

Supplementary Material

Cytotoxic Compounds from Marine Fungi: Sources, Structures, and Bioactivity

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Figure S1. Percentages of antitumor compounds published in different journals (1991–2023).

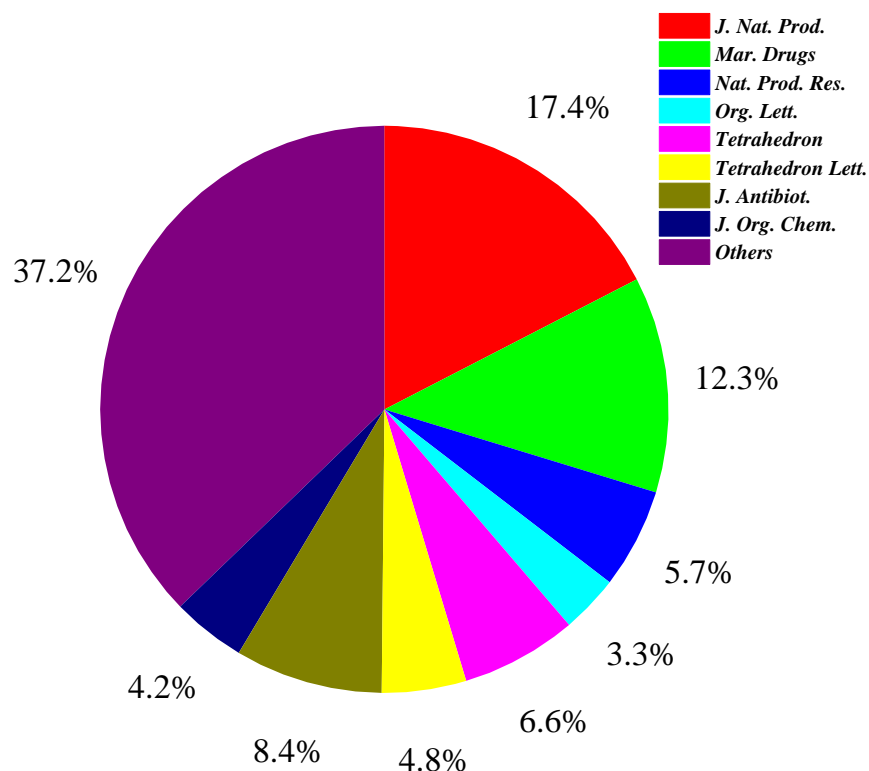


Table S1. Cytotoxic compounds isolated from marine fungi (1991–2023).

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|--|---|--|--|------|
| 2.1. Polyketides | | | | |
| 2.1.1. Macrolides, lactones, pyrones, and lactams | | | | |
| 1 | <i>Hyphomycetes</i> sp. | Zoanthid <i>Zoanthus</i> sp., Amami Island, Kagoshima Prefecture, Japan | Azetinone (α,β -unsaturated- β -lactam) | [6] |
| 2 | <i>Periconia byssoides</i> OUPS-N133 | Sea hare <i>Aplysia kurodai</i> , Osaka Bay of Japan | 16-membered macrolide | [7] |
| 3–5 | <i>Aspergillus ostianus</i> 01F313 | Unidentified marine sponge, Pohnpei, Federated States of Micronesia | 14-membered macrolide | [8] |
| 6 | <i>Cladosporium</i> sp. F14 | Seawater nearby the mangrove stand at Kei Ling Ha Lo Wai, Sai Kung, Hong Kong | nine-membered lactone | [9] |
| 7–8 | <i>Cladosporium</i> sp. L037 | Brown alga, Seragaki Beach, Okinawa Island | 12-membered macrolide | [10] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|-------------------------------------|---|---|----------|
| 9–18 | <i>Dendrodochium</i> sp. | Sea cucumber <i>Holothuria nobilis</i> Selenka, South China Sea | 12-membered macrolide | [11] |
| 19–22 | <i>Pestalotiopsis microspore</i> . | Fresh, healthy fruits of <i>Drepanocarpus lunatus</i> | 14-membered macrolide | [12] |
| 23 | <i>Myrothecium roridum</i> 98F42 | A submerged woody material, Palau | Macrocyclic trichothecene | [13] |
| 24 | <i>Myrothecium</i> sp. TUF 02F6 | Marine sponge, Indonesia | Macrocyclic trichothecene | [14] |
| 25 | <i>Diaporthe</i> sp. | Submerged rotten leaves of <i>Kandelia candel</i> , Fujian Province of China | Isobenzofuranone phthalide | or [15] |
| 26 | <i>Penicillium</i> sp. BM923 | Sea sediment sample, Miho, Sizuoka prefecture, Japan | Isobenzofuranone phthalide | or [16] |
| 27 | <i>Penicillium</i> sp. ZH58 | Leaves of mangrove tree <i>Avicennia</i> , Dong Sai, Hainan of the South China Sea coast | Isobenzofuranone phthalide | or [17] |
| 28 | <i>Chrysosporium articulatum</i> | Unidentified dictyoceratid sponge, the coast of Gagudo, Korea | Isobenzofuranone phthalide | or [18] |
| 29 | <i>Guignardia</i> sp. 4382 | South-China Sea | Isobenzofuranone phthalide | or [19] |
| 30 | <i>Acremonium</i> sp. AWA16-1 | Sea mud off Awajishima Island, Japan | γ -lactone- δ -lactam rings | [20] |
| 31–32 | <i>Phialocephala</i> sp. FL30r | Deep-sea sediment | Sorbicillinoid benzofuranone | and [21] |
| 33 | <i>Pseudallescheria boydii</i> | Inner tissue of sea star <i>Acanthaster planci</i> , Hainan Sanya National Coral Reef Reserve | Isobenzofuranone phthalide | or [22] |
| 34–40 | <i>Aspergillus</i> sp. 16-02-1 | Deep-sea sediment sample, Lau Basin hydrothermal vent, southwest Pacific | C ₉ polyketides | [23] |
| 41 | <i>Trichoderma citrinoviride</i> | Sediment samples, Min River estuary, China | Dioxolanone ester derivative | [24] |
| 42 | <i>Verruculina enalia</i> BCC 22226 | Driftwood, Phetchaburi province, Thailand | Oxa-spiro derivative | [25] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|--|------|
| 43 | <i>Aigiaus parvus</i> sp. BCC 5311 | Mangrove wood | 14-membered resorcylic macrolide | [26] |
| 44–45 | Zh6-B1 | Bark of <i>Sonneratia apetala</i> , Zhu Hai, Guangdong, China | 10-membered resorcylic | [27] |
| 46–48 | <i>Penicillium</i> <i>sumatrense</i> MA-92 | Rhizosphere of the mangrove plant <i>Lumnitzera</i> <i>racemose</i> , WenChang, Hainan Island, China | Sulfur-containing curvularin derivative | [28] |
| 49 | MF593 | Green alga, Toyama Bay, Japan Sea | Ramulosin derivative | [29] |
| 50 | <i>Penicillium waksmanii</i> Zaleski OUPS-N133 | Brown alga <i>Sargassum</i> <i>ringgoldianum</i> | Pyrenocine derivative | [30] |
| 51 | <i>Petriella</i> sp. TUBS 7961 | Marine sponge <i>Suberitis</i> <i>domuncula</i> , Rovinj, Croatia | Pyrenocine derivative | [31] |
| 52 | <i>Penicillium</i> <i>chrysogenum</i> QEN- 24S | Unidentified marine red algal species of the genus <i>Laurencia</i> | α -pyrone derivative | [32] |
| 53 | <i>Penicillium</i> <i>citreonigrum</i> XT20- 134 | Southeast Indian Ocean sediments at 2910 m | Pyrenocine derivative | [33] |
| 54 | <i>Aspergillus</i> sp. 16-02- 1 | Deep-sea sediment sample, Lau Basin hydrothermal vent, southwest Pacific | C ₉ polyketides | [23] |
| 55 | <i>Penicillium citrinum</i> | Marine sediments, Langqi Island, Fujian, China | Alkaloid | [34] |
| 56 | Mixed broth of No. K38 and E33 | South China sea coast | Diimide derivative | [35] |
| 57 | <i>Aspergillus flavus</i> | Marine algae <i>Enteromorpha</i> <i>tubulosa</i> , Putian Pinghai, China | Cyclopiazonic acid | [36] |
| 58–59 | <i>Monascus albidus</i> BB3 | Fresh inner tissue of marine shellfish <i>Meretrix</i> <i>lusoria</i> , Hailing Island, Yangjiang, China | γ -lactam derivative | [37] |
| 60–61 | <i>Aspergillus oryzae</i> | Marine sediments, Langqi Island, Fujian, China | Tetracyclic oxindole alkaloids | [38] |
| 62 | <i>Trichoderma</i> <i>citrinoviride</i> | Sediment samples, Min River estuary, China | Succinimide derivative | [24] |

