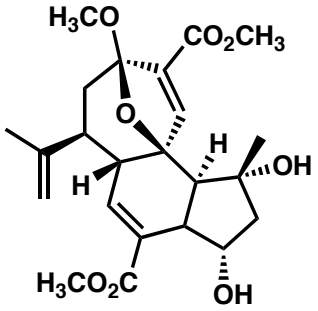
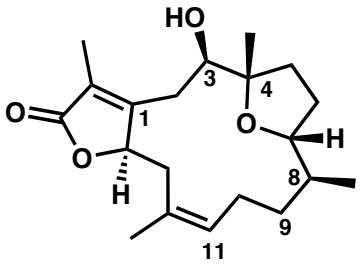
Cembranoids of Marine Invertebrates!

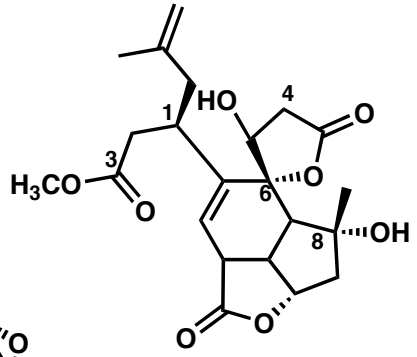
Hundreds of Natural Products, So Little Time



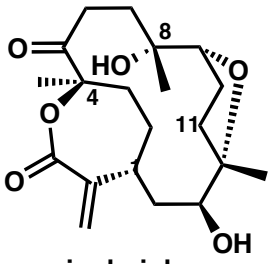
mandapamate



Pachyclavulariolide O
Pachyclavularia violacea

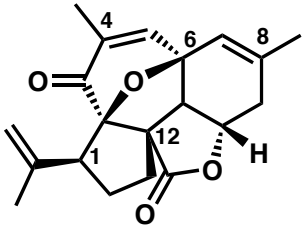


havellockate

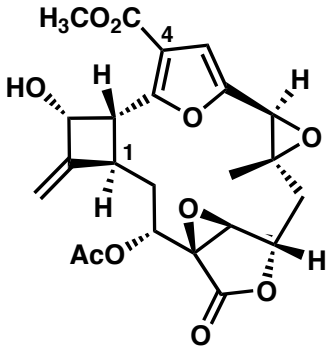


sinulariolone
Sinularia flexibilis

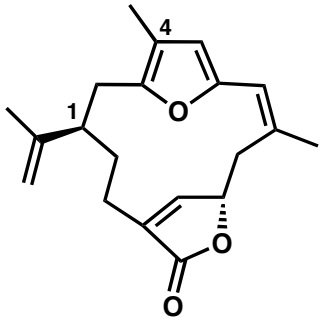
Jennifer Roizen
Stoltz Group Literature Presentation
Noyes 147
8pm, April 17, 2006



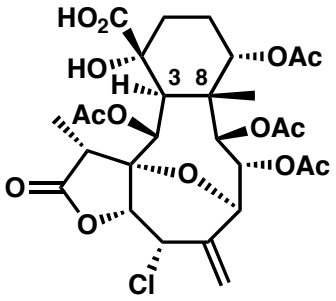
intricarene



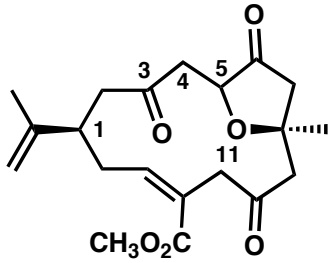
providencin
Pseudopterogorgia kallos



rubifolide
Gersemia rubiformis



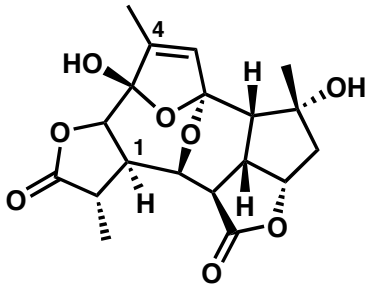
juncin N
Junceella juncea



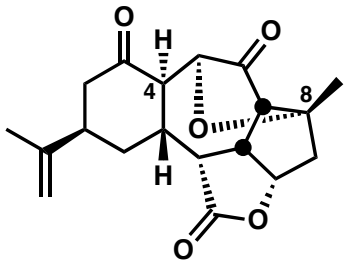
Sinularia granosa

Outline

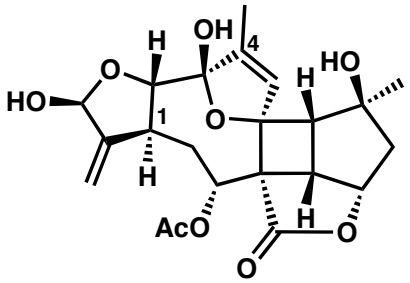
1. ID the cembranoid



verrillin
Pseudopterogorgia bipinnata



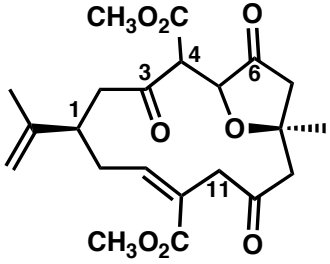
ineleganolide
Sinularia inelegans



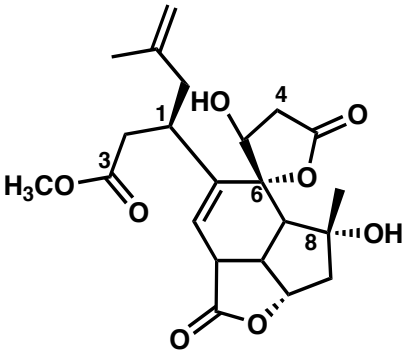
bielschowskysin
Pseudopterogorgia kallos

2. Origins of cembranoids

- **corals**
- **biosynthesis**
- **stereochemical implications**



hypothetical



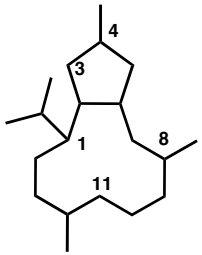
havellockate

Reviews (among others):

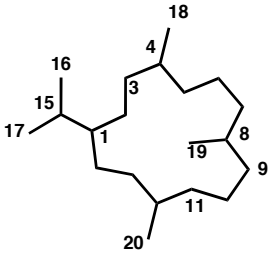
1. Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 - comprehensive review of cembranoids.
2. Kamel, H. N.; Slattery, M. *Pharmaceutical Biology* **2005**, *43*(3), 253-269 - comprehensive review of terpenoids from *Sinularia*.
3. Anything titled "Marine Natural Products" in *Nat. Prod. Rep.* - annual review of marine natural products (Blunt, prev. Faulkner).

Skeletal Terms

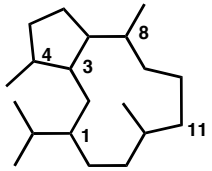
diterpene?



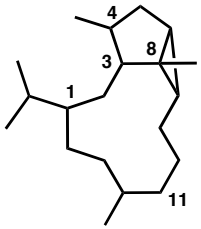
2,6-cyclized cembranoid



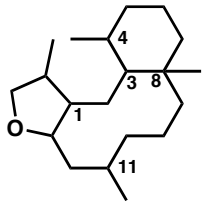
cembrane



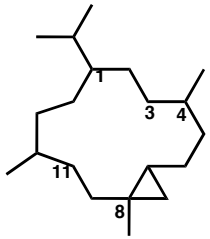
capnosane



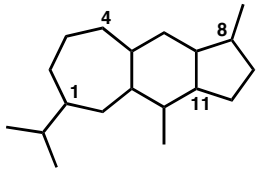
erythranoid



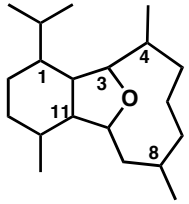
briaran



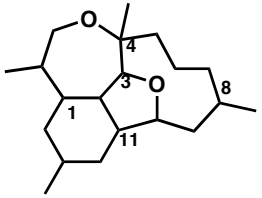
gersolanoid



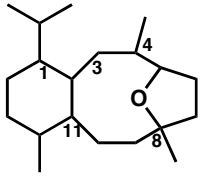
yonarane



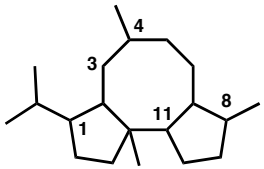
cladiellin



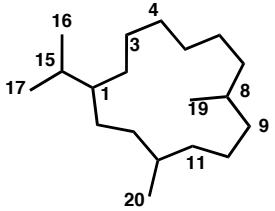
asbestinin



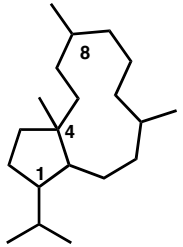
sarcodictyin



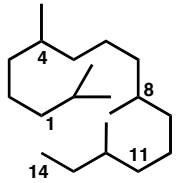
basmane



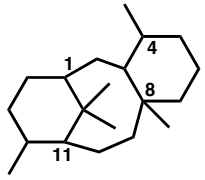
norcembrane



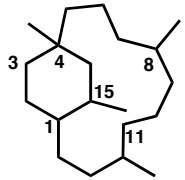
dolabellane



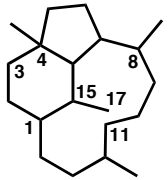
diterpene



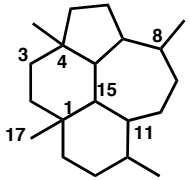
taxane



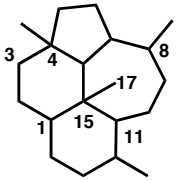
secotrinervitane



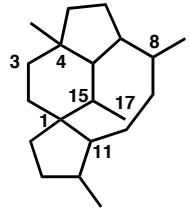
triervitane



rippertane



kempane

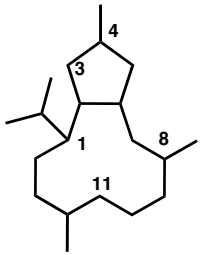


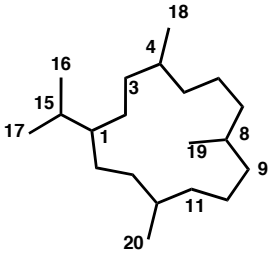
longipane

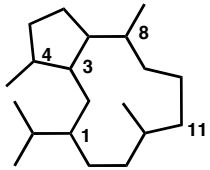
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

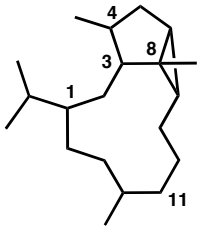
Skeletal Terms

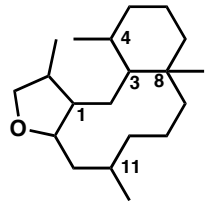
diterpene: composed of 4 isoprene subunits

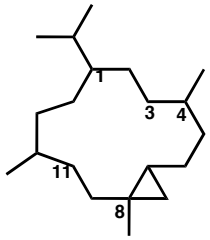


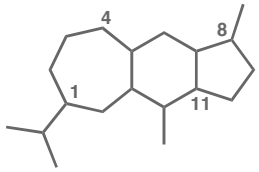


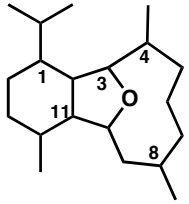


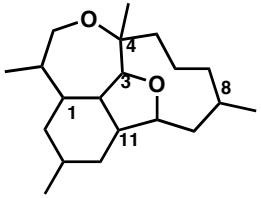


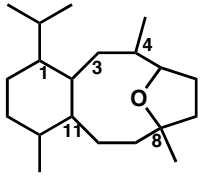


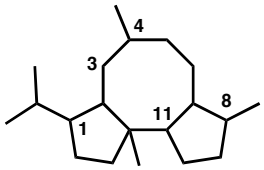


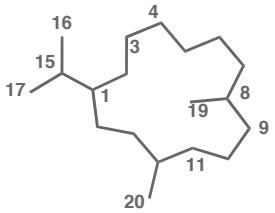


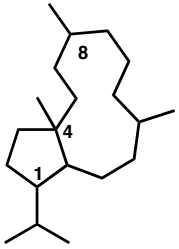


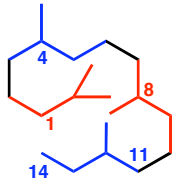


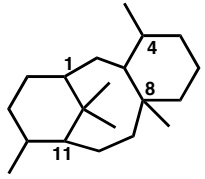


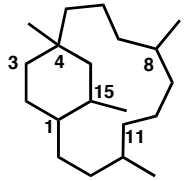


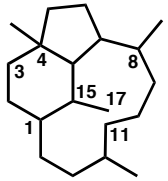


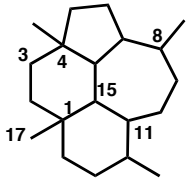


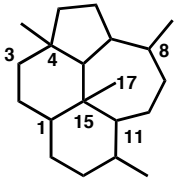


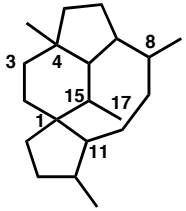








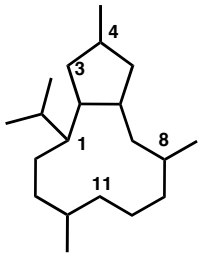




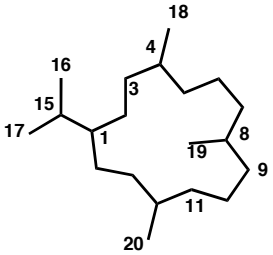
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

Skeletal Terms

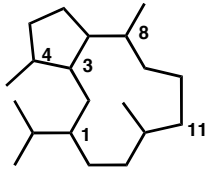
norditerpene?



