soft coral Sinularia flexibilis. Chem. Nat. Comp. 2018, 54, 168–169. [CrossRef]

125. Tursch, B.; Braekman, J.C.; Daloze, D.; Herin, M.; Karlsson, R.; Losman, D. Chemical studies of marine invertebrates–XI. Sinulariolide, a new cembranolide diterpene from the soft coral, Sinularia flexibilis. Tetrahedron 1975, 31, 129–133. [CrossRef]

126. Kazlauskas, R.; Murphy, P.T.; Wells, R.J.; Schönholzer, P.; Coll, J.C. Cembranoid constituents from an Australian collection of the soft coral Sinularia flexibilis. Aust. J. Chem. 1978, 31, 1817–1824. [CrossRef]

127. Morì, K.; Suzuki, S.; Iguchi, K.; Yamada, Y. 8,11-Epoxy bridged cembranolide diterpenoid from the soft coral Sinularia flexibilis. Chem. Lett. 1983, 12, 1515–1516. [CrossRef]

128. Wen, T.; Ding, Y.; Deng, Z.; van Ofwegen, L.; Proksch, P.; Lin, W. Sinulaflexiolides A–K, cembre-type diterpenoids from the Chinese soft coral Sinularia flexibilis. J. Nat. Prod. 2008, 71, 1133–1144. [CrossRef]

129. Michalek, K.; Bowden, B.F. A natural algaicid from soft coral Sinularia flexibilis (Coelenterata, Octocorallia, Alcyonacea). J. Chem. Ecol. 1997, 23, 259–273. [CrossRef]

130. Lo, K.-L.; Khalil, A.T.; Kuo, Y.-H.; Shen, Y.-C. Sinuladiterpenes A–F, new cembrane diterpenes from Sinularia flexibilis. Chem. Biodivers. 2009, 6, 2227–2235. [CrossRef]

131. Xu, S.H.; Zeng, L.M. The identification of two new sterols from marine organism. Chin. Chem. Lett. 2000, 11, 531–534.

132. Liao, X.; Xu, S.; Lin, H. Isolation and identification of two tetrahydroxylated sterols with cytotoxic activity. Chin. J. Org. Chem. 2010, 30, 749–752.

133. Elkhayat, E.S.; Ibrahim, S.R.M.; Fouad, M.A.; Mohamed, G.A. Dendronephtholides A–C, new sesquiterpenoids from the Red Sea soft coral Dendronephthya sp. Tetrahedron 2014, 70, 3822–3825. [CrossRef]

134. Ioannou, E.; Abdel-Razik, A.F.; Zervou, M.; Christofidis, D.; Alexi, X.; Vagias, C.; Alexis, M.N.; Roussis, V. 5α,8α-Epidoxy steroids from the gorgonian Eunicella cavolini and the ascidian Trididemnum inarnatum: Isolation and evaluation of their antiproliferative activity. Steroids 2009, 74, 73–80. [CrossRef]
135. Huynh, T.-H.; Chen, P.-C.; Yang, S.-N.; Lin, F.-Y.; Su, T.-P.; Chen, L.-Y.; Peng, B.-R.; Hu, C.-C.; Chen, Y.-Y.; Wen, Z.-H.; et al. New 1,4-dienosteroids from the octocoral Dendronephthya sp. *Mar. Drugs* 2019, 17, 530. [CrossRef]

136. Gallina, C.; Remo, A.; Tortorella, V.; D’Agnolo, G. Racemic deoxymycelianamide. *Chem. Ind.* 1966, 30, 1300–1301.

137. Gallina, C.; Remo, A.; Tortorella, V.; D’Agnolo, G. Synthesis of racemic deoxymycelianamide. *Ann. Chim.* 1968, 58, 280–285.

138. Birch, A.; Donovan, F.W. Studies in relation to biosynthesis. I. Some possible routes to derivatives of orcinol and phloroglucinol. *Aust. J. Chem.* 1953, 6, 360–368. [CrossRef]

139. Birch, A.J.; Massy-Westropp, R.A.; Rickards, R.W.; Smith, H. Studies in relation to biosynthesis. Part XIII. Griseofulvin. *J. Chem. Soc.* 1958, 360–365. [CrossRef]

140. Tanabe, M.; Detre, G. The use of 13C-labeled acetate in biosynthetic studies. *J. Am. Chem. Soc.* 1966, 88, 4515–4517. [CrossRef]

141. Harris, C.M.; Roberson, J.S.; Harris, T.M. Biosynthesis of griseofulvin. *J. Am. Chem. Soc.* 1976, 98, 5380–5386. [CrossRef]

142. Cole, R.J.; Kirksey, J.W.; Holaday, C.E. Detection of griseofulvin and dechlorogriseofulvin by thin-layer chromatography and gas-liquid chromatography. *Appl. Microbiol.* 1970, 19, 106–108. [CrossRef]

143. Jarvis, B.B.; Zhou, Y.; Jiang, J.; Wang, S.; Sorenson, W.G.; Hintikka, E.-L.; Nikulin, M.; Parikka, P.; Etzel, R.A.; Dearborn, D.G. Toxigenic molds in water-damaged buildings: Dechlorogriseofulvens from *Memnoniella echinata*. *J. Nat. Prod.* 1996, 59, 553–554. [CrossRef]