| Compound | Producing strain | Strain source | Architectural feature | | Ref. |
|----------|--|--|-------------------------------------|----------|------|
| 63 | <i>Aspergillus versicolor</i> ZBY-3 | Deep-sea water sample collected at a depth of 800 m in the southeast Pacific | γ -lactam derivative | | [39] |
| 64 | <i>Aspergillus sydowi</i> D2-6 | Marine sediments, Jiaozhou Bay, China | Hetero-spirocyclic γ -lactam | | [40] |
| 65 | <i>Aspergillus fumigatus</i> OUPS-T106B-5 | Marine fish <i>Mugil cephalus</i> | Hetero-spirocyclic γ -lactam | | [41] |
| 66–67 | <i>Aspergillus fumigatus</i> OUPS-T106B-5 | Marine fish <i>Mugil cephalus</i> | Hetero-spirocyclic γ -lactam | | [42] |
| 68 | <i>Campylocarpon</i> sp. HDN13-307 | Root of mangrove plant <i>S. caseolaris</i> | 2-pyridone derivative | alkaloid | [43] |
| 69–70 | <i>Aspergillus niger</i> | Mediterranean sponge <i>Axinella damicornis</i> | 2-pyridone derivative | alkaloid | [44] |
| 71 | <i>Aspergillus carbonarius</i> WZ-4-11 | Marine sediment, Weizhou island, China | 2-pyridone derivative | alkaloid | [45] |
| 72 | <i>Aspergillus versicolor</i> Y31-2 | Seawater samples, Indian Ocean | Phenylquinolinone | | [46] |
| 73 | <i>Chaunopycnis</i> sp. CMB-MF028 | Rock surfaces in the intertidal zone of Moora Park, Shorncliffe, Queensland | 2-pyridone derivative | alkaloid | [47] |
| 74–76 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Chloro-azaphilone derivative | | [48] |
| 77–89 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Chloro-azaphilone derivative | | [49] |
| 80–81 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Chloro-azaphilone derivative | | [50] |
| 82 | <i>Penicillium chrysogenum</i> | Mediterranean sponge <i>Ircinia fasciculata</i> | Sorbicillin derivative | | [51] |
| 83–86 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Chloro-azaphilone derivative | | [52] |
| 87–88 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Azaphilone derivative | | [53] |
| 87 | <i>Chaetomium globosum</i> HDN151398 | Deep-sea sediment sample, South China Sea | Chloro-azaphilone derivative | | [54] |
| 90–91 | <i>Phomopsis tersa</i> FS441 | Sediment sample collected at the depth of 3000 m in the Indian Ocean | Chloro-azaphilone derivative | | [55] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|---|------|
| 92–94 | <i>Chaetomium</i> sp. NA-S01-R1 | Seawater sample at a depth of 4050 m, West Pacific Ocean | Chloro-azaphilone derivative | [56] |
| 95–96 | <i>Pyrenochaetopsis</i> sp. FVE-001 | Brown alga <i>Fucus vesiculosus</i> , Kiel Fjord | Decalinoylspirotetramic acid derivative | [57] |
| 97 | <i>Mollisia</i> sp. SCSIO41409 | Root bark of <i>Ardisia cornudentata</i> Mez | Chlorinated pyrrole-2,5-dione | [58] |
| 98 | <i>Talaromyces</i> sp. SCSIO 41050 | Mangrove sediment sample, Zhanjiang, coastline of the northern part of Beibu Gulf, China | Maleic anhydride derivative | [59] |
| 99 | <i>Talaromyces</i> sp. HM-4-3-T3 | Sea water, Dongshan Island, China | Benzoquinone | [60] |
| 100 | <i>Cladosporium halotolerans</i> FS702 | Sediment sample collected at the depth of 2372 m in the South China Sea | Pyrone derivative | [61] |
| 101 | <i>Aspergillus aculeatinus</i> WHF0198 | Sediments collected at the deep-sea of the South China Sea | Paraherquamide | [62] |
| 102 | <i>Alternaria</i> sp. LV52 | Deep-sea cold seep sediment sample collected from the South China Sea | Polyketide | [63] |
| 103 | <i>Pestalotiopsis</i> sp. HQD-6 | Leaf of Chinese mangrove plant <i>Rhizophora mucronate</i> | Polyketide | [64] |
| 104 | <i>Trichoderma</i> sp. 307 | Stem bark of <i>Clerodendrum inerme</i> , Zhanjiang Mangrove National Nature Reserve in Guangdong Province, China | Depsidone | [65] |
| 105 | <i>Penicillium</i> sp. XL-01 | Bohai Sea | Verrucosidin derivative | [66] |