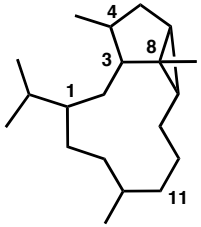
2,6-cyclized cembranoid



cembrane



capnosane



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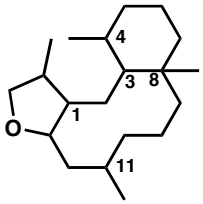

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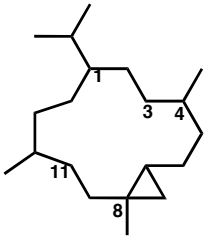

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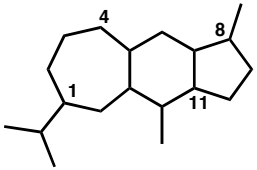

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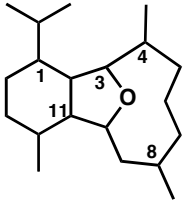

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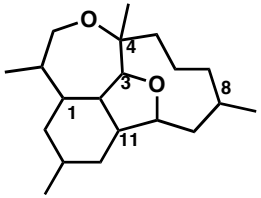

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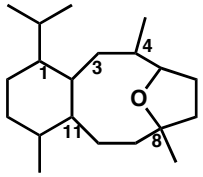

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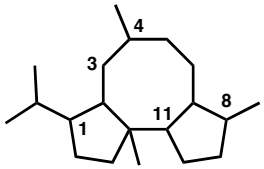

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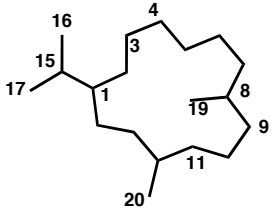

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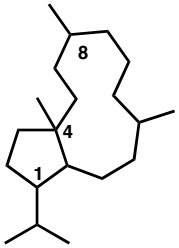

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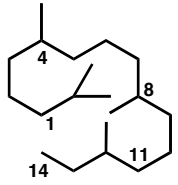

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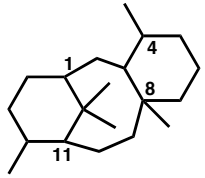

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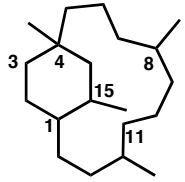

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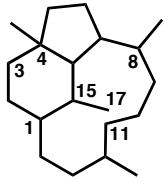

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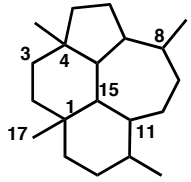
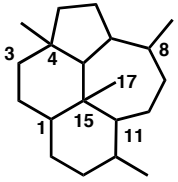
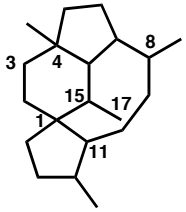


rippertane



kempane

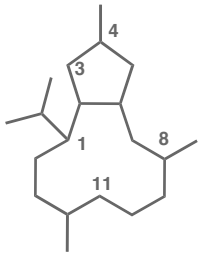


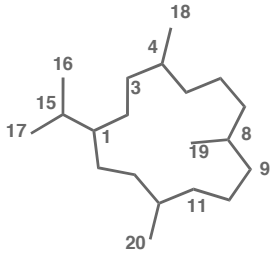
longipane

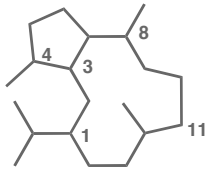
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

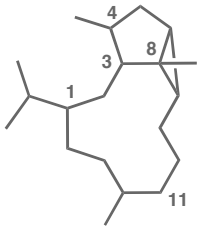
Skeletal Terms

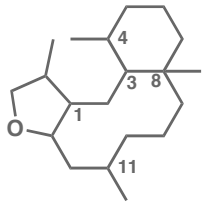
*nor**diterpene: composed of 4 isoprene subunits, sans one (or more) carbons*

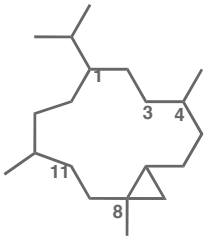


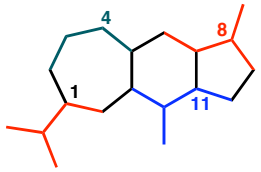


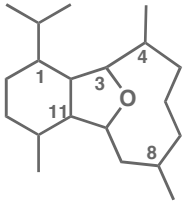


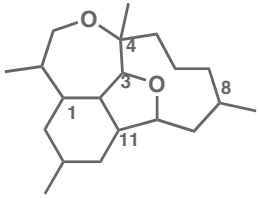


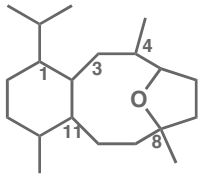


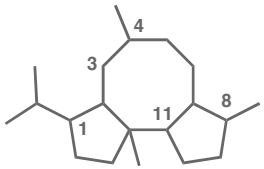


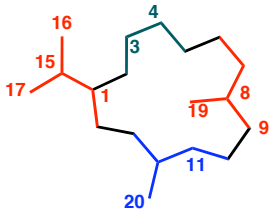


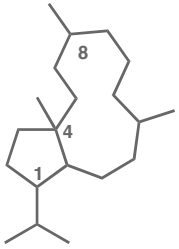


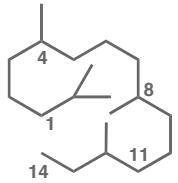


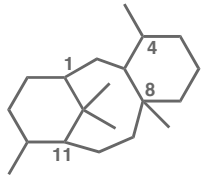


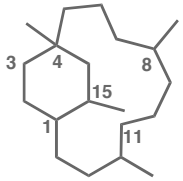


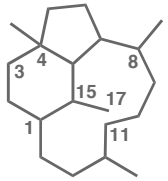


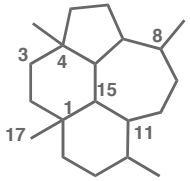


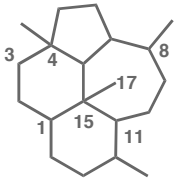


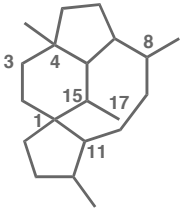








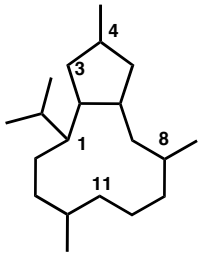




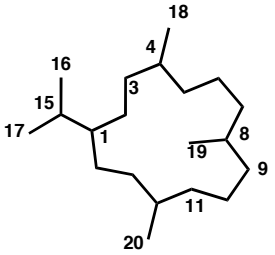
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

Skeletal Terms

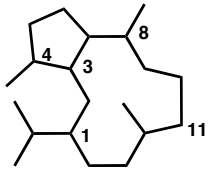
cembrane?



2,6-cyclized cembranoid



cembrane



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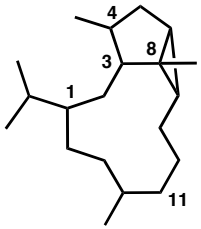

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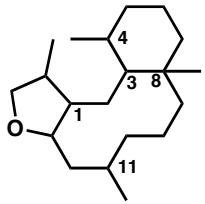

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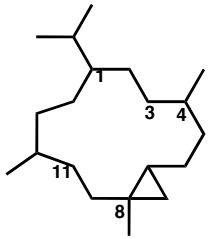

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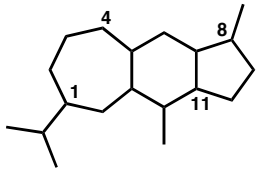

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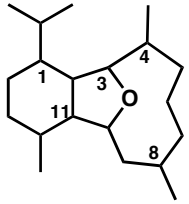

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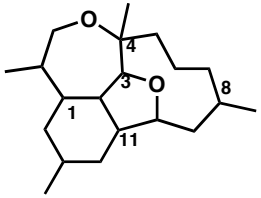

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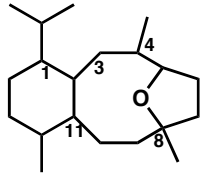

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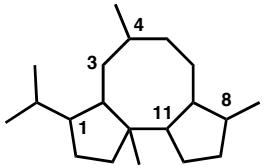

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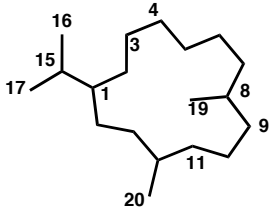

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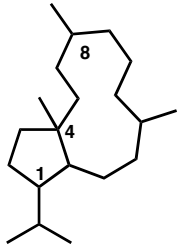
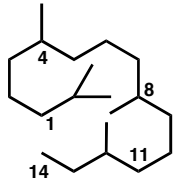
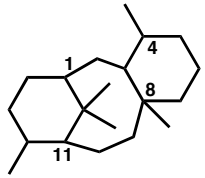


dolabellane



diterpene



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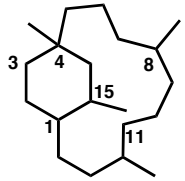

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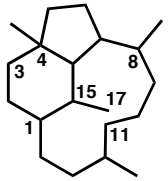

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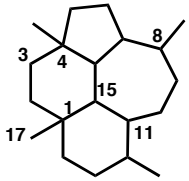

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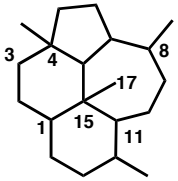

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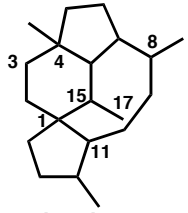
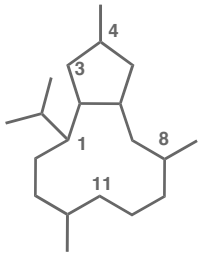


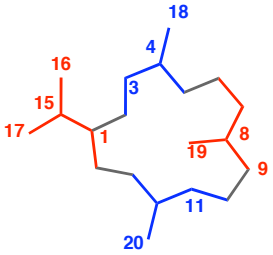
longipane

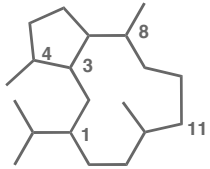
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

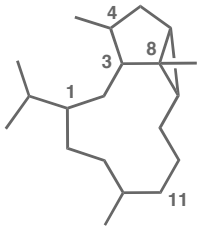
Skeletal Terms

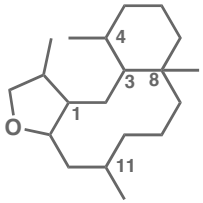
cembrane: natural monocyclic diterpene

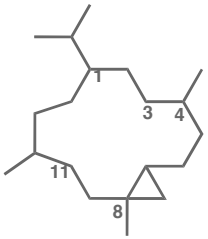


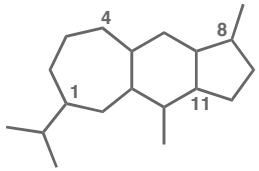


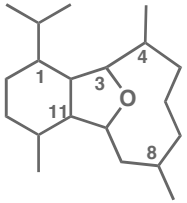


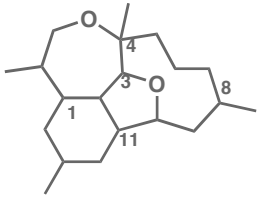


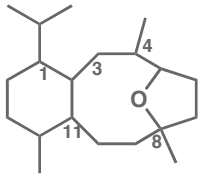


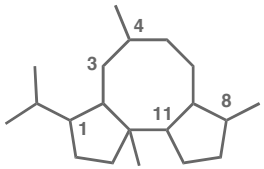


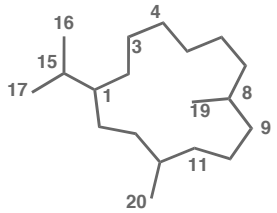


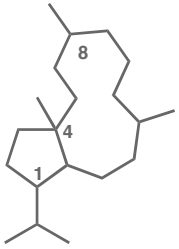


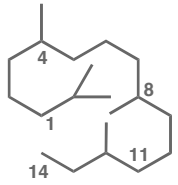


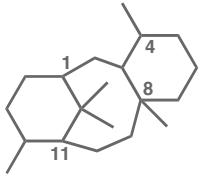


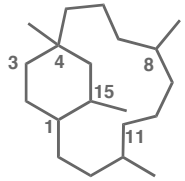


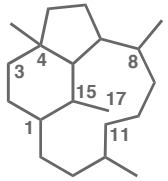


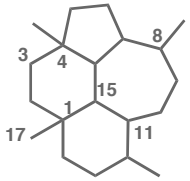


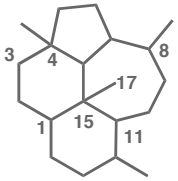


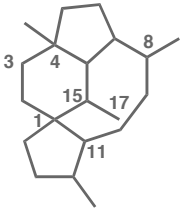








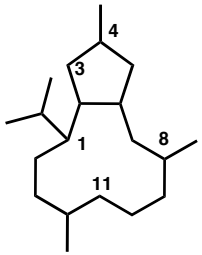




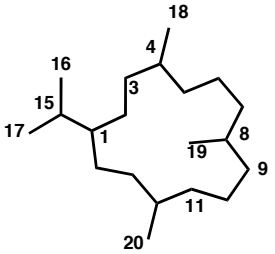
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

Skeletal Terms

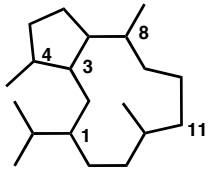
cembranoid?



2,6-cyclized cembranoid



cembrane



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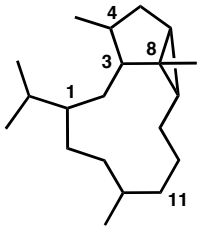

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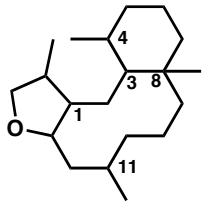

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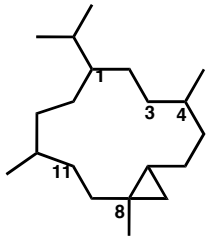

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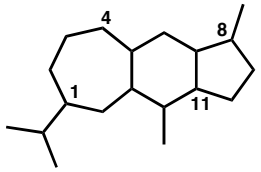

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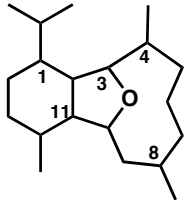

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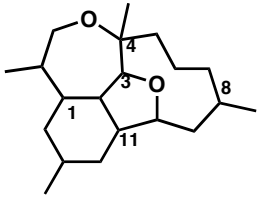

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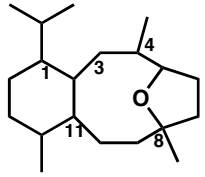

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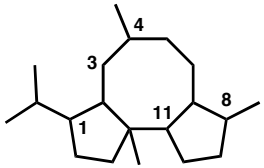

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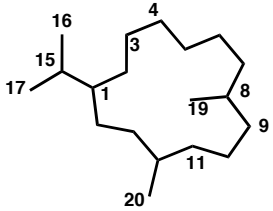

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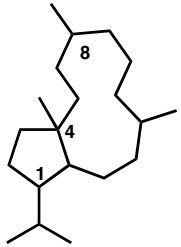

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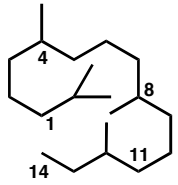

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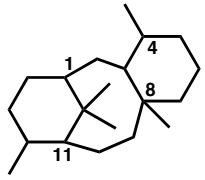

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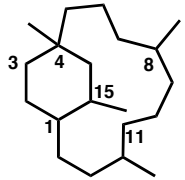

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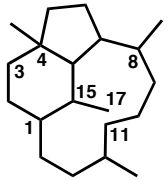

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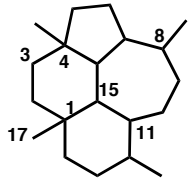

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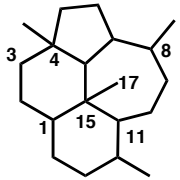