144. MacMillan, J. Griseofulvin. Part VII. Dechlorogriseofulvin. *J. Chem. Soc.* 1953, 1697–1702. [CrossRef]

145. Xue, C.; Li, T.; Deng, Z.; Fu, H.; Lin, W. Janthinolide A-B, two new 2,5-piperazinedione derivatives from the endophytic *Penicillium janthinellum* isolated from the soft coral *Dendronephthya* sp. *Pharmazie* 2006, 61, 1041–1044. [CrossRef]

146. Itokawa, H.; Akita, Y.; Yamazaki, M. The indole derivatives isolated from the oil cakes of *Camellia* seeds. On the relation to the components of the fungus infecting the oil cakes. *Yakugaku Zasshi* 1973, 93, 1251–1252. [CrossRef]

147. Casnati, G.; Pochini, P.; Ungaro, R. Neoechinulin: A new isoprenyl-indole metabolite from *Aspergillus amstelodami*. *Gazz. Chim. Ital.* 1973, 103, 141–151.

148. Dossena, A.; Marchelli, R.; Pochini, A. New metabolites of *Aspergillus amstelodami* related to the biogenesis of neoechinulin. *J. Chem. Soc. Chem. Comm.* 1974, 771–772. [CrossRef]

149. Nagasawa, H.; Isogai, A.; Ikeda, K.; Sato, S.; Murakoshi, S.; Suzuki, A.; Tamura, S. Isolation and structure elucidation of a new indole metabolite from *Aspergillus ruber*. *Agric. Biol. Chem.* 1975, 39, 1901–1902. [CrossRef]

150. Cardillo, R.; Fuganti, C.; Ghiringhelli, D.; Grasselli, P.; Gatti, G. Stereochemical course of the α,β-desaturation of L-tryptophan in the biosynthesis of cryptoechinuline A in *Aspergillus amstelodami*. *J. Chem. Soc. Chem. Comm.* 1975, 778–779. [CrossRef]

151. Marchelli, R.; Dossena, A.; Casnati, G. Biosynthesis of neoechinulin by *Aspergillus amstelodami* from cyclo-L-[U-14C]alanyl-L-[5,7,3-H2]-tryptophyl. *J. Chem. Soc. Chem. Comm.* 1975, 779–780. [CrossRef]

152. Marchelli, R.; Dossena, A.; Pochini, A.; Dradi, E. The structures of five new dihydrodropireptides related to neoechinulin, isolated from *Aspergillus amstelodami*. *J. Chem. Soc. Perkin Trans. I* 1977, 713–717. [CrossRef]

153. Yagi, R.; Doi, M. Isolation of an antioxidative substance produced by *Aspergillus repens*. *Biosci. Biotechnol. Biochem.* 1999, 63, 932–933. [CrossRef]

154. Li, Y.; Li, X.; Kim, S.-K.; Kang, J.S.; Choi, H.D.; Rho, J.R.; Son, B.W. Golmaenone, a new diketopiperazine alkaloid from the marine-derived fungus *Aspergillus* sp. *Chem. Pharm. Bull.* 2004, 52, 375–376. [CrossRef]

155. Stipanovic, R.D.; Schroeder, H.W. Preechinulin, a metabolite of *Aspergillus chevalieri*. *Trans. Br. Mycol. Soc.* 1976, 66, 178–179. [CrossRef]

156. Hamasaki, T.; Nagayama, K.; Hatsuda, Y. Structure of a new metabolite from *Aspergillus chevalieri*. *Agric. Biol. Chem.* 1976, 40, 203–205. [CrossRef]

157. Nagasawa, H.; Isogai, A.; Suzuki, A.; Tamura, S. Structures of isoechinulins A, B and C, new indole metabolites from *Aspergillus ruber*. *Tetrahedron Lett.* 1976, 17, 1601–1604. [CrossRef]

158. Fujimoto, H.; Fujimaki, T.; Okuyama, E.; Yamazaki, M. Immunomodulatory constituents from an Ascomycete, *Microascus tardifaciens*. *Chem. Pharm. Bull.* 1999, 47, 1426–1432. [CrossRef]

159. Wang, W.-L.; Lu, Z.-Y.; Tao, H.-W.; Zhu, T.-J.; Fang, Y.-C.; Gu, Q.-Q.; Zhu, W.-M. Isoechinulin-type alkaloids, variecolorins A–L, from halotolerant *Aspergillus variecolor*. *J. Nat. Prod.* 2007, 70, 1558–1564. [CrossRef]
160. Li, Y.; Li, X.; Kang, J.S.; Choi, H.D.; Son, B.W. New radical scavenging and ultraviolet-a protecting prenylated dioxopiperazine alkaloid related to isoechinulin A from a marine isolate of the fungus *Aspergillus*. *J. Antibiot.* 2004, 57, 337–340. [CrossRef]

161. Hamasaki, T.; Nagayama, K.; Hatsuda, Y. A new metabolite, L-alanyl-L-tryptophan anhydride from *Aspergillus chevalieri*. *Agric. Biol. Chem.* 1976, 40, 2487. [CrossRef]

162. Sun, X.-P.; Xu, Y.; Cao, F.; Xu, R.-F.; Zhang, X.-L.; Wang, C.-Y. Isoechinulin-type alkaloids from a soft coral-derived fungus *Nigrospora oryzae*. *Chem. Nat. Comp.* 2014, 50, 1153–1155. [CrossRef]

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