2.1.2. Chromones, xanthenes, coumarins, benzoquinones, naphthoquinones, anthraquinones and other aromatic compounds

| | | | | |
|---------|----------------------------------|--|-----------------|------|
| 106–108 | <i>Aspergillus</i> sp. ZA-01 | Sediment collected from the Bohai Sea of Huanghuagang, Hebei Province of China | Prenylxanthenes | [67] |
| 109–111 | <i>Penicillium brocae</i> F97S76 | Tissue homogenate of <i>Zyzzya</i> sp. sponge, Fiji | Polyketides | [68] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|--|-------------------------------------|------|
| 112 | <i>Phomopsis</i> sp. ZSU-H26 | Stem of the mangrove tree <i>Excoecaria agallocha</i> , Dong Zai, Hainan, China | Naphtho- γ -pyrone | [69] |
| 113 | <i>Trichoderma</i> sp. AF007 | Seastar <i>Acanthaster planci</i> , Hainan Sanya National Coral Reef Reserve, China | Sorbicillinoid analogue | [70] |
| 114 | <i>Penicillium oxalicum</i> SCSGAF 0023 | South China Sea gorgonian <i>Muricella flexuosa</i> | Dihydrothiophene-condensed chromone | [71] |
| 115–116 | <i>Penicillium oxalicum</i> SCSGAF 0023 | South China Sea gorgonian <i>Muricella flexuosa</i> | Dihydrothiophene-condensed chromone | [72] |
| 117 | <i>Penicillium purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay, China | Chromone | [73] |
| 118 | <i>Penicillium purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay, China | Cyclopentachromone sulfide | [74] |
| 119 | <i>Cladosporium halotolerans</i> GXIMD 02502 | Coral <i>Porites lutea</i> , Weizhou Islands coral reef in Guangxi Zhuang autonomous region, China | Benzopyranone | [75] |
| 120 | <i>Pestalotiopsis</i> sp. | Leaves of the Chinese Mangrove plant <i>Rhizophora mucronate</i> | Chromone | [76] |
| 121–124 | <i>Rhytidhysteron rufulum</i> | Leaves of the Thai mangrove plant <i>Bruguiera gymnorrhiza</i> | Oxygenated chromones | [77] |
| 125–126 | <i>Penicillium purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay, China | Chromones | [73] |
| 127–129 | <i>Tritirachium</i> sp. SpB081112MEf2 | Marine sponge <i>Pseudoceratina purpurea</i> , offshore sites in Sakuraguchi, Ishigaki Island, Okinawa Prefecture, Japan | Xanthoquinodins | [78] |
| 130 | <i>Phomopsis</i> sp. (No. SK7RN3G1) | Mangrove sediment of Shankou, Hainan, China | Xanthone | [79] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|-------------------------------------|---|---------------------------------|------|
| 131 | <i>Phomopsis</i> sp. ZH76 | Stem of <i>Excoecaria agallocha</i> of the mangrove tree Euphorbiaceae, Dong Sai of the South China Sea coast | Xanthone O-glycoside | [80] |
| 132 | <i>Engyodontium album</i> DFFSCS021 | Marine sediment sample, South China Sea | Chromone | [81] |
| 133–134 | <i>Aspergillus nomius</i> NC06 | Marine sponge <i>Neopetrosia chaliniformis</i> , Mandeh Island, West Sumatra, Indonesia | Oxisterigmatocystin derivatives | [82] |
| 135 | <i>Aspergillus niger</i> | Mediterranean sponge <i>Axinella damicornis</i> | Polyketides | [44] |
| 136 | <i>Aspergillus flavus</i> 092008 | Root of the mangrove plant <i>Hibiscus tiliaceus</i> (Malvaceae), Wenchang, Hainan province of China | Aflatoxin | [83] |
| 137 | <i>Penicillium</i> sp. | Deep water (-4380 ft) sedimentX | Pentaketide | [84] |
| 138 | No. ZSU-H16 | Leaves of the mangrove tree <i>avicennia</i> from the South China Sea coast | Xanthone | [85] |
| 139 | <i>Fusarium</i> sp. ZZF41 | Stem of the mangrove tree <i>Kandelia candel</i> (L.) Druce | Isoflavone | [86] |
| 140 | <i>Fusarium</i> spp. PSU-F135 | Gorgonian sea fan (<i>Annella</i> sp.) collected near Koh Hin Ran Pet, Suratthani Province | Hydronaphthoquinone | [87] |
| 141 | <i>Nigrospora</i> sp. ZJ-2010006 | Unidentified sea anemone (GX-WZ-20100026), Weizhou coral reef, South China Sea | Hydroanthraquinone analogue | [88] |
| 142 | <i>Acaromyces ingoldii</i> FS121 | Marine sediment sample, South China Sea | Pyrandione analogue | [89] |
| 143 | <i>Penicillium</i> sp. F011 | Korea | Polyaromatic metabolite | [90] |
| 144 | <i>Emericella varicolor</i> | Marine sponge <i>Haliclona valliculata</i> , collected in a depth of 20–30 m at Secca di Capo di Fenza, Italy | Anthraquinone evariquinone | [91] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--------------------------------------|---|-------------------------------------|-------|
| 145 | <i>Alternaria</i> sp. ZJ-2008003 | <i>Sarcophyton</i> sp. soft coral, South China Sea | Anthranoid dimer | [92] |
| 146 | <i>Halorosellinia</i> sp. 1403 | Mangrove | Anthracenedione derivative | [93] |
| 147–148 | <i>Alternaria</i> sp. ZJ9-6B | Mangrove <i>Aegiceras corniculatum</i> , South China Sea | Bianthraquinone derivative | [94] |
| 149 | <i>Aspergillus</i> sp. SCSIO F063 | Marine sediment sample, South China Sea | Chlorinated anthraquinone | [95] |
| 150 | <i>Stemphylium globuliferum</i> | <i>Mentha pulegium</i> (Lamiaceae), Morocco | Anthracene derivative | [96] |
| 151–152 | <i>Stemphylium globuliferum</i> | <i>Juncus acutus</i> collected from the shore of the hypersaline lake El Hamra in Wadi el Natrun, Egypt | Tetrahydroanthraquinone derivatives | [97] |
| 153 | <i>Aspergillus glaucus</i> | Marine sediment, Fujian, China | Nnthaquinone derivative | [98] |
| 154 | <i>Emericella varicolor</i> | Sponge collected in Venezuelan waters of the Caribbean Sea | Polyketides | [99] |
| 155 | <i>Humicola</i> <i>grisea</i> Traaen | Drifting wood, southeastern lagoon of New Caledonia | Anthraquinone derivative | [100] |
| 156 | <i>Phialocephala</i> sp. FL30r | Deep-sea sediment | Polyketides | [21] |
| 157 | <i>Penicillium terrestre</i> | Marine sediments, Jiaozhou Bay, China | Monomeric derivative | [101] |
| 158 | <i>Trichoderma</i> sp. f-13 | Marine sediment, Fujian, China | Polyketides | [102] |
| 159 | <i>Penicillium</i> sp. M207142 | Sea sediment | Polyketides | [103] |
| 160 | <i>Aspergillus fischeri</i> FS452 | Deep-sea sludge, Indian Ocean | Globoscin derivative | [104] |
| 161 | <i>Alternaria</i> sp. MCCC 3A00467 | Sediment of Pacific Ocean at depth of 5295 m | Phomalone derivative | [105] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|--|------------------------------|-------|
| 162 | <i>Lasiodiplodia</i> sp. 318# | <i>Excoecaria agallocha</i> of Mangrove National Nature Reserve in Gaoqiao, Zhanjiang city, Guangdong, China | Polyketides | [106] |
| 163 | <i>Aspergillus pseudodeflectus</i> | Seaweed, <i>Sargassum fusiform</i> , Miura Peninsula | Isochroman derivative | [107] |
| 164 | <i>Penicillium auratiogriseum</i> | Sponge <i>Mycale plumose</i> , Qingdao, China | Aromatic ester | [108] |
| 165 | <i>Penicillium janczewskii</i> H-TW5/869 | Marine water sample | Quinolinone | [109] |
| 166 | <i>Acremonium</i> sp. AWA16-1 | Sea mud, Awajishima Island, Japan | Dihydrobenzofuran derivative | [110] |
| 167 | <i>Aspergillus</i> sp. B-F-2 | Marine sediments, Behai Bay, China | Diphenyl ether | [111] |
| 168 | <i>Aspergillus carbonarius</i> WZ-4-11 | Marine sediment, Weizhou island, China | Polyketides | [45] |
| 169–176 | <i>Penicillium terrestre</i> | Marine sediments, Jiaozhou Bay, China | Gentisyl alcohol derivative | [101] |
| 177–178 | <i>Aspergillus versicolor</i> ZLN-60 | Sediment of the Yellow Sea | Gentisyl alcohol derivatives | [112] |
| 179–181 | <i>Aspergillus taichungensis</i> ZHN-7-07 | Root soil of the mangrove plant <i>Acrostichum aureum</i> | Polyketides | [113] |
| 182–183 | <i>Aspergillus aculeatus</i> | | Polyketides | [114] |
| 184–185 | <i>Penicillium</i> sp. WC-29-5 | Mangrove soil around the roots of <i>Aegiceras corniculatum</i> , Wenchang, Hainan Province of China | Polyketides | [115] |
| 186 | <i>Ascochyta</i> sp. NGB4 | Floating scrap of festering rope collected at a fishing port in Nagasaki prefecture, Japan | Polyketides | [116] |
| 187–188 | <i>Rhytidhysterion</i> sp. AS21B | Leaves of <i>Azima sarmentosa</i> , collected from the mangrove forest in Samutsakhon province, Thailand | Polyketides | [117] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|--|-----------------------------|-------|
| 189 | <i>Phomopsis</i> sp. ZSU-H76 | Stem of the mangrove tree <i>E. agallocha</i> , South China Sea | Polyketides | [118] |
| 190–191 | <i>Sporothrix</i> sp. (#4335) | Bark of the inshore mangrove tree <i>Kandelia candel</i> | Polyketides | [119] |
| 192–193 | <i>Penicillium citrinum</i> | marine sediments collected from Langqi Island, Fujian, China | Citrinin derivatives | [120] |
| 194–196 | <i>Penicillium commune</i> QSD-17 | Marine sediment sample, southern China Sea | Azaphilone derivatives | [121] |
| 197 | <i>Penicillium paneum</i> SD-44 | Marine sediment sample, South China Sea | Triazole carboxylic acid | [122] |
| 198 | <i>Aspergillus</i> sp. | Gorgonian <i>Dichotella gemmacea</i> | Benzylazaphilone derivative | [123] |
| 199–200 | <i>Paecilomyces variotii</i> EN-291 | Red alga <i>Grateloupia turuturu</i> | Indole derivatives | [124] |
| 201 | <i>Fusarium incarnatum</i> (HKI0504) | Mangrove plant <i>Aegiceras corniculatum</i> | Alkaloid | [125] |
| 202–204 | <i>Penicillium raistrichii</i> | Saline soil sample, Bohai Bay in Zhanhua, China | Spiroketal | [126] |
| 205 | <i>Pestalotiopsis vaccinii</i> | A branch of <i>Kandelia candel</i> (L.) Druce (Rhizophoraceae), southern China | Aromatic amine | [127] |
| 206–207 | <i>Alternaria</i> sp. R6 | Root of a marine semi-mangrove plant <i>Myoporum bontiodes</i> A. Gray, Leizhou peninsula, Guangdong Province, China | Resveratrol derivatives | [128] |
| 208–209 | <i>Lasiodiplodia theobromae</i> ZJ-HQ1 | Leaves of the marine mangrove <i>Acanthus ilicifolius</i> , Zhanjiang Mangrove Nature Reserve in Guangdong Province, China | Chlorinated preussomerins | [129] |
| 210 | <i>Penicillium citreonigrum</i> XT20-134 | Southeast Indian Ocean sediments at 2910 m | Polyketides | [33] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|--|----------------------------|-------|
| 211–212 | <i>Penicillium aculeatum</i> | Red alga <i>Laurencia obtusa</i> , Egyptian Red Sea | Sulfonyl metabolites | [130] |
| 213 | <i>Aspergillus candidus</i> OUCMDZ-1051 | Unidentified sponge sample (No. XS-3), Xisha islands, South China Sea | Terphenyl | [131] |
| 214 | <i>Aspergillus</i> <i>micronesiensis</i> | An edible red seaweed <i>Kappaphycus alvarezii</i> | Dibenzospiroketal | [132] |
| 215 | <i>Eurotium</i> sp. SCSIO F452 | Sea sediment sample, South China Sea | Salicylaldehyde derivative | [133] |
| 216 | <i>Alternaria</i> sp. LV52 | Deep-sea cold seep sediment sample collected from the South China Sea | Polyketides | [63] |
| 217 | <i>Penicillium</i> sp. GXIMD 03101 | Mangrove plant <i>Acanthus</i> <i>ilicifolius</i> L., South China Sea | Xanthene derivative | [134] |
| 218 | <i>Penicillium</i> sp. ZH16 | Leaves of mangrove tree <i>avicennia</i> from the Dong Sai, Hainan of the South China Sea coast | Furanocoumarin | [135] |
| 219 | <i>Alternaria tenuis</i> Sg17-1 | Marine alga, Zhoushan Island, China | Isocoumarin | [136] |
| 220–221 | <i>Chrysosporium</i> <i>articulatum</i> | Unidentified dictyoceratid sponge, the coast of Gagu- do, Korea | Isocoumarin | [18] |
| 222 | No. dz17 | South China Sea | Isocoumarin | [137] |
| 223 | <i>Phomopsis</i> sp. Gx-4 | Mangrove sediment, ZhuHai, Guangdong, China | Isocoumarin | [138] |
| 224 | <i>Penicillium</i> sp. 091402 | Root of the mangrove <i>Bruguiera sexangula</i> Linn, Qinglan Port, Hainan, China | Isocoumarin | [139] |
| 225–226 | <i>Penicillium</i> <i>chrysogenum</i> SCSIO 41001 | Deep sea sediment of the Indian Ocean | Isocoumarin | [140] |