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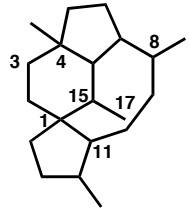
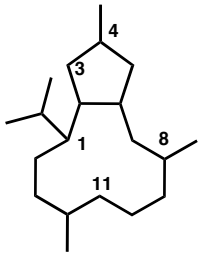


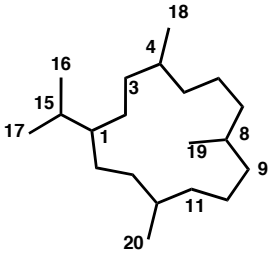
longipane

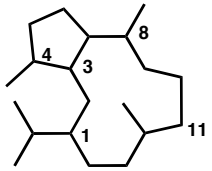
Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

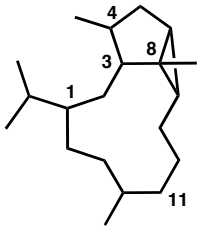
Skeletal Terms

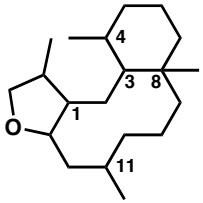
cembranoid: natural monocyclic diterpene derived from cembranes

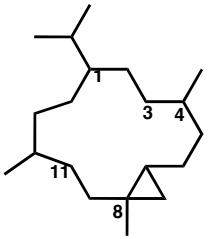


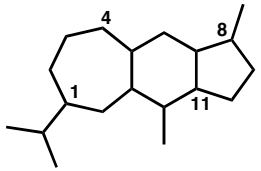


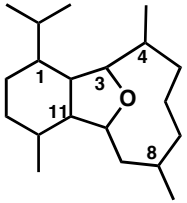


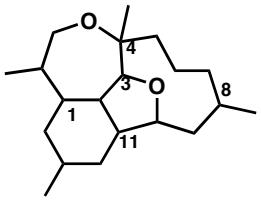


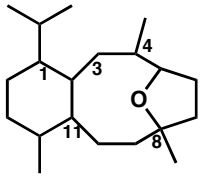


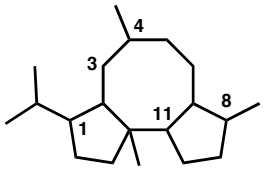


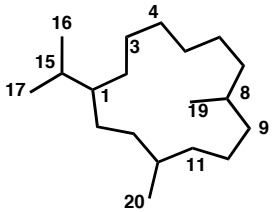


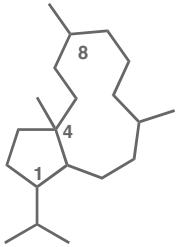


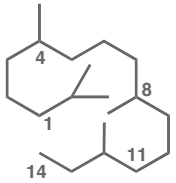


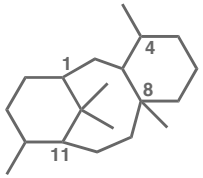


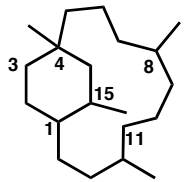


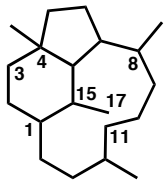


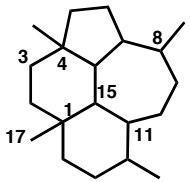


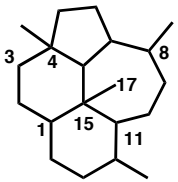


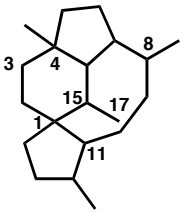












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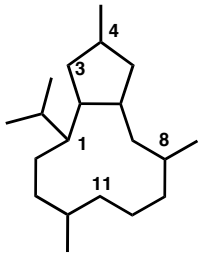
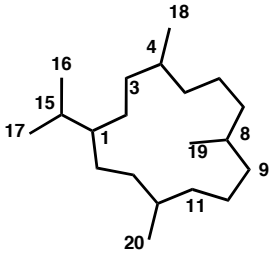
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

Skeletal Origin

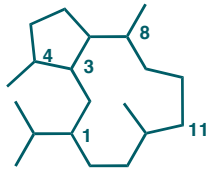
cembranoids are found in marine invertebrates, insects and tobacco



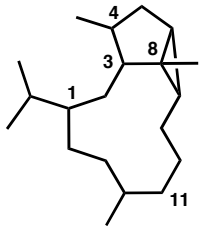
2,6-cyclized cembranoid



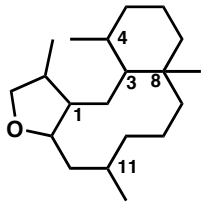
cembrane



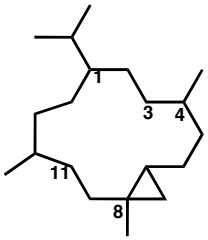
capnosane
(found in tobacco and marine)



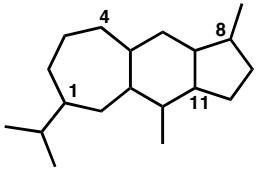
erythranoid



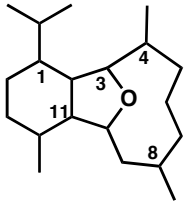
briaran



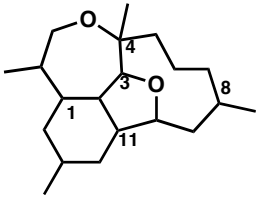
gersolanoid



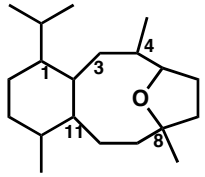
yonarane



cladiellin

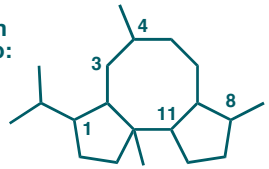


asbestinin

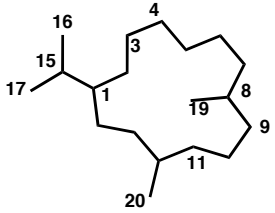


sarcodictyin

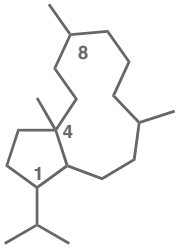
found in tobacco:



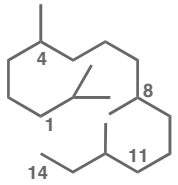
basmane



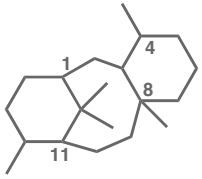
norcembrane



dolabellane



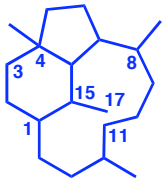
diterpene



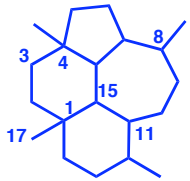
taxane

found in insects:

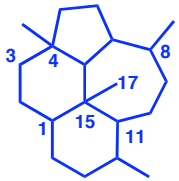
secotrinervitane



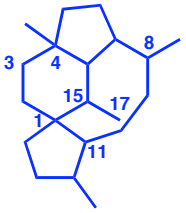
triervitane



rippertane



kempane

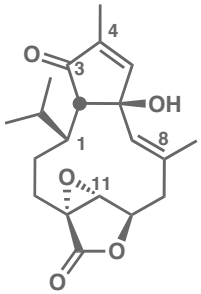


longipane

Most skeletons: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Yonarane skeleton: Iguchi, Kazuo *Tetrahedron Lett.* **1995**, *36*(48), 8807-8808.

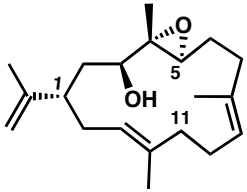
Skeletal Terms

examples



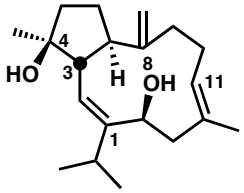
coralloidolide F
Alcyonium coralloides

2,6-cyclized cembranoid



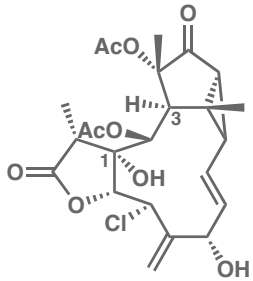
(–)-13-hydroxy-11,12-epoxyneocembrene
absolute stereochemistry
(total synthesis)
Sinularia trocheliophorum

cembrane



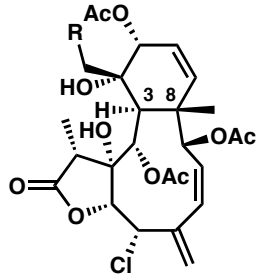
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry

capnosane
(found in tobacco and marine)



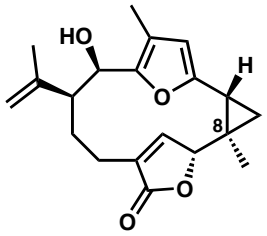
erythrolide V
Erythropodium caribaeorum

erythranoid



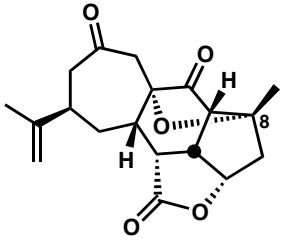
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*

briaran



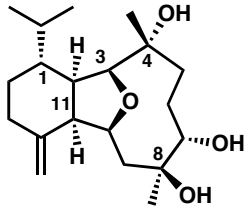
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J

gersolanoid



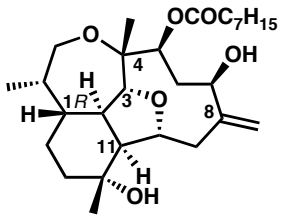
sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)

yonarane



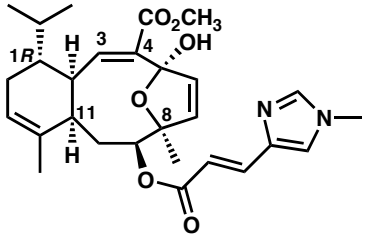
sclerophytin A
total syntheses

cladiellin



briarellin E
Briareum aspestinum
enantioselective total synthesis

asbestinin

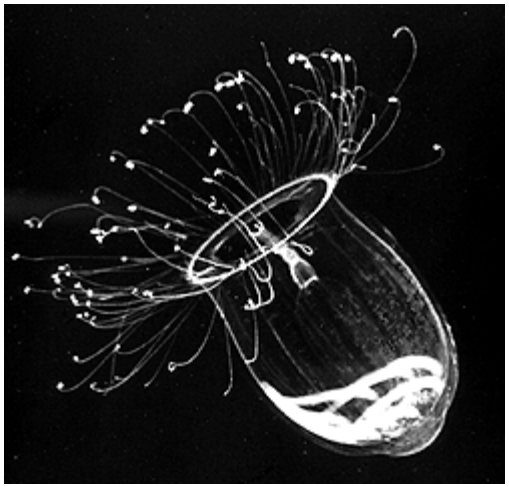


(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

sarcodictyin

Coralloidoilide F: D'Ambrosio, M.A. *et al. Helv. Chim. Acta*, **1990**, *73*, 804-807; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Cembrene: Zhang, T. *et al. Synthesis* **2001**, *3*, 393; sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816.
Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196; Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331;
Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Erythrolide V: Andersen, R. J. *et al. Eur. J. Org. Chem.* **2003**, 3515.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650 ; isolation: Rodríguez, A. D. *Chem. Pharm. Bull.* **1995**, *43*, 1853.
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368.
Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

Taxonomic Relationships

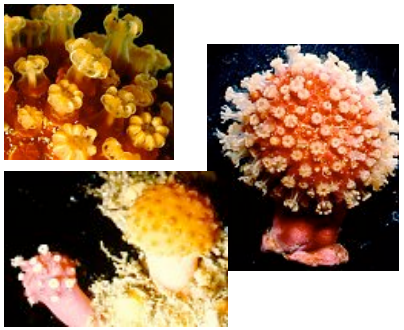


Aglantha digitale
mouth, radial symmetry, gonads, nematocysts (tentacles with singing cells), carnivorous

PHYLUM Coelenterata (Cnidaria)

SUBPHYLUM Anthozoa
(lack medusa stage = "adult" sexual phase)

CLASS Alcyontaria
(8 pinnate tentacles / polyp)



Alcyonium variable

ORDER Alcyonacea
Gorgonacea
Pennatulacea
Stolonifera
Telestacea

soft corals
0-75% $CaCO_3$ per colony

Coenothecalea

Scleractina

hard corals
95% $CaCO_3$ per colony

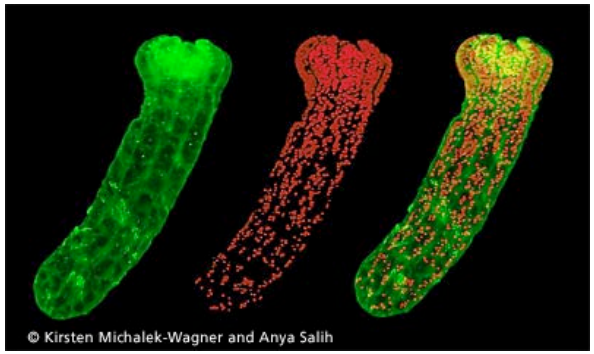
Zoantharia
(6 pinnate tentacles / polyp)

Actiniaria
Corallimorpharia
Zoanthiniaria (Zoanthidae)

Acropora
(scleractina)

(other SUBPHYLUM Medusozoa)

Aglantha digitale: Fautin, Daphne G. and Romano, Sandra L. 1997. Cnidaria. Sea anemones, corals, jellyfish, sea pens, hydra. Version 24 April 1997. http://tolweb.org/Cnidaria/2461/1997.04.24 in The Tree of Life Web Project, http://tolweb.org
Alcyonium variable: http://www.museums.org.za/bio/cnidaria/alcyonacea.htm
Acropora: people.hws.edu/mitchell/cards01/LEI2.html
Taxonomic relationships: Coll, John C. *Chem. Rev.* **1992**, *92*(4), 613-631.
Cool taxonomic tree: http://www.aims.gov.au/pages/reflib/bigbank/images/bb44a.gif



Lobophytum compactum
polyp tissue (green); zooxanthellae (red)

Corals

simple animals with endo-symbiotic algae (zooxanthellae)

Corals derive energy from:
(1) carnivorous consumption
(2) photosynthesis by internal algae

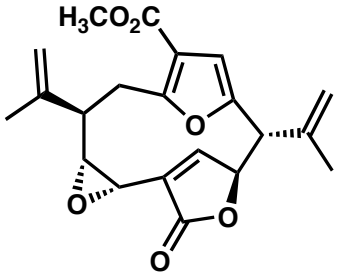
Cembranoids in corals - formed by zooxanthellae or made by corals

Evidence:

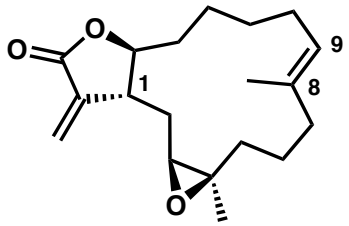
(1) *Pseudopterogorgia acerosa* with pseudopterolide without zooxanthellae
- could be dietary in origin

(2) larvae from *Lobophytum compactum* reared with and without zooxanthellae with isolobophytolide

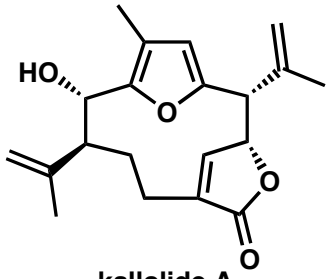
(3) ^{3}H-labeled precursor (GGPP) converted to kallolide A by zooxanthellae



pseudopterolide
abs. by X-ray of derivative



isolobophytolide



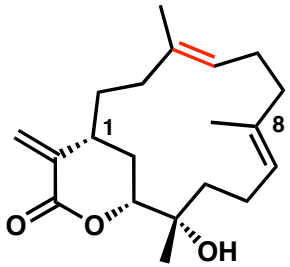
kallolide A
Symbiodinium (zooxanthellae)

Lobophytum compactum: http://www.reefed.edu.au/explorer/landscapes/reefs/
Pseudopterolide: Fenical, W.; Clardy, J. *et al. J. Am. Chem. Soc.* **1982**, *104*, 6463-6466.
Isolobophytolide: Michalek-Wagner, K. *et al. Marine Biology* **2001**, *138*, 753-760.
Kallolide A: Kerr, R. G. *et al. Mar. Ecol. Prog. Ser.* **2005**, *303*, 105-111.