2.1.3. Polyketides (Other cyclic polyketides)

| | | | | |
|---------|--|---|--------------------|-------|
| 227–229 | <i>Penicillium</i> sp. | Marine alga <i>Emeromorpha</i> <i>intestinalis</i> | Cyclic polyketides | [141] |
| 230–232 | <i>Trichoderma</i> <i>harzianum</i> OUPS- N115 | Marine sponge <i>Halichondria okadai</i> | Cyclic polyketides | [142] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|-----------------------------|-----------|
| 233 | <i>Trichoderma</i> sp. GIBH-Mf082 | Marine sediment, South China Sea | Cyclopentenone | [143] |
| 234–236 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Polyketides | [144] |
| 237–239 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Polyketides | [145,146] |
| 240–242 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Polyketides | [147] |
| 243–244 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Polyketides | [148] |
| 245–246 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Polyketides | [149] |
| 247–248 | <i>Periconia byssoides</i> OUPS-N133 | Sea hare <i>Aplysia kurodai</i> | Polyketides | [150] |
| 249–253 | <i>Periconia byssoides</i> OUPS-N133 | Sea hare <i>Aplysia kurodai</i> | Polyketides | [151] |
| 254 | <i>Aspergillus</i> sp. | Mussel <i>Mytilus edulis</i> , Toyama Bay | Polyketides | [152] |
| 255 | <i>Penicillium terrestre</i> | Marine sediment, Jiaozhou Bay, Qingdao | Polyketides | [153] |
| 256–259 | <i>Trichoderma reesei</i> | Marine mud in the tideland of Lianyungang, China | Polyketides | [154] |
| 260–263 | <i>Phialocephala</i> sp. FL30r | Underwater sample | Sorbicillin trimers | [155,156] |
| 264 | <i>Penicillium citrinum</i> SpI080624G1f01 | Marine sponge <i>Demospongiae</i> collected offshore of Ishigaki island, Okinawa. Prefecture, Japan | Sorbicillinoid | [157] |
| 265–266 | <i>Penicillium terrestre</i> | | Polyketides | [158] |
| 267 | <i>Trichoderma</i> sp. f-13 | Marine sediment, Fujian, China | Polyketide | [102] |
| 268–270 | <i>Penicillium</i> sp. F23–2 | Deep sea | Sorbicillinoids | [159] |
| 271–272 | <i>Penicillium terrestre</i> | Marine sediments, Jiaozhou Bay, China | Chlorinated sorbicillinoids | [160] |
| 273–274 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish, Mugil cephalus | Polyketides | [161] |
| 275–278 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish <i>Mugil cephalus</i> | Polyketides | [50] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|---|--|---|------------------------------------|-----------|
| 279 | <i>Chaetomium globosum</i> OUPS-T106B-6 | Marine fish, Mugil cephalus | Polyketides | [162] |
| 280 | <i>Penicillium</i> 303# | Sea water, Zhanjiang Mangrove National Nature Reserve in Guangdong Province, China | Polyketides | [163] |
| 281 | <i>Penicillium sclerotiorum</i> M-22 | Rotted leaf sample collected on the west coast of Haikou, Hainan province, China | Azaphilonidal derivative | [164] |
| 282 | <i>Rhizopus</i> sp. 2-PDA-61 | Bryozoan <i>Bugula</i> sp., Jiaozhou Bay, China | Pyran derivative | [165] |
| 283–284 | <i>Talaromyces</i> sp. ZH-154 | Stem bark of <i>Kandelia candel</i> , Qi'ao Island of Zhuhai, China | Polyketides | [166] |
| 285 | <i>Penicillium raistrickii</i> | Saline soil collected along the coast of Bohai Bay in Zhanhua, Shandong Province of China | Polyketides | [167] |
| 286 | <i>Penicillium</i> sp. F23–2 | Deep sea | Nitrogen-containing sorbicillinoid | [159] |
| 287 | <i>Aspergillus sulphureus</i> KMM 4640 | Marine sediments | Decaline derivative | [168] |
| 288 | <i>Penicillium</i> sp. F11 | Deep marine | Polyketides | [169] |
| 289 | <i>Penicillium purpurogenum</i> G59 | | Polyketides | [170] |
| 290 | <i>Isaria feline</i> KMM 4639 | Marine sediments collected at a depth of 10 m, South China Sea, coast of Vietnam | Polyketides | [171] |
| 291 | <i>Penicillium citrinum</i> SCSIO41402 | Marine alga <i>Coelarthrum</i> sp. collected in Yongxing Island, South China Sea | Sorbicillinoid | [172] |
| 292 | <i>Eurotium</i> sp. SCSIO F452 | Sea sediment sample, South China Sea | Salicylaldehyde derivative | [133] |
| 2.1.4. Linear polyketides and others | | | | |
| 293–294 | <i>Gliocladium roseum</i> KF-1040 | Seaweed sample collected at Yap Island | Linear polyketides | [173–175] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|--|-----------------------|-------|
| 295–296 | <i>Aspergillus flavipes</i> | Sea anemone <i>Anthopleura xanthogrammica</i> | Linear polyketides | [176] |
| 297 | <i>Gliocladium</i> sp. L049 | Sea grass <i>Syringodium isoetifolium</i> , Maeda Cape, Okinawa Island | Linear polyketides | [177] |
| 298 | <i>Aspergillus</i> sp. 16-02-1 | Deep-sea sediment sample, Lau Basin hydrothermal vent, southwest Pacific | Linear polyketides | [23] |
| 299 | <i>Pestalotiopsis clavispora</i> | Mangrove plant <i>Rhizophora harrisonii</i> , Port Harcourt (Nigeria) | Linear polyketides | [178] |
| 300 | <i>Acremonium citrinum</i> . MMF4 | Sediment at the root of mangrove plant <i>Kandelia obovata</i> , Yunxiao county, Zhangzhou City, Fujian Province, in China | Linear polyketides | [179] |
| 301 | <i>Fusarium graminearum</i> FM1010 | Shallow-water volcanic rock, Richardson's Beach, Big Island, Hawaii | Linear polyketides | [180] |
| 302–307 | <i>Pestalotiopsis heterocornis</i> XWS03F09 | Sponge <i>Phakellia fusca</i> collected from the Xisha Islands, close to Sansha City, Hainan Province, China | Polyketides | [181] |

2.2. Peptides

2.2.1. Diketopiperazine

| | | | | |
|---------|--|--|-------------------|-----------|
| 308 | <i>Aspergillus niger</i> | Caribbean <i>Hyrtios</i> sponge | Diketopiperazines | [182] |
| 309–329 | <i>Leptosphaeria</i> sp. OUPS-4 | Marine alga <i>Sargassum tortile</i> | Diketopiperazines | [183–188] |
| 330–333 | <i>Exserohilum rostratum</i> CNK-630 | Cyanobacterial mat collected off the northwest corner of Lanai Island, Hawaii | Diketopiperazines | [189] |
| 334–336 | <i>Oidiodendron truncatum</i> GW3-13 | Soil collected under lichens near the Great Wall station (Chinese Antarctic station) | Diketopiperazines | [190] |
| 337 | <i>Fusarium chlamydosporum</i> OUPS-N124 | Marine alga <i>Carpopeltis affinis</i> | Diketopiperazines | [191] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|-----------------------|-------|
| 338 | <i>Gliocladium roseum</i> OUPS-N132 | The sea hare <i>Aplysia kurodai</i> collected in coast of Kata | Diketopiperazines | [192] |
| 339 | <i>Phoma</i> sp. OUCMDZ-1847 | Mangrove plant <i>Kandelia candel</i> (Rhizophoraceae) Wenchang, Hainan Province, China | Diketopiperazines | [193] |
| 340–341 | <i>Penicillium brocae</i> MA-231 | Mangrove | Diketopiperazines | [194] |
| 342 | <i>Penicillium purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay | Diketopiperazines | [195] |
| 343–345 | <i>Aspergillus nidulans</i> SD-531 | Deep-sea sediment collected in cold seep region (at a depth 1331 m) in the South China Sea | Diketopiperazines | [196] |
| 346–349 | <i>Aspergillus</i> sp. EGF 15-0-3 | Soft coral | Diketopiperazines | [197] |
| 350–351 | <i>Penicillium</i> sp. F23-2 | Underwater sample | Diketopiperazines | [198] |
| 352–353 | <i>Eurotium</i> sp. SCSIO F452 | South China Sea sediment sample | Diketopiperazines | [199] |

2.2.2. Cyclic peptides

| | | | | |
|---------|--------------------------------------|---|--------------------------|-------|
| 354 | <i>Fusarium</i> sp. CNL- 292 | Seagrass <i>Halodule wrightii</i> | Cyclic pentadepsipeptide | [200] |
| 355 | <i>Fusarium</i> sp. CNL- 619 | Green alga <i>Avrainvillea</i> sp., southeast end of St. Thomas at Bovoni Cay, United States Virgin Islands | Cyclic depsipeptide | [201] |
| 356–357 | <i>Scytalidium</i> sp. CNC- 310 | Green alga <i>Halimeda</i> sp. collected from a patch reef at a depth of 15 m from the northern end of Long Island, the Bahamas | Cyclic heptapeptides | [202] |
| 358 | <i>Zygosporium masonii</i> CNK458 | Marine cyanobacterium, island of Maui, Hawaii | Cyclic pentadepsipeptide | [203] |
| 359 | Strain No. 1962 | Leaf of <i>Kandelia candel</i> from an estuarine mangrove, Hong Kong | Cyclic pentadepsipeptide | [204] |
| 360 | <i>Trichoderma reesei</i> YZ48-08 | | Cyclotetrapeptide | [205] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|------------------------|-------|
| 361 | <i>Clonostachys</i> sp. ESNA-A009 | Unidentified marine sponge, Japan | Cyclodepsipeptide | [206] |
| 362–363 | <i>Spicellum roseum</i> 193H5 | Sponge <i>Ectyplasia perox</i> | Cyclohexadepsipeptides | [207] |
| 364–365 | <i>Scopulariopsis brevicaulis</i> | Marine sponge <i>Tethya aurantium</i> , Limski Fjord, Croatia | Cyclodepsipeptides | [208] |
| 366 | <i>Aspergillus sclerotiorum</i> PT06-1 | Putian SeaSalt Field, Fujian, China | Cyclic hexapeptide | [209] |
| 367 | <i>Bionectria ochroleuca</i> | Leaf tissues of the plant <i>Sonneratia caseolaris</i> (Sonneratiaceae) from Hainan Island (China) | Cyclicpetide | [210] |
| 368–369 | <i>Acremonium persicinum</i> SCSIO 115 | Marine sediment sample, South China Sea | Cycloheptapeptides | [211] |
| 370 | <i>Phaeosphaeriopsis</i> sp. S296 | Sediment of a mangrove plant <i>Bruguiera gymnorhiza</i> , Techeng Isle, Zhanjiang, Guangdong Province, China | Cyclodecadepsipeptide | [212] |

2.2.3. Linear peptides

| | | | | |
|---------|--|--|----------------------------------|-------|
| 371–372 | <i>Acremonium</i> sp. 021172cKZ | Marine sponge <i>Teichaxinella</i> sp., Papua New Guinea | N-methylated linear octapeptides | [213] |
| 373 | <i>Aspergillus versicolor</i> | Marine sponge <i>Petrosia</i> sp. | Linear peptide | [214] |
| 374–377 | <i>Simplicillium obclavatum</i> EIODSF 020 | Marine sediment sample, East Indian Ocean | Linear peptides | [215] |