Reasons for Being

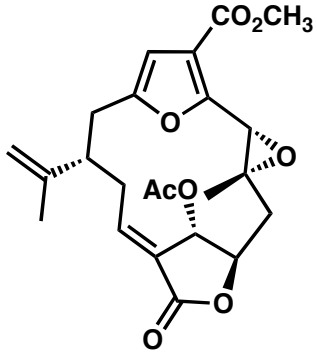
role of cembranoids in coral colonies

(1) Toxic to fish (mosquitofish)



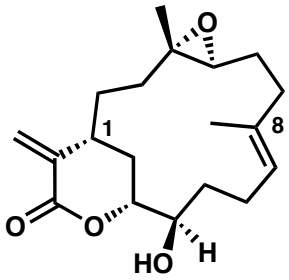
Uchio's toxin
Sinularia flexibilis

(2) Feeding deterrence (local reef fish)



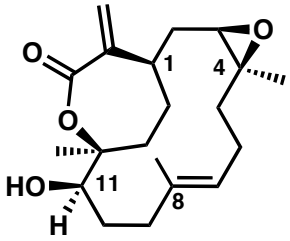
Sinularia maxima

(3) Allelopathy (to eliminate the competition)



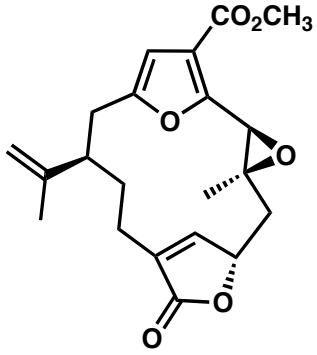
Flexibilide
Sinularia flexibilis
killed hard coral at 5-10 ppm over 8 h

(4) Antifouling (to limit / select algae)

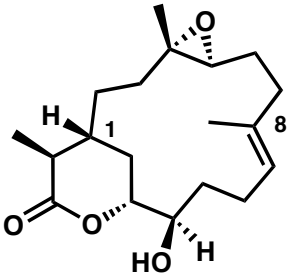


Sinulariolide
Sinularia flexibilis
absolute configuration

(5) spawning (expulsion of egg from polyp)



pukalide
Sinularia polydactyla
absolute configuration
by synthesis of unnatural deoxypukalide

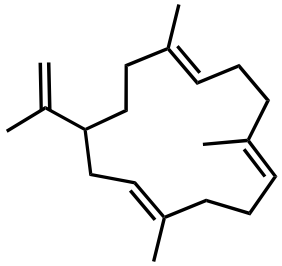


Dihydroflexibilide
Sinularia flexibilis

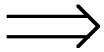
Coll, J. C. *Chem. Rev.* **1992**, *92*(4), 613-631 (review).
Pukalide absolute configuration: Marshall, J. A. *et al. J. Org. Chem.* **2001**, *66*, 8037-8041.

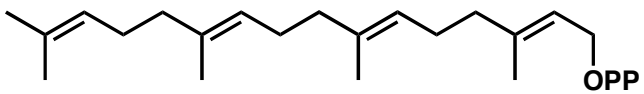
Biogenesis of Cembranes

Lessons from terrestrial metabolism applied to marine organisms

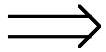


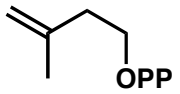
a cembrane





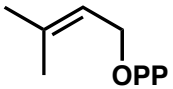
geranylgeranyl diphosphate (GGPP)



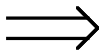


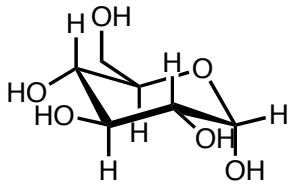
isopentyl diphosphate (IPP)

+



dimethyl allyl diphosphate (DMAPP)



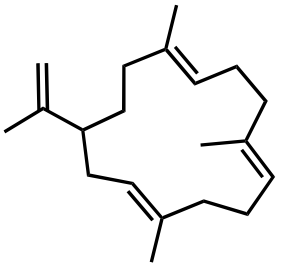


D-Glucose

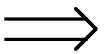
Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).

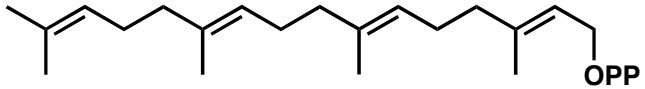
Biogenesis of Cembranes

Lessons from terrestrial metabolism applied to marine organisms

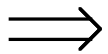


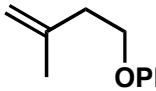
a cembrane





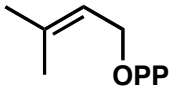
geranylgeranyl diphosphate (GGPP)



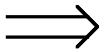


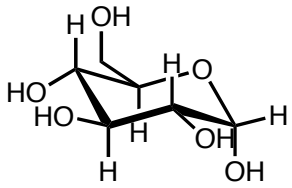
isopentyl diphosphate (IPP)

+



dimethyl allyl diphosphate (DMAPP)





D-Glucose

Marine metabolism:

(1) symbiotic associations

(2) seawater pH~ 8.2-8.5 ($NaHCO_3$/Na_2CO_3), 40% salt with osmotoic pressure 15-25 atm
- **unique cellular strucutres to cope with marine environment**

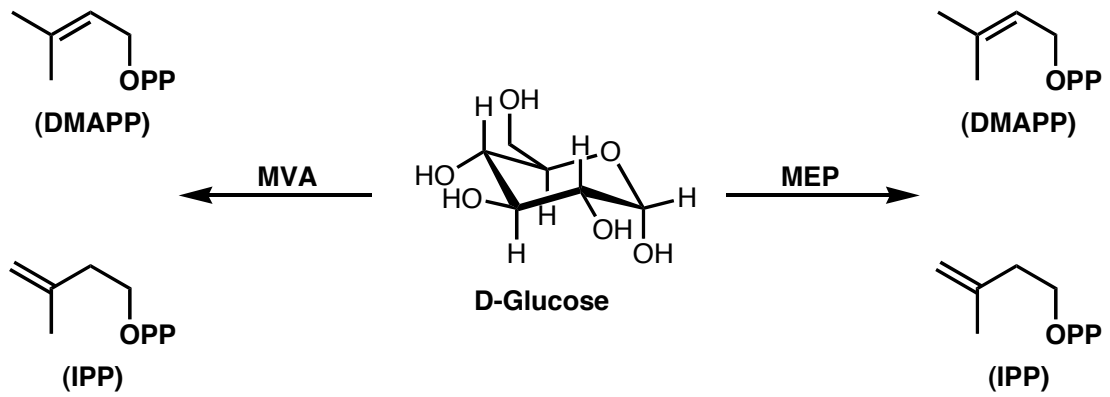
(3) halogens, isocyanates rare in terrestrial metabolites

(4) product absolute stereochemistry may differ

Garson, M. J. *J. Nat. Prod. Res.* **1989**, *6*(2), 143-170 (review).
Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).

Pathway Comparison

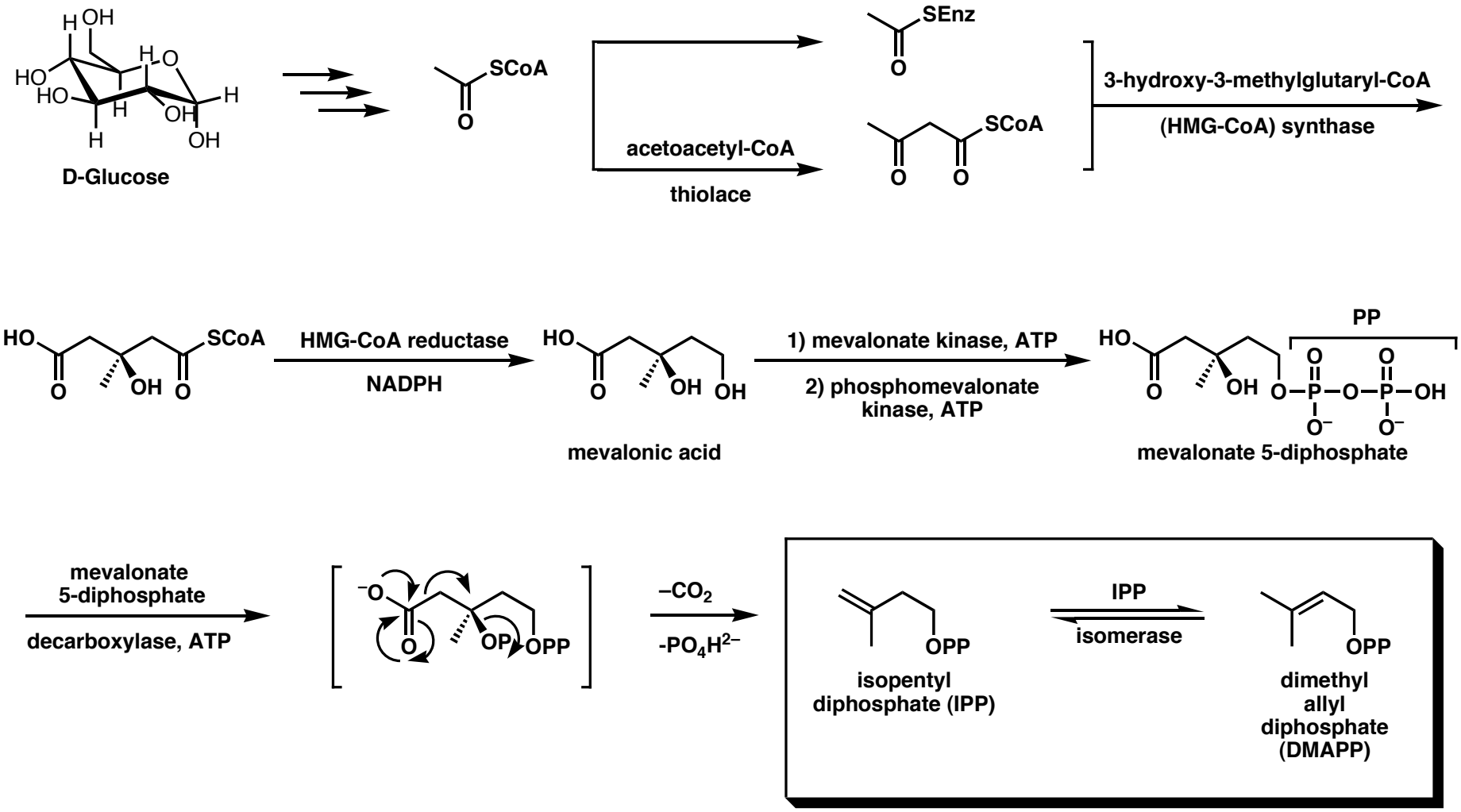
Mevalonate (MVA) Pathway; Methylerythritol Phosphate (MEP) Pathway



Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).

Mevalonate Pathway

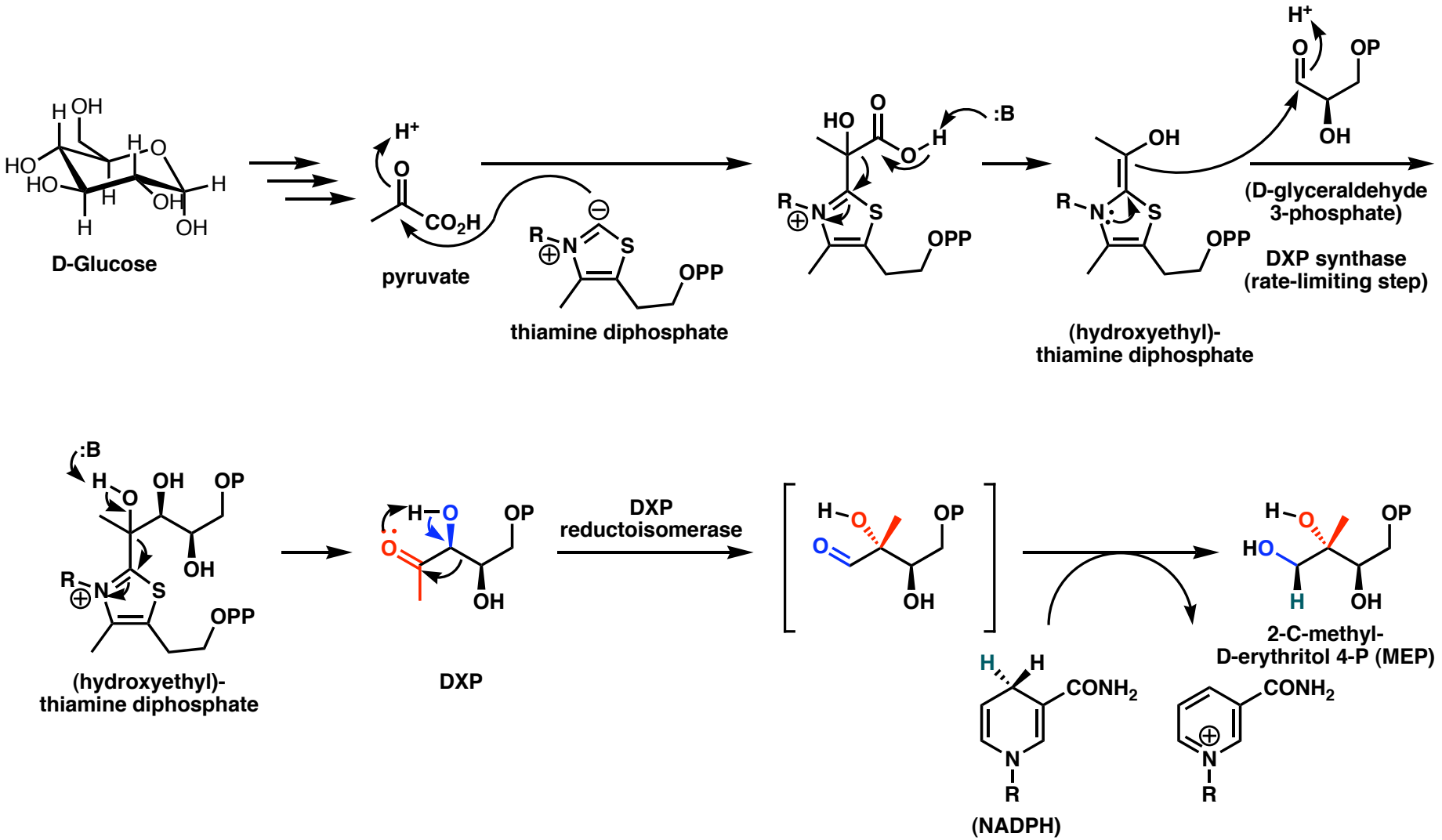
to geranylgeranyl diphosphate



Dewick, P. M. *Nat. Prod. Rep.* **1999**, *16*, 97-130 (review).