2.3. Terpenoids and sterols

2.3.1. Sesquiterpenoids

| | | | | |
|---------|--|---|---------------------------------|-------|
| 378 | <i>Penicillium</i> sp. SS080624SCf1 | Tunicate <i>D. molle</i> , Ishigaki Island, Okinawa Prefecture, Japan | Sesquiterpenoid | [216] |
| 379–380 | <i>Aspergillus</i> sp. | Marine sponge <i>Xestospongia testudinaria</i> , South China Sea | Sesquiterpenoid dimers | [217] |
| 381 | <i>Chondrostereum</i> sp. nov. SF002 | Soft coral <i>Sarcophyton tortuosum</i> , the South China Sea | Triquinane-type sesquiterpenoid | [218] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|--|---|-------|
| 382 | <i>Chondrostereum</i> sp. nov. SF002 | Soft coral <i>Sarcophyton tortuosum</i> , the South China Sea | Sesquiterpenoid | [219] |
| 383 | <i>Penicillium</i> sp. FJ-1 | Marine plant of <i>Avicennia marina</i> , Fujian, China | Sesquiterpenoid | [220] |
| 384–385 | <i>Penicillium</i> sp. PR19 N-1 | Marine sludge collected from Prydz Bay (-1000 m), Antarctica | Eremophilane-type sesquiterpenes | [221] |
| 386–387 | <i>Ascotricha</i> sp. ZJ-M-5 | Mud sample collected on the coastal beach in Fenghua County, Zhejiang Province, China | Sesquiterpenoids | [222] |
| 388 | <i>Aspergillus flocculosus</i> | Sediment sample, Nha Trang Bay, South China Sea, Vietnam | Sesquiterpenoid | [223] |
| 389 | <i>Aspergillus ochraceus</i> Jcma1F17 | Marine alga <i>Coelarthrum</i> sp., Paracel Islands, South China Sea | Nitrobenzoyl sesquiterpenoid | [224] |
| 390 | <i>Penicillium chrysogenum</i> LD-201810 | Marine red alga <i>Grateloupia turuturu</i> , Qingdao, China | Sesquiterpenoid | [225] |
| 391–392 | <i>Aspergillus niger</i> | Marine sponge <i>Dysidea</i> sp., South China Sea | Sesquiterpenoids | [226] |
| 393–394 | <i>Aspergillus flavipes</i> 297 | Seawater collected at coastal zone of Yantai, China | Sesquiterpenoids | [227] |
| 396 | Unidentified fungi | Marine sponge <i>Jaspis</i> aff. <i>Johnstoni</i> | Sesquiterpenoid | [228] |
| 397 | <i>Acremonium neocaledoniae</i> | Drifting wood, Gadgi Bay, New Caledonia | Sesquiterpenoid | [229] |
| 398–401 | <i>Talaromyces flavus</i> | Leaves of mangrove plant <i>Sonneratia apetala</i> collected on the coastal saltmarsh of the South China Sea | Sesquiterpenoids | [230] |
| 402 | <i>Penicillium</i> sp. PR19N-1 | Marine sludge collected from Prydz Bay (-1000 m), Antarctica | Chloro-trinoreremophilane sesquiterpene | [231] |

2.3.2. Diterpenoids

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|---|--------------------------------|-------|
| 403 | <i>Arthrinium</i> sp. 9287 | Mediterranean sponge <i>Geodia cydonium</i> , Adriatic Ocean | Diterpenoids | [232] |
| 404–405 | <i>Epicoccum</i> sp. HS-1 | | Pimarane diterpenes | [233] |
| 406–409 | <i>Eutypella scoparia</i> FS26 | Marine sediment sample collected at the depth of 139 m in the South China Sea | Oxygenated pimarane diterpenes | [234] |
| 410 | <i>Eutypella</i> sp. FS46 | Marine sediment sample collected at the depth of 292 m in the South China Sea | Pimarane-type diterpene | [235] |
| 411 | <i>Penicillium brefeldianum</i> strain WZW-F-69 | Soil near an abalone aquaculture base of Fujian province, China | Indole diterpenoid | [236] |
| 412–413 | <i>Aspergillus wentii</i> EN-48 | Unidentified marine brown algal species of the genus <i>Sargassum</i> | Tetranorlabdane diterpenoids | [237] |
| 414 | <i>Aspergillus terreus</i> GX73B | Coastal salt marsh of the South China Sea, Guangxi Province | Diterpenoids | [238] |
| 415 | <i>Aspergillus wentii</i> SD-310 | Deep sea sediment sample, South China Sea at a depth of 2038 m | Diterpenoids | [239] |
| 416–420 | <i>Aspergillus wentii</i> SD-310 | Deep-sea sediment sample | Diterpenoids | [240] |
| 421–423 | <i>Penicillium</i> sp. | Deep water sediment sample, East Pacific | Breviane spiroditerpenoids | [241] |
| 424–429 | <i>Penicillium</i> sp. F23-2 | Underwater sample | Diterpenoids | [198] |
| 430 | <i>Aspergillus candidus</i> HDN15-152 | Sponge collected from Pulitzer Bay, Antarctica | Indole diterpenoids | [242] |
| 431–433 | <i>Acremonium striatisporum</i> KMM 4401 | Holothurian <i>Eupentacta fraudatrix</i> | Diterpene glycosides | [243] |
| 434–437 | <i>Acremonium striatisporum</i> KMM 4401 | Holothurian <i>Eupentacta fraudatrix</i> | Diterpene glycosides | [244] |

2.3.3. Sesterterpenoids

| | | | | |
|---------|--------------------------------------|---|----------------|-------|
| 438–439 | <i>Fusarium heterosporum</i> CNC-477 | Driftwood collected from a mangrove habitat at Sweetings Cay, Bahamas | Sesterterpenes | [245] |
|---------|--------------------------------------|---|----------------|-------|

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--------------------------------------|---|-----------------------|-------|
| 440–446 | <i>Fusarium heterosporum</i> CNC-477 | Driftwood collected from a mangrove habitat at Sweetings Cay, Bahamas | Sesterterpenes | [246] |
| 447–449 | <i>Aspergillus</i> CNK-371 | Unidentified sponge collected at 40 feet from Manele Bay, Lanai, Hawaii | Meroterpenoids | [247] |
| 450–451 | <i>Phomopsis tersa</i> FS441 | Deep-sea sediment sample | Meroterpenoids | [248] |
| 452 | <i>Aspergillus insuetus</i> (OY-207) | The Mediterranean sponge <i>Psammocinia</i> sp., Sdot-Yam, Israel | Meroterpenoid | [249] |
| 453–454 | <i>Aspergillus</i> sp. 094102 | Zoanthid <i>Zoanthus</i> collected at Ayamaru Cape, Amami Island, Kagoshima Prefecture, Japan | Sesterterpenes | [250] |
| 455–456 | <i>Penicillium</i> sp. 303# | Sea water, Zhanjiang Mangrove National Nature Reserve in Guangdong Province, China | Meroterpenoids | [163] |

2.3.4. Sterols

| | | | | |
|---------|---|---|-------------|-------|
| 457 | <i>Gymnacella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Sterols | [251] |
| 458–461 | <i>Gymnascella dankaliensis</i> | Sponge <i>Halichondria japonica</i> , Osaka Bay, Japan | Sterols | [252] |
| 462–467 | <i>Rhizopus</i> sp. | Marine <i>Bugula</i> sp., Jiaozhou Bay, China | Ergosterols | [253] |
| 468 | <i>Penicillium chrysogenum</i> QEN-24S | Unidentified marine red algal species of the genus <i>Laurencia</i> | Sterols | [254] |
| 469–470 | <i>Aspergillus niger</i> MA-132 | A fresh healthy sample of the mangrove plant <i>Avicennia marina</i> | Sterols | [255] |
| 471–473 | <i>Penicillium purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay, China | Sterols | [256] |
| 474 | <i>Penicillium citrinum</i> SCSIO 41017 | Sponge <i>Callyspongia</i> sp. collected from the sea area near Xuwen County, Guangdong Province, China | Sterol | [257] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|--|---|--|-----------------------|-------|
| 475 | <i>Aspergillus flavus</i> YJ07-1 | Bohai Sea | Oxygenated steroid | [258] |
| 2.4. Hybrids | | | | |
| 2.4.1. Hybrids of polyketides and peptides (or amino acids) | | | | |
| 476–477 | <i>Penicillium</i> <i>fellutanum</i> Btource | Marine fish <i>Apogon</i> <i>endekataenia</i> Bleeker | Hybrids | [259] |
| 478–483 | <i>Aspergillus fumigatus</i> | Marine fish <i>Pseudolabrus japonicus</i> | Hybrids | [260] |
| 484–486 | <i>Gliocladium roseum</i> OUPS-N132 | The sea hare <i>Aplysia kurodai</i> collected in coast of Kata | Hybrids | [192] |
| 487–488 | <i>Penicillium aurantiogriseum</i> SP0-19 | Sponge <i>Mycale plumose</i> (Mycalidae), Jiaozhou Bay, Qingdao, China | Hybrids | [261] |
| 489–490 | <i>Acrostalagmus luteoalbus</i> SCSIO F457 | Deep-sea sediment | Hybrids | [262] |
| 491–492 | <i>Penicillium purpurogenum</i> G59 | | Hybrids | [170] |
| 493–495 | <i>Leptosphaeria</i> sp. OUPS-4 | Marine alga <i>Sargassum tortile</i> | Hybrids | [183] |
| 496 | <i>Trichoderma virens</i> CNL910 | A sample of the marine ascidian <i>Didemnum mole</i> , Madang, Papua New Guinea | Hybrids | [263] |
| 497–498 | <i>Microsporum gypseum</i> CNL-629 | cf. A sample of the bryozoan <i>Bugula</i> sp., U.S. Virgin Islands | Hybrids | [264] |
| 499–501 | <i>Penicillium</i> sp. | Marine alga <i>Enteromorpha intestinalis</i> , Tanabe Bay, Japan | Hybrids | [265] |
| 502–506 | <i>Penicillium</i> sp. OUPS-79 | Marine alga <i>Enteromorpha intestinalis</i> | Hybrids | [266] |
| 507 | <i>Phomopsis asparagi</i> | Sponge <i>Rhaphidophlus juniperina</i> | Hybrids | [267] |
| 508–510 | <i>Spicaria elegans</i> KLA03 | Marine sediments, Jiaozhou Bay, China | Hybrids | [268] |
| 511–512 | <i>Spicaria elegans</i> KLA03 | Marine sediments, Jiaozhou Bay, China | Hybrids | [269] |
| 513 | <i>Spicaria elegans</i> KLA03 | Marine sediments, Jiaozhou Bay, China | Hybrids | [270] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|---|----------------------------|-------|
| 514–515 | <i>Spicaria elegans</i> KLA03 | Marine sediments, Jiaozhou Bay, China | Hybrids | [271] |
| 516–517 | <i>Spicaria elegans</i> KLA03 | Marine sediments, Jiaozhou Bay, China | Hybrids | [272] |
| 518 | <i>Xylaria</i> sp. SCSIO156 | Marine sediment, South China Sea | Hybrids | [273] |
| 519–522 | <i>Phoma</i> sp. | Giant jellyfish <i>Nemopilema</i> <i>nomurai</i> | Hybrids | [274] |
| 523 | <i>Aspergillus oryzae</i> | Red Sea sediments collected off Jeddah, Saudi Arabia | Hybrids | [275] |
| 524 | <i>Aspergillus versicolor</i> | Marine sponge <i>Petrosia</i> sp. | Lipopeptide | [276] |
| 525 | <i>Aspergillus terreus</i> SCSGAF0162 | The tissue of the gorgonian <i>Echinogorgia aurantiaca</i> , Sanya, Hainan Province, China | Cyclic tetrapeptide | [277] |
| 526–527 | <i>Aspergillus clavatus</i> C2WU | Hydrothermal vent crab <i>Xenograpsus testudinatus</i> , Kueishantao, Taiwan | Cyclodepsipeptides | [278] |
| 528–534 | <i>Penicillium</i> <i>purpurogenum</i> G59 | Soil sample collected at the tideland of Bohai Bay, China | Lipopeptides | [279] |
| 535 | <i>Aspergillus</i> | Brown algal species belonging to the genus <i>Sargassum</i> collected off Helgoland, North Sea, Germany | Cyclotriptide | [280] |
| 536 | <i>Aspergillus versicolor</i> SCSIO 41016 | Marine sponge | Diketopiperazine alkaloids | [281] |
| 537 | <i>Aspergillus sydowii</i> MCCC 3A00324 | Deep sea sediment (2246 meters), South Atlantic Ocean | Hybrids | [282] |
| 538 | <i>Penicillium citrinum</i> | Deep-sea sediment sample | Pentacyclic alkaloid | [283] |
| 539–540 | <i>Aspergillus</i> sp. | Marine-submerged decaying wood | Lipopeptidyl benzophenones | [284] |