Deoxyxylulose Phosphate Pathway

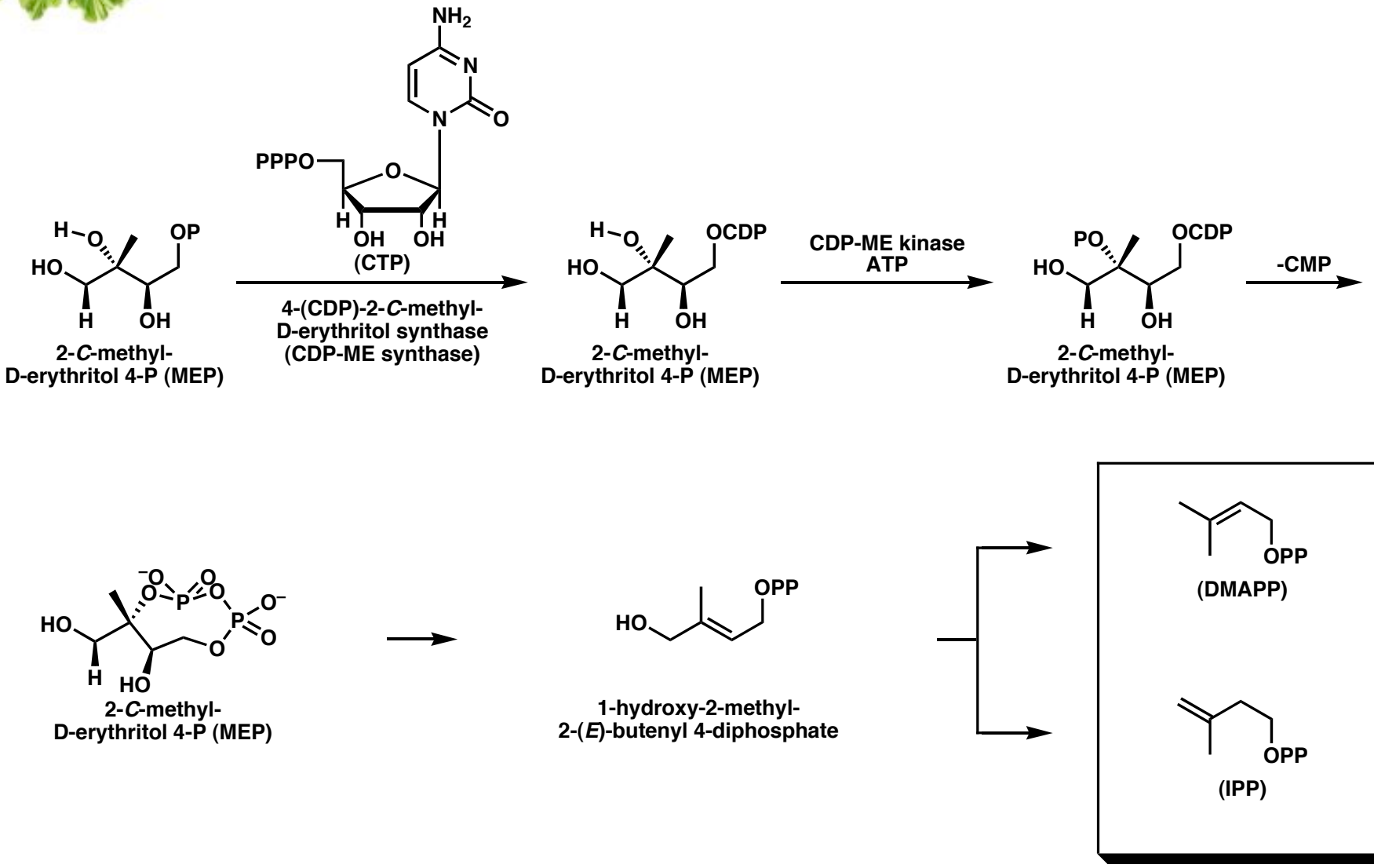
Methylerythritol Phosphate Pathway; Mevalonate-Independent Pathway



Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).

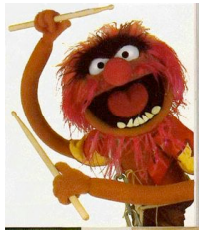
Deoxyxylulose Phosphate Pathway

Methylerythritol Phosphate Pathway; Mevalonate-Independent Pathway



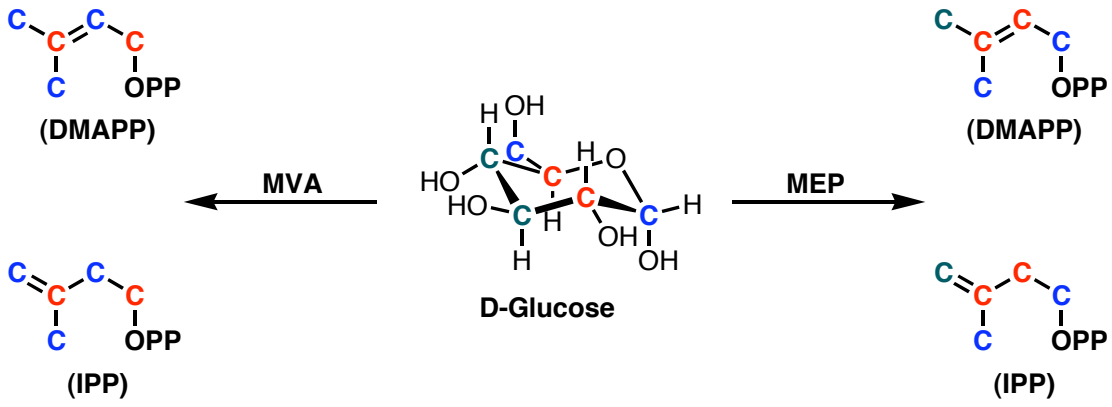
Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).

Green algae image: http://www.cryptogamicbotany.com/oa_chlorophyta_01.html



Pathway Comparison

Mevalonate (MVA) Pathway; Methylerythritol Phosphate (MEP) Pathway



Animals
Archaea
Fungi

Plants
Eubacteria

Green Algae

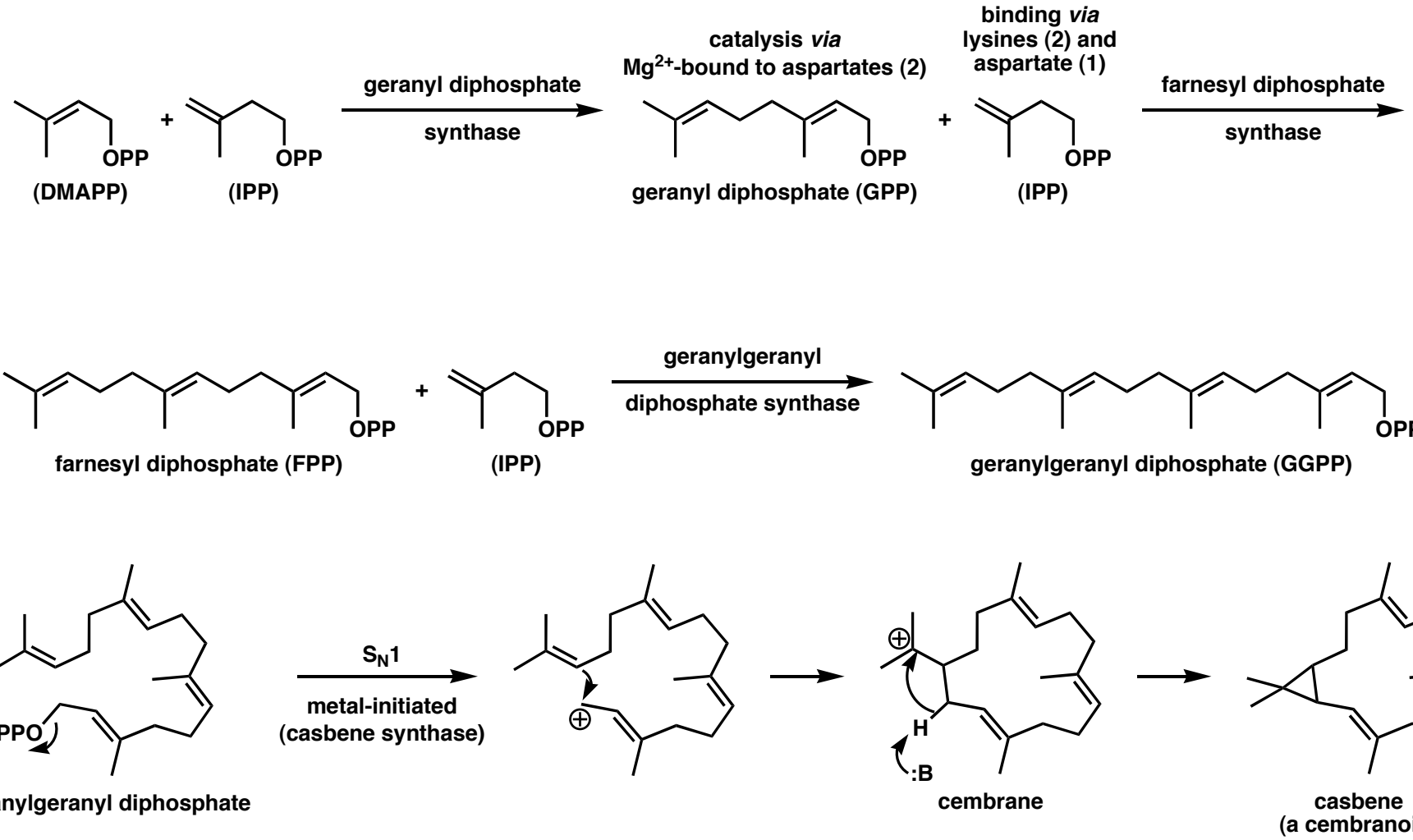
In bacteria:
MVP in cytosol
(steroids, triterpenoids, sesquiterpenoids)

MEP in plastids
(monoterpenes, diterpenes, sesquiterpenes, tetraterpenes)

Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).
Animal image: http://www.youam.de/~alphascorpii/img/animal.jpg

Away We Go

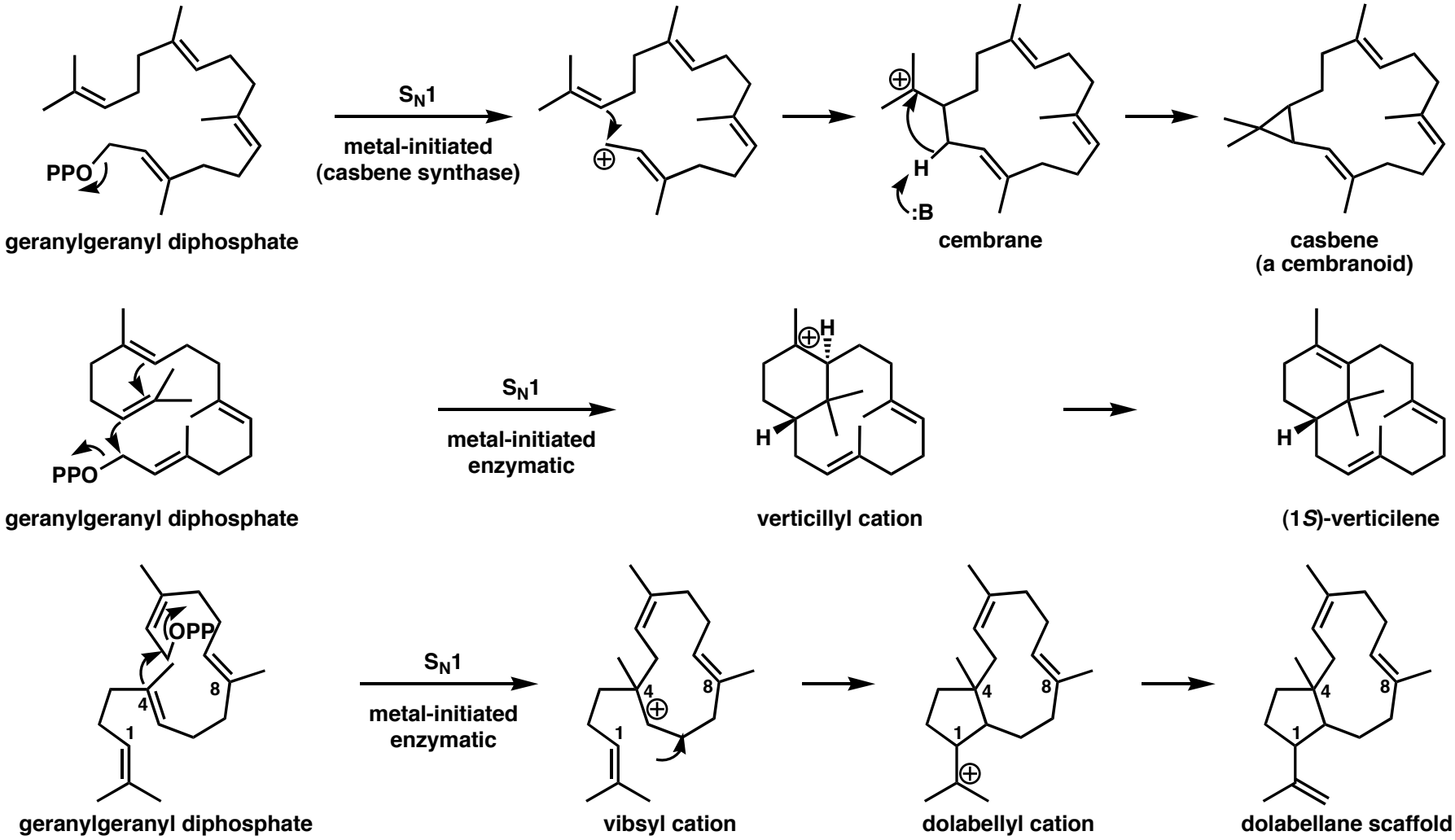
To a Cembrane via Geranylgeranyl Diphosphate



Dewick, P. M. *Nat. Prod. Rep.* **2002**, *19*, 181-222 (review).
Eisenreich, W. *et al. Cell. Mol. Life Sci.* **2004**, *61*, 1401-1426 (review).
chain length control: Nishino, T. *et al. J. Biol. Chem.* **1996**, *27*(31), 18831-18837.
residues binding GPP and IPP: Koyama, T. *et al. Biochemistry* **1996**, *35*(29), 9533-9538.
Casbene examples (in review): Dewick, P. M. *Nat. Prod. Rep.* **1999**, *16*, 97-130.

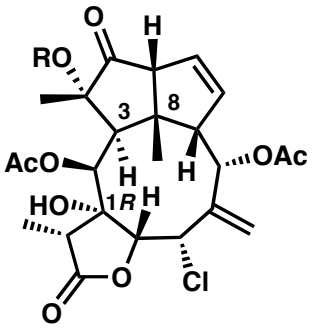
Biosynthesis of Cembranoids v. Non-cembranoids

revisiting skeletal terms

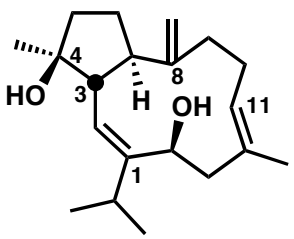


Dolabellane review: Hiersemann, M.; Helmboldt, H. *Top. Curr. Chem.* **2005**, *243*, 73-136.
Verticilene and Casbene examples: Dewick, P. M. *Nat. Prod. Rep.* **1999**, *16*, 97-130 (review).

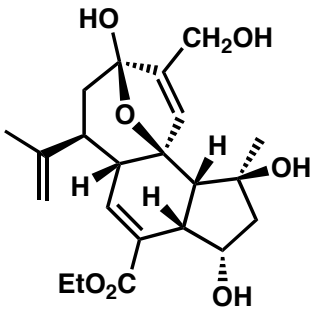
More Complex Cembranoids



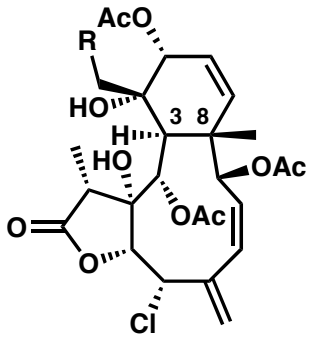
aquariolide A, R=H
Erythropodium caribaeorum
absolute stereochemistry (ROSEY, NMR)



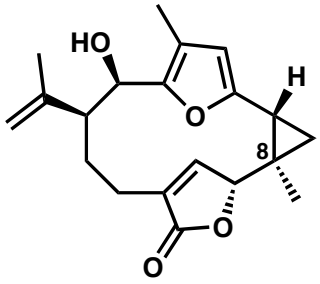
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry



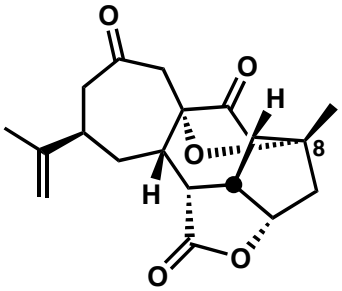
plumarellic acid



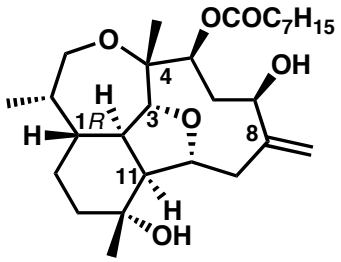
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*



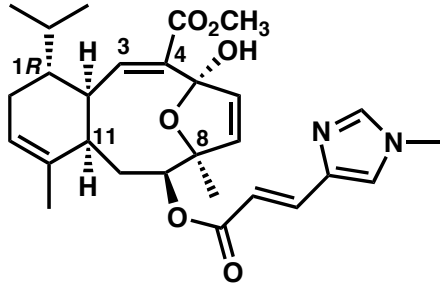
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J



sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)



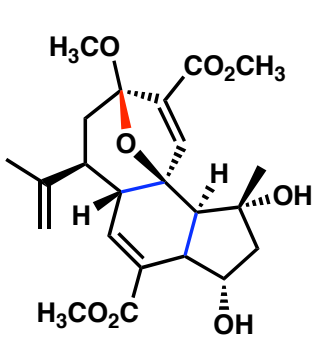
briarellin E
Briareum aspestinum
enantioselective total synthesis



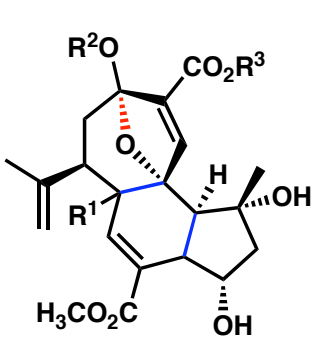
(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

Aquariolide A: Andersen, R. J. *Org. Lett.* **2002**, *4*, 4085; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816;Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196.
Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331; Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368; Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

Yonaranes and more!



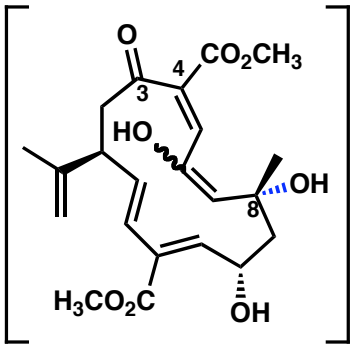
mandapamate

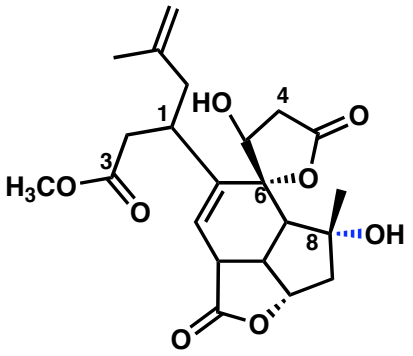


isomandapamate
R^1=b-H, R^2=CH_3, R^3=CH_3
bishomoisomandapamate
R^1=a-H, R^2=Et, R^3=Et

Inverse-demand Diels-Alder

hemiketalization

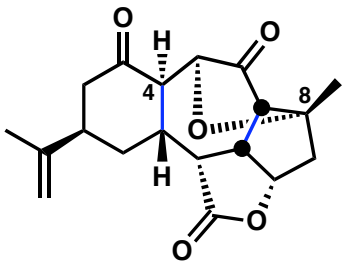




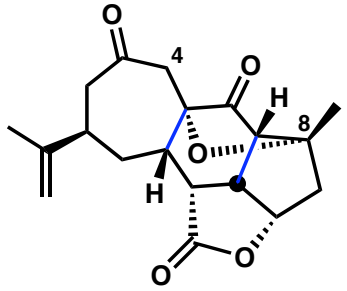
havellockate

furan

retro-aldol-like C(3)-C(4) break

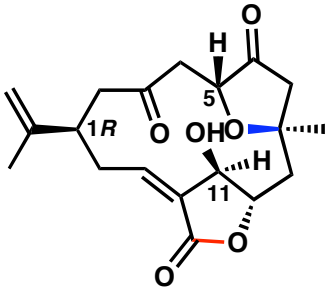


ineleganolide
Sinularia inelegans



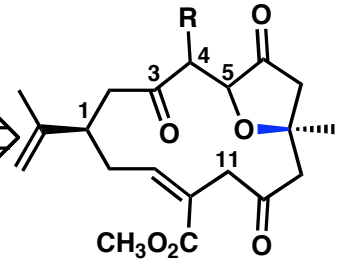
sinulochmodin C
Sinularia lochmodes

Double Michael Addition



sinuleptolide (71)
absolute stereochemistry (Mosher)
Sinularia dissecta

reductive condensation

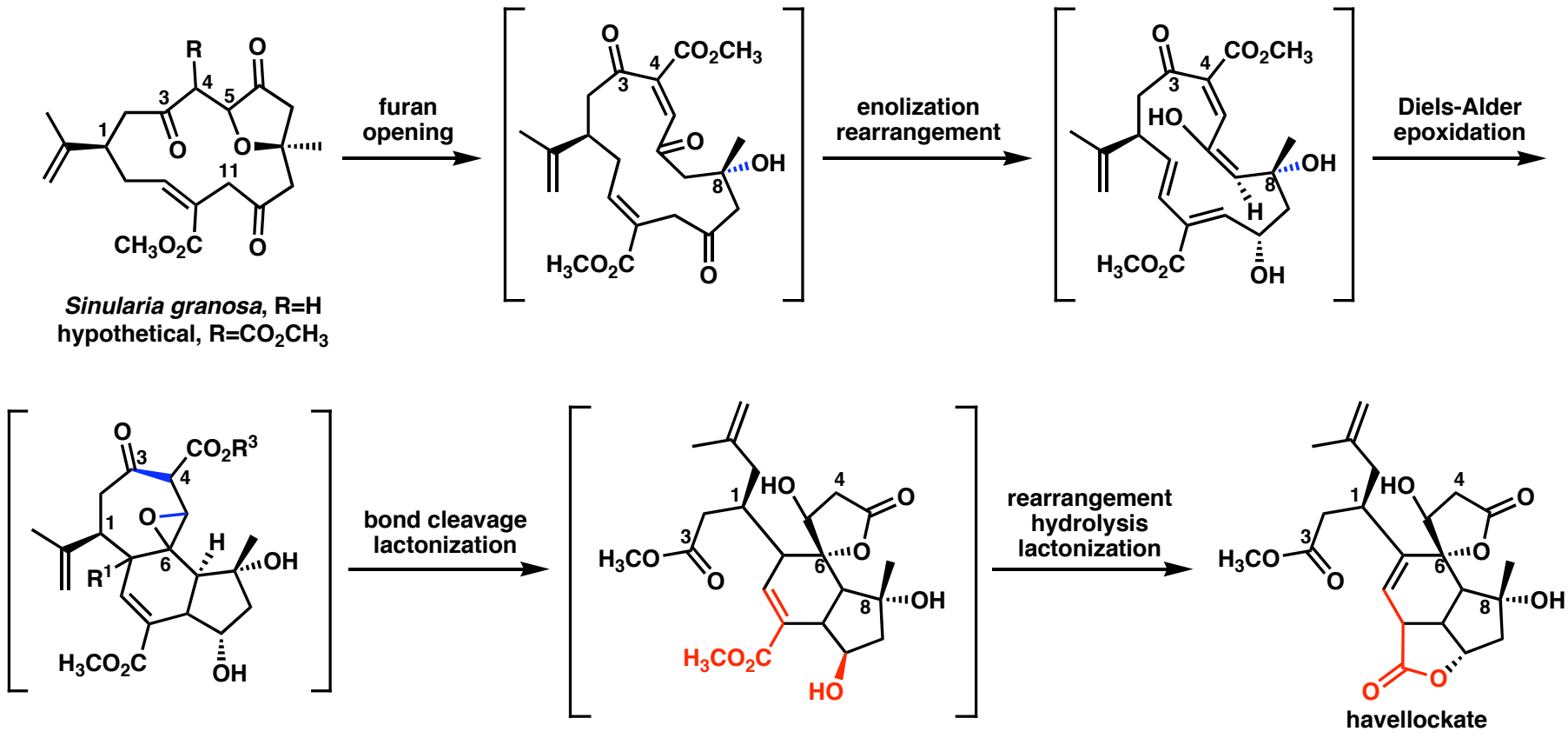


***Sinularia granosa*, R=H**
hypothetical, R=CO_2CH_3

Ineleganolide: Duh, C.-Y. *et al. Tetrahedron Lett.* **1999**, *40*, 6033-6035.
Mandapamates, havellockate norcembrene and biosynthetic proposal thereof: Anjaneyulu, A. S. R. *et al. Indian Journal of Chemistry* **2000**, *39B*, 530-535.
Sinulochmodin C and sinuleptolide: Sheu, J.-H. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816.

Disclaimer: Retrosynthetic analysis for ineleganolide, sinuleptolide proposed by me.

Proposed Biogenesis of Havellockate



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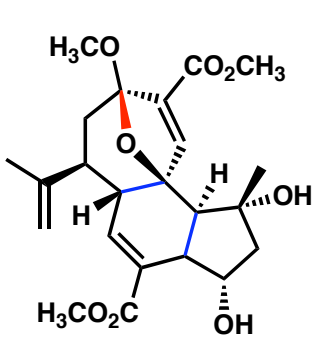
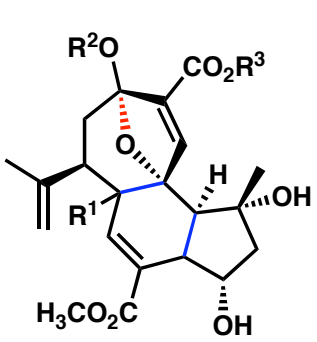
Biosynthetic proposal: Anjaneyulu, A. S. R. *et al. Indian Journal of Chemistry* **2000**, *39B*, 530-535.