2.4.2. Hybrids of polyketides and terpenoids (or steroids or isoprenyls)

| | | | | |
|-----|--|--|---------------------------------------|-------|
| 541 | <i>Aspergillus versicolor</i> CNC 327 | Caribbean green alga <i>Penicillus capitatus</i> | Sesquiterpenoid nitrobenzoyl ester | [285] |
| 542 | <i>Gymnacella</i> <i>dankaliensis</i> | Sponge <i>Halichondria</i> <i>japonica</i> , Osaka Bay, Japan | Hybrid | [252] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|----------------------------|-------|
| 543 | <i>Hypoxylon croceum</i> M97-25 | Driftwood in a mangrove estuary in the Everglades/Florida | Sordarin derivative | [286] |
| 544 | <i>Xylariaceous</i> LL- 07H239 | | Eremophilane sesquiterpene | [287] |
| 545 | <i>Chaetomium globosum</i> | Fresh algal sample, Qingdao coastline, <i>Polysiphonia urceolata</i> | Hybrids | [288] |
| 546–547 | <i>Aspergillus ustus</i> 8009 | Marine sponge <i>Suberites</i> <i>domuncula</i> , Adriatic Sea | Drimane sesquiterpenoids | [289] |
| 548–549 | <i>Phoma</i> sp. | Marine sponge <i>Ectyplasia</i> <i>perox</i> , the Caribbean Sea, Dominica | Prenylated polyketides | [290] |
| 550 | <i>Paraconiothyrium</i> sp. 193H12 | Marine sponge <i>Ectyplasia</i> <i>perox</i> , the Caribbean Sea, Dominica | Hybrid | [291] |
| 551 | <i>Aspergillus insuetus</i> (OY-207) | The Mediterranean sponge <i>Psammocinia</i> sp., Sdot- Yam, Israel | Drimane sesquiterpenoids | [249] |
| 552 | <i>Aspergillus ustus</i> | Rhizosphere soil of the mangrove plant <i>Acrostichum aureum</i> , Guangxi Province, China | Drimane sesquiterpenoids | [292] |
| 553–554 | <i>Aspergillus ustus</i> 094102 | Rhizosphere soil of the mangrove plant <i>Bruguiera</i> <i>gymnorhiza</i> , Wenchang, Hainan Province of China | Drimane sesquiterpenoids | [293] |
| 555 | <i>Penicillium</i> sp. F00120 | Sediment of the northern South China Sea | Sesquiterpene quinone | [294] |
| 556 | <i>Penicillium</i> sp. C9408-3 | Deep sea sediment sample collected at a depth of 5115 m | Breviane spiroditerpenoid | [295] |
| 557 | <i>Neosartorya laciniosa</i> KUFC 7896 | Coastal forest soil, Samaersarn island, Chonburi Province, Thailand | Hybrids | [296] |
| 558–560 | <i>Aspergillus versicolor</i> OUPS-N136 | Sea urchin <i>Anthocidaris</i> <i>crassispina</i> collected in Tanabe Bay in Wakayama, Japan | Hybrids | [297] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|-----------------------------------|-------|
| 561 | <i>Cryptosphaeria</i> sp. CNL-523 | Unidentified ascidian collected in the Bahamas | Ester-substituted sesquiterpenoid | [298] |
| 562 | <i>Penicillium concentricum</i> ZLQ-69 | Water sample taken from the coast of the Bohai Sea in Binzhou, Shandong Province, China | Meroterpene | [299] |
| 563–566 | <i>Aspergillus flavus</i> CF13-11 | Marine sediment collected from the Bohai Sea | Drimane sesquiterpene esters | [300] |
| 567 | <i>Paecilomyces</i> sp. | Saprophytic bark of mangrove from the Taiwan Strait | Hybrids | [301] |
| 568–569 | <i>Penicillium expansum</i> 091006 | Surface-sterilized roots of the mangrove plant <i>Excoecaria agallocha</i> , Wenchang, Hainan Province, China | Hybrids | [302] |
| 570–571 | <i>Penicillium expansum</i> 091006 | Surface-sterilized roots of the mangrove plant <i>Excoecaria agallocha</i> , Wenchang, Hainan Province, China | Hybrids | [303] |
| 572 | <i>Aspergillus ustus</i> 094102 | Rhizosphere soil of the mangrove plant <i>Bruguiera gymnorhiza</i> , Wenchang, Hainan Province of China | Isochromane derivative | [293] |
| 573 | <i>Nigrospora</i> sp. MA75 | Stem of the semi-mangrove plant <i>Pongamia pinnata</i> | Hybrids | [304] |
| 574–575 | <i>Stachylidium</i> sp. 220 | Sponge <i>Callyspongia</i> sp. cf. <i>C. flammea</i> , Bear Island, Sydney, Australia | Phthalide derivatives | [305] |
| 576–577 | <i>Stachylidium</i> sp. 220 | Sponge <i>Callyspongia</i> sp. cf. <i>C. flammea</i> , Bear Island, Sydney, Australia | Phthalimidine derivatives | [306] |
| 578–588 | <i>Alternaria</i> sp. JJY-32 | Sponge <i>Callyspongia</i> sp. collected off the coast of Hainan Island, China | Hybrids | [307] |
| 589 | <i>Neosartorya laciniosa</i> KUFC 7896 | Coastal forest soil, Samaersarn island, Chonburi Province, Thailand | Meroditerpene | [296] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|--|---|-----------------------------|-------|
| 590 | <i>Penicillium</i> sp. ZLN29 | Sediments collected, Jiaozhou Bay, China | Penicillide derivative | [308] |
| 591 | <i>Penicillium</i> <i>Canescentia</i> MMS35 | Seawater sample gathered on the French Atlantic coast near the Loire River estuary | Chlorinated sesquiterpenoid | [309] |
| 592 | <i>Penicillium</i> sp. FJ-1 | Marine plant of <i>Avicennia marina</i> , Fujian, China | Hybrids | [220] |
| 593–594 | <i>Aspergillus terreus</i> OUCMDZ-1925 | Viscera of <i>C. haematocheilus</i> grown in the waters of the Yellow River Delta | Hybrids | [310] |
| 595–596 | <i>Aspergillus flavus</i> OUCMDZ-2205 | Prawn <i>Penaeus vannamei</i> from the Lianyungang Sea area, Jiangsu Province of China | Indole-diterpenoids | [311] |
| 597 | <i>Stachybotrys</i> sp. MF347 | Driftwood sample collected at Helgoland, North Sea, Germany | Hybrids | [312] |
| 598–600 | <i>Mucor irregularis</i> QEN-189 | Mangrove plant <i>Rhizophora stylosa</i> , Hainan Island, China | Indole-diterpenes | [313] |

2.4.3. Hybrids of peptides and terpenoids (or isoprenyls)

| | | | | |
|---------|--|--|---------------------------------------|-------|
| 601 | <i>Aspergillus ustus</i> NSC-F038 | | Hybrids | [314] |
| 602–604 | <i>Aspergillus</i> sp. | Mussel <i>Mytilus edulis</i> , Noto Peninsula, Sea of Japan | Indole alkaloids | [315] |
| 605 | <i>Aspergillus</i> sp. | Mussel <i>Mytilus edulis</i> , Noto Peninsula, Sea of Japan | Prenylated indole alkaloid | [316] |
| 606–609 | <i>Aspergillus fumigatus</i> | Holothurian <i>S. japonicus</i> , Lingshan Island, Qingdao, China | Prenylated indole diketopiperazine | [317] |
| 610–612 | <i>Aspergillus sydowi</i> PFW1-13 | Driftwood sample beach of Baishamen, Hainan, China | Diketopiperazine alkaloids | [318] |
| 613 | <i>Aspergillus sclerotiorum</i> PT06-1 | Sediments collected in the Putian salt field, Fujian Province of China | Hybrids | [319] |

| Compound | Producing strain | Strain source | Architectural feature | | Ref. |
|----------------------|---|--|--|---------------|-----------|
| 614–615 | <i>Aspergillus fumigatus</i> YK-7 | Sea mud of intertidal zone collected from Yingkou, China | Hybrids | | [320] |
| 616–617 | <i>Aspergillus westerdijkiae</i> DFFSCS013 | Marine sediment sample collected in the South China Sea | Prenylated indole alkaloids | | [321] |
| 618 | <i>Penicillium crustosum</i> HDN153086 | Antarctic sediment, Prydz Bay | Hybrids | | [322] |
| 2.4.4. Other hybrids | | | | | |
| 619 | <i>Penicillium citrinum</i> | Red alga <i>Actinotrichia fragilis</i> , Hedo Cape, Okinawa Island | Hybrids | | [323,324] |
| 620 | <i>Gliocladium</i> sp. YUP08 | Sea mud collected in Rushan, Shandong province, China | Hybrids | | [325,326] |
| 621–622 | <i>Gliocladium</i> sp. YUP08 | Sea mud collected in Rushan, Shandong province, China | Piperazine-2,5-dione derivatives | | [326] |
| 623 | <i>Aspergillus effuses</i> H1-1 | The mud under mangroves along the coast of Fujian province, China | Spiro-polyketide-diketopiperazine hybrid | | [327] |
| 624–625 | <i>Neosartorya fischeri</i> | Marine mud in the intertidal zone of Hainan Province of China | Hybrids | | [328] |
| 626 | <i>Aspergillus versicolor</i> HDN08-60 | Sediments collected in the South China Sea | Hybrids | | [329] |
| 2.5. Others | | | | | |
| 627–628 | <i>Penicillium</i> sp. | Marine alga <i>Enteromorpha Intestinalis</i> | Others | | [330] |
| 629–630 | <i>Penicillium</i> sp. | Sponge <i>Axinella verrucosa</i> , Mediterranean Sea | Others | | [331] |
| 631 | <i>Penicillium</i> sp. | Mangrove | Pyrrolyl alkaloid | 4-quinolinone | [332] |
| 632 | <i>Fusarium incarnatum</i> (HKI0504) | Mangrove plant <i>Aegiceras corniculatum</i> | Others | | [125] |
| 633 | <i>Acremonium strictum</i> | Unidentified sponge collected from Korean waters | Others | | [333] |
| 634 | <i>Penicillium aurantiogriseum</i> | Marine mud of the Bohai Sea | Others | | [334] |

| Compound | Producing strain | Strain source | Architectural feature | Ref. |
|----------|---|---|-----------------------|-------|
| 635 | <i>Penicillium</i> sp. F23-2 | Deep sea | Others | [159] |
| 636–637 | <i>Penicillium paneum</i> SD-44 | Sediment sample collected from the South China Sea | Others | [335] |
| 638–640 | <i>Aspergillus violaceus</i> WZXY-m64-17 | Sponge | Others | [336] |
| 641 | <i>Aspergillus terreus</i> [CFCC 81836] | | Others | [337] |
| 642 | <i>Aspergillus niger</i> BRF-074 | Sediments of the Northeastern coast of Brazil | Others | [338] |