Yonaranes and more!



mandapamate



isomandapamate
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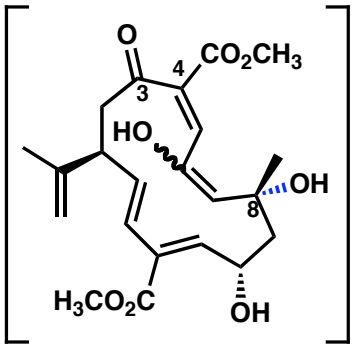
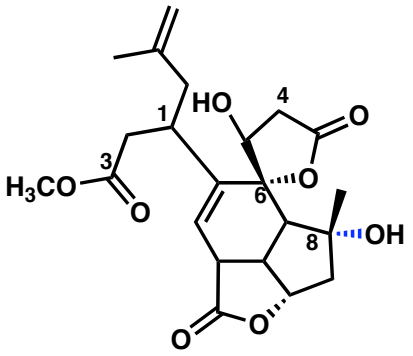
bishomoisomandapamate
R^1=a-H, R^2=Et, R^3=Et

Inverse-demand Diels-Alder

hemiketalization

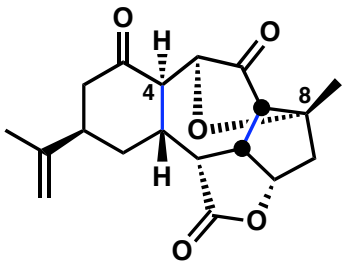




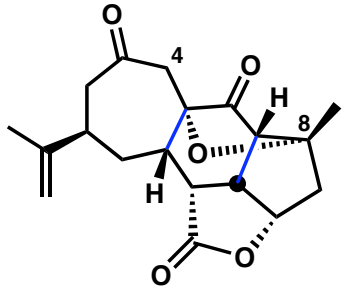
havellockate

furan

retro-aldol-like C(3)-C(4) break



ineleganolide
Sinularia inelegans



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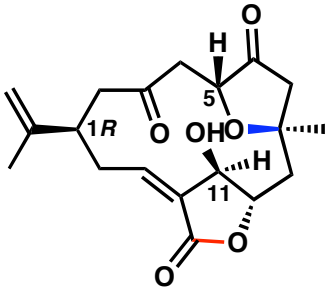
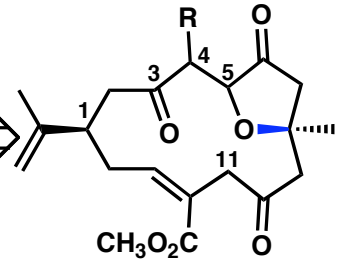
Sinularia lochmodes

Double Michael Addition



sinuleptolide (71)
absolute stereochemistry (Mosher)
Sinularia dissecta

reductive condensation



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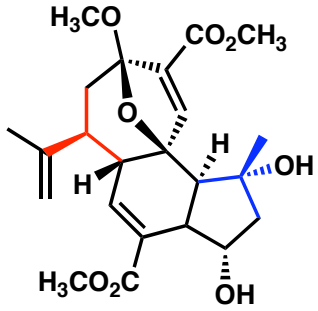
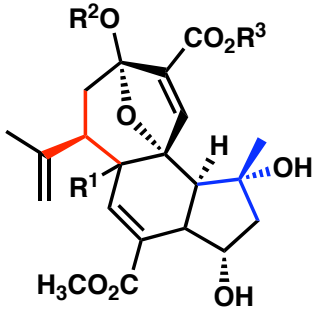
Disclaimer: Retrosynthetic analysis for ineleganolide, sinuleptolide proposed by me.

C(1)–C(8) Stereochemistry

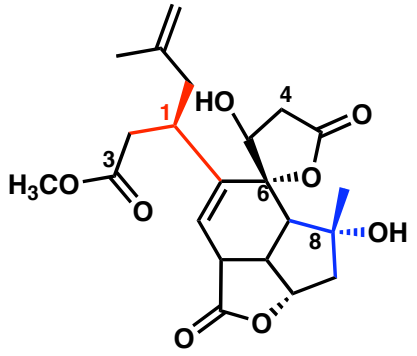
Not Enough Data



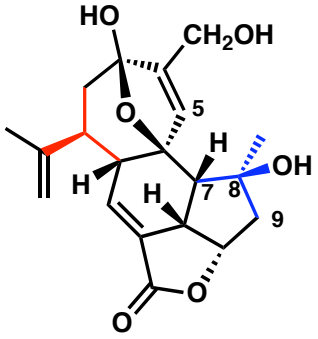
mandapamate



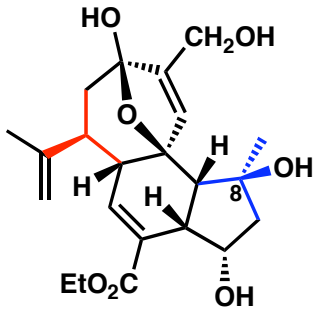
isomandapamate
R^1=b-H, R^2=CH_3, R^3=CH_3
bishomoisomandapamate
R^1=a-H, R^2=Et, R^3=Et



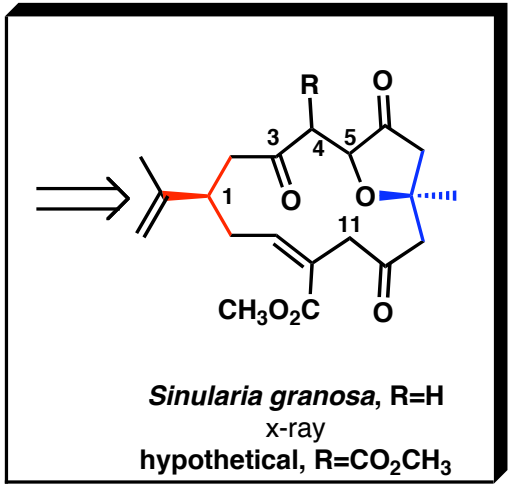
havellockate
x-ray



plumarellide
NOE with CH_3-19 and H-5,7,9β



plumarellic acid
NOE with CH_3-19 and H-5,7,9α,β



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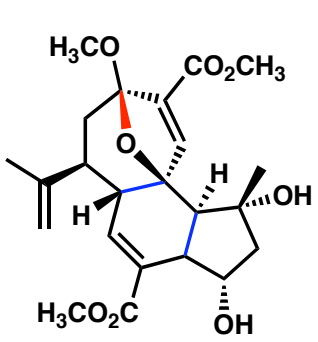
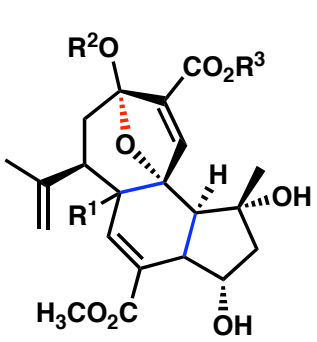
Plumarellide and plumarellic acid: Stonik, V. A. *Tetrahedron Lett.* **2002**, *43*, 315-317.

Yonaranes and more!



mandapamate



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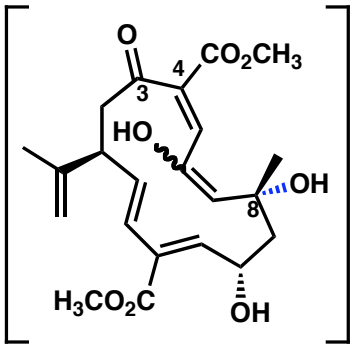
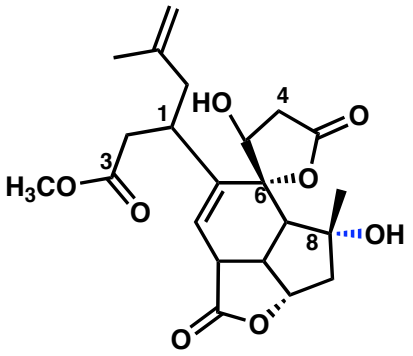
Inverse-demand Diels-Alder

hemiketalization

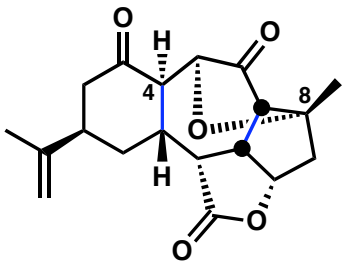




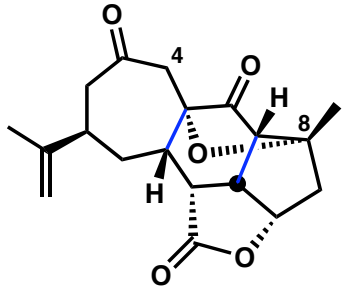
havellockate

furan

retro-aldol-like C(3)-C(4) break

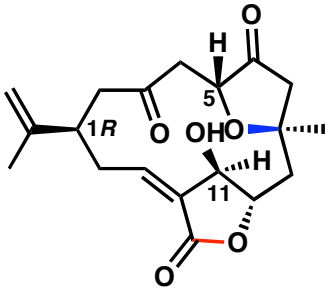


ineleganolide
Sinularia inelegans



sinulochmodin C
Sinularia lochmodes

Double Michael Addition



sinuleptolide (71)
absolute stereochemistry (Mosher)
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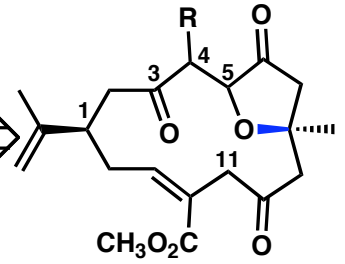
reductive condensation



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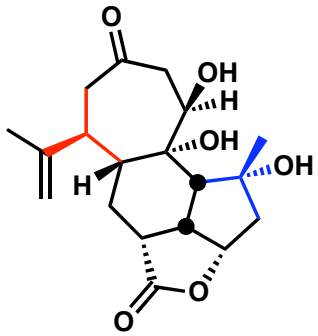
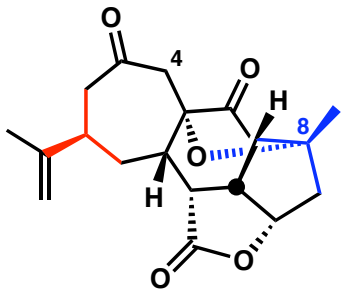
C(1)–C(8) Stereochemistry

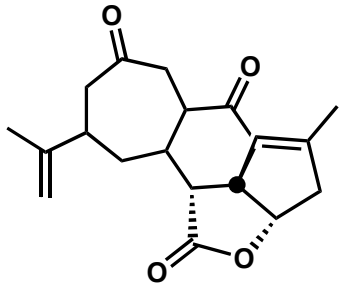
of Compounds Derived from Sinuleptolide-Like Intermediates



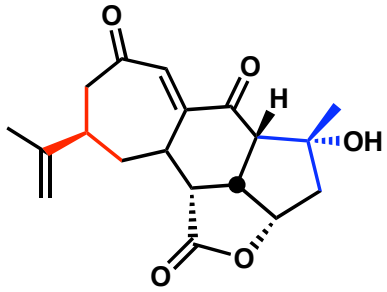
dissectolide



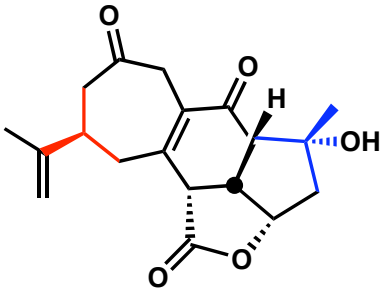
sinulochmodin C
Sinularia lochmodes



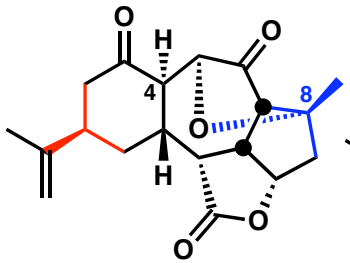
(yonaronlide)



scabrolide B



scabrolide A



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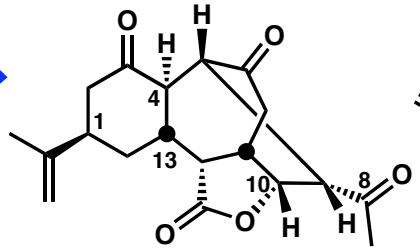
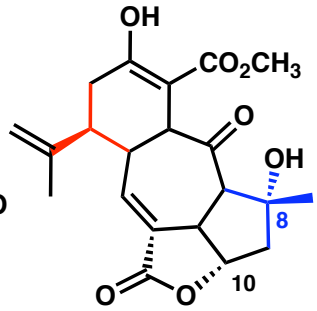
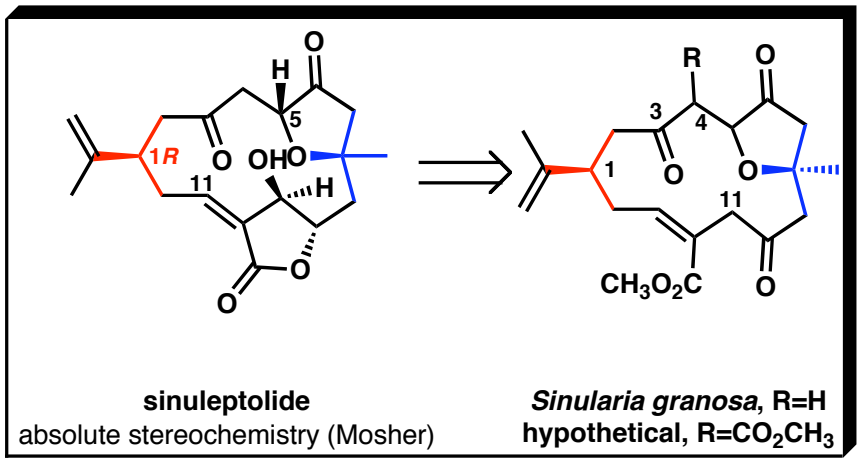
Sinularia inelegans



horiolide



rameswaralide



sinuleptolide
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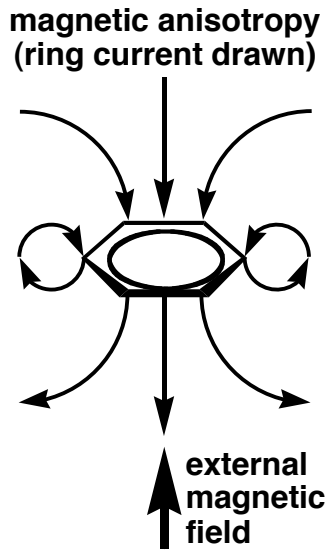
Rameswaralide: Ramesh, P. *Tetrahedron Lett.* **1998**, *38*, 8271-8220.
Dissectolide: Iguchi, K. *J. Org. Chem.* **1996**, *61*, 5998-6000.
Horolide: Radhika, P. *et al. J. Nat. Prod.* **2002**, *65*, 737-739.
The depicted yonaronlide: Iguchi, K. *Tetrahedron Lett.* **1995**, *36*, 8807-8808.

Disclaimer: Biosynthetic relationships of all but sinulochmodin C postulated by me.

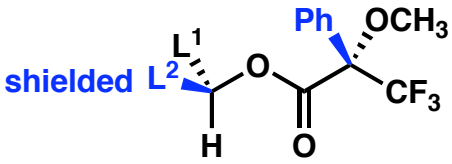
Absolute Stereochemistry of Sinuleptolide

Forays into Mosher's Ester Analysis

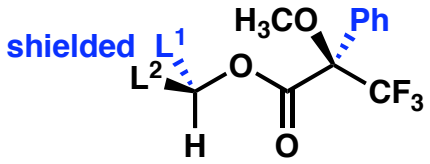


DESHIELDING region
(in plane of ring)

SHIELDING region
(above and below ring)

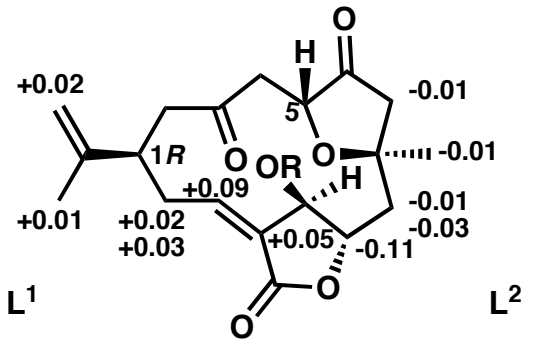


(*S*)-MTPA ester



(*R*)-MTPA ester

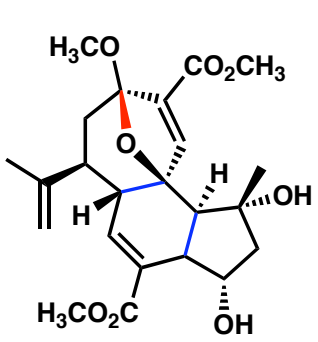
so for L^1, $\Delta\delta = \delta_S - \delta_R > 0$
and for L^2, $\Delta\delta = \delta_S - \delta_R < 0$



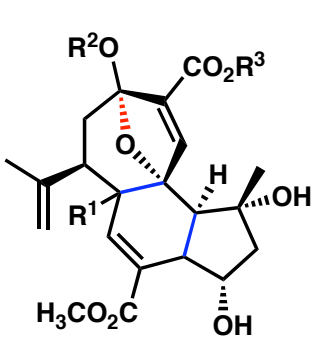
^{1}H-NMR shifts (ppm):
$\Delta\delta = \delta_S - \delta_R$

Explanation of magnetic anisotropy: Ege, Seyhan *Organic Chemistry: Structure and Reactivity* (**1994** 3rd edition, USA), p. 409.
Mosher's method: Kakisawa, H. *et al. J. Am. Chem. Soc.* **1991**, *113*(11), 4092-4096.
Sinuleptolide: Sheu, J.-H. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816.

Yonaranes and more!



mandapamate



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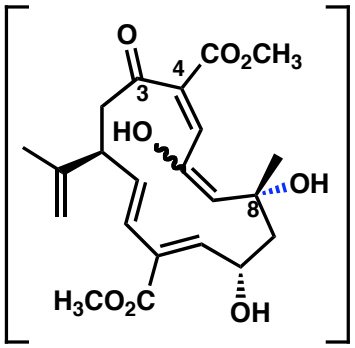

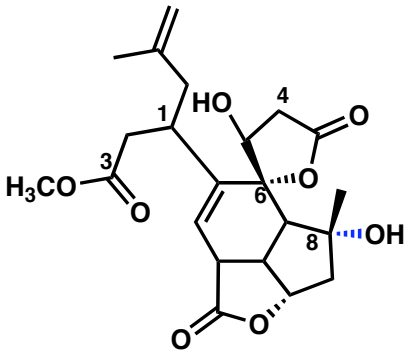

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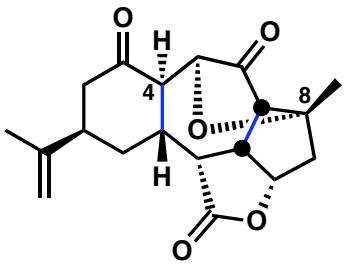
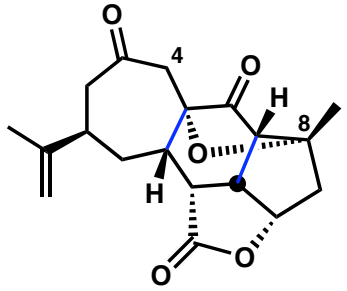


ineleganolide
Sinularia inelegans



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Sinularia lochmodes

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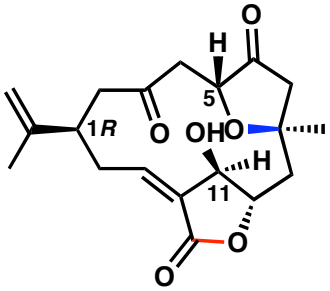

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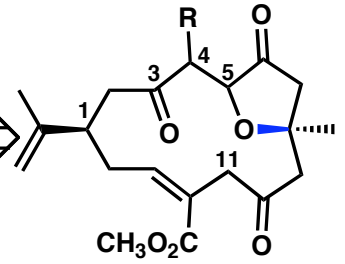

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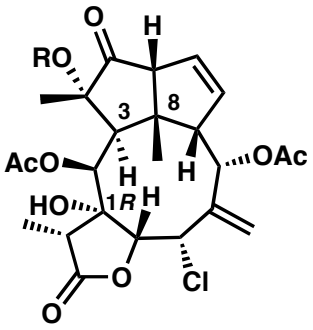
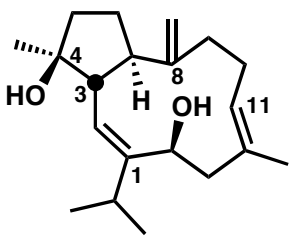
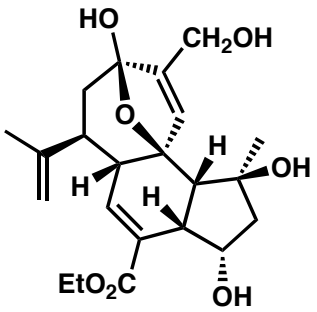
More Complex Cembranoids



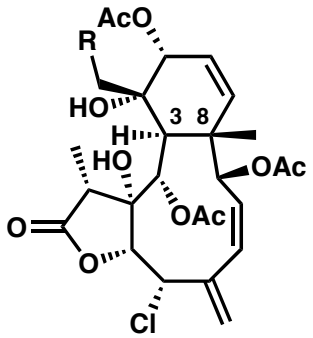
aquariolide A, R=H
Erythropodium caribaeorum
absolute stereochemistry (ROSEY, NMR)



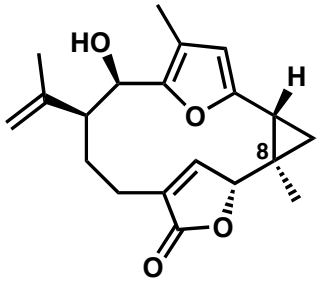
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry



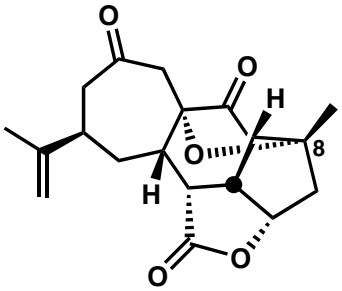
plumarellic acid



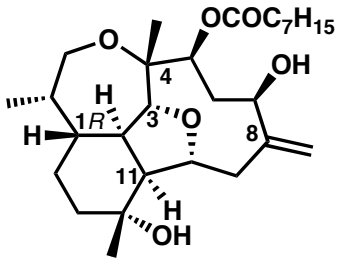
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*



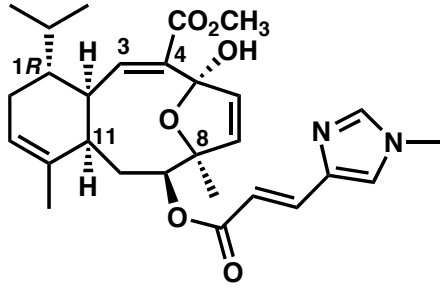
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J



sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)



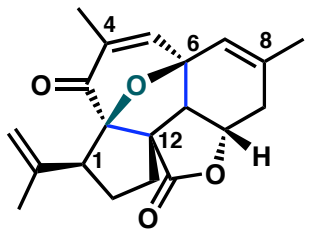
briarellin E
Briareum aspestinum
enantioselective total synthesis



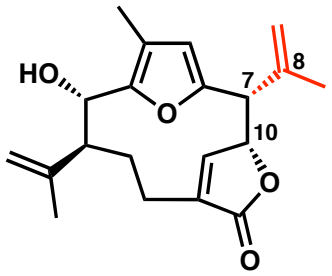
(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

Aquariolide A: Andersen, R. J. *Org. Lett.* **2002**, *4*, 4085; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816;Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196.
Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331; Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368; Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

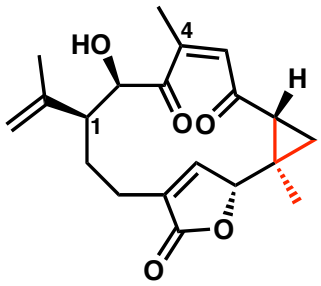
Gersolanoids, Pseudopteranes, and more!



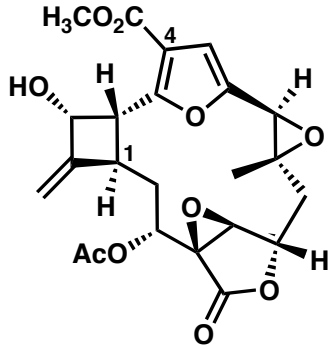
intricarene



kallolide A
absolute stereochemistry



pinnatin C
absolute stereochemistry
by synthesis from bipinnatin J

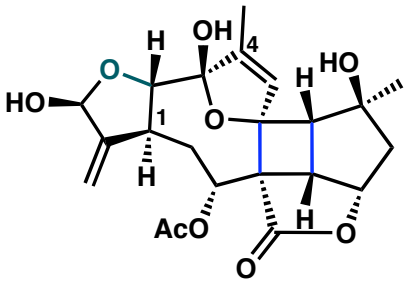


providencin
Pseudopterogorgia kallos

formal
oxidative
[5+2]

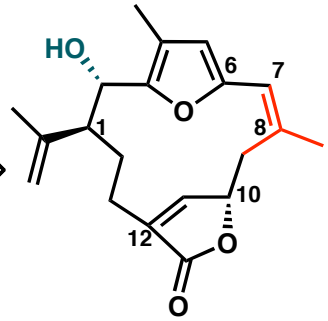
hν, 2 h
CH_3CN, 25 °C, 40%
1,3-allylic shift

hν (minor)
1,2-migration
(antarafacial)



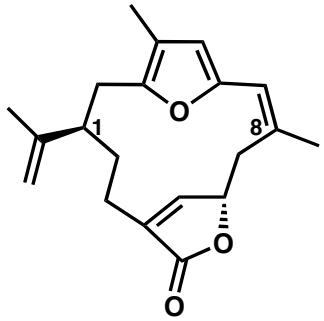
bielschowskysin
Pseudopterogorgia kallos

[2+2]



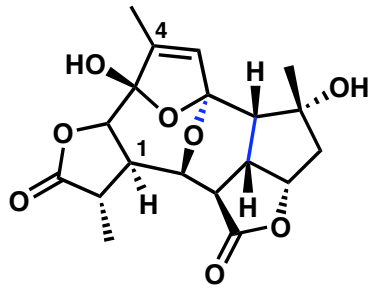
bipinnatin J
absolute stereochemistry
by synthesis of kallolide A

oxidation



rubifolide
enantioselective total syntheses
Gersemia rubiformis

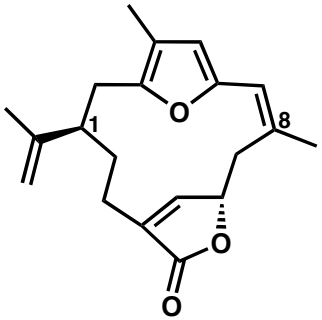
[3+2]

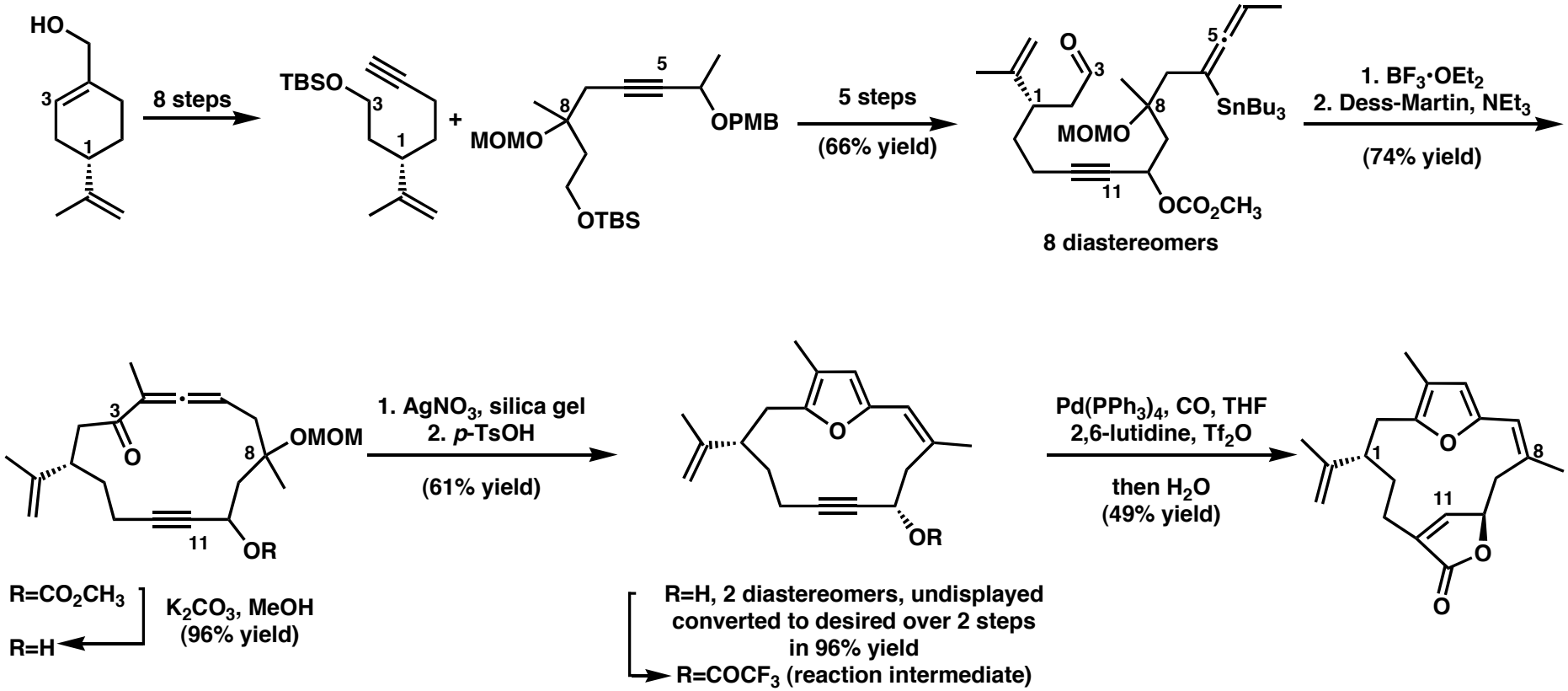


verrillin
Pseudopterogorgia bipinnata

Bipinnatin J–kallolide A cycloisomerization: Rodríguez, A. D. *et al. J. Org. Chem.* **1998**, *63*(3), 420-421.
Bipinnatin J–pinnatin C cycloisomerization: Rodriguez, A. D. *et al. J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Hypothesized biosynthetic relationship between intricarene, BSK, rubifolide and bipinnatin J: Trauner, D. *et al. Org. Lett.* **2006**, *8*(2), 345-347.
Enantioselective total synthesis of rubifolide: Marshall, J. A. *et al. J. Org. Chem.* **1997**, *62*(13),4313-4320.
Rubifolide isolation: Williams, D. *et al. J. Org. Chem.* **1987**, *52*, 332.
Verrillin isolation: Cichewicz, R. H. *J. Am. Chem. Soc.* **2004**, *126*, 14910; Williams, D. E. *J. Nat. Prod.* **2004**, *67*, 2127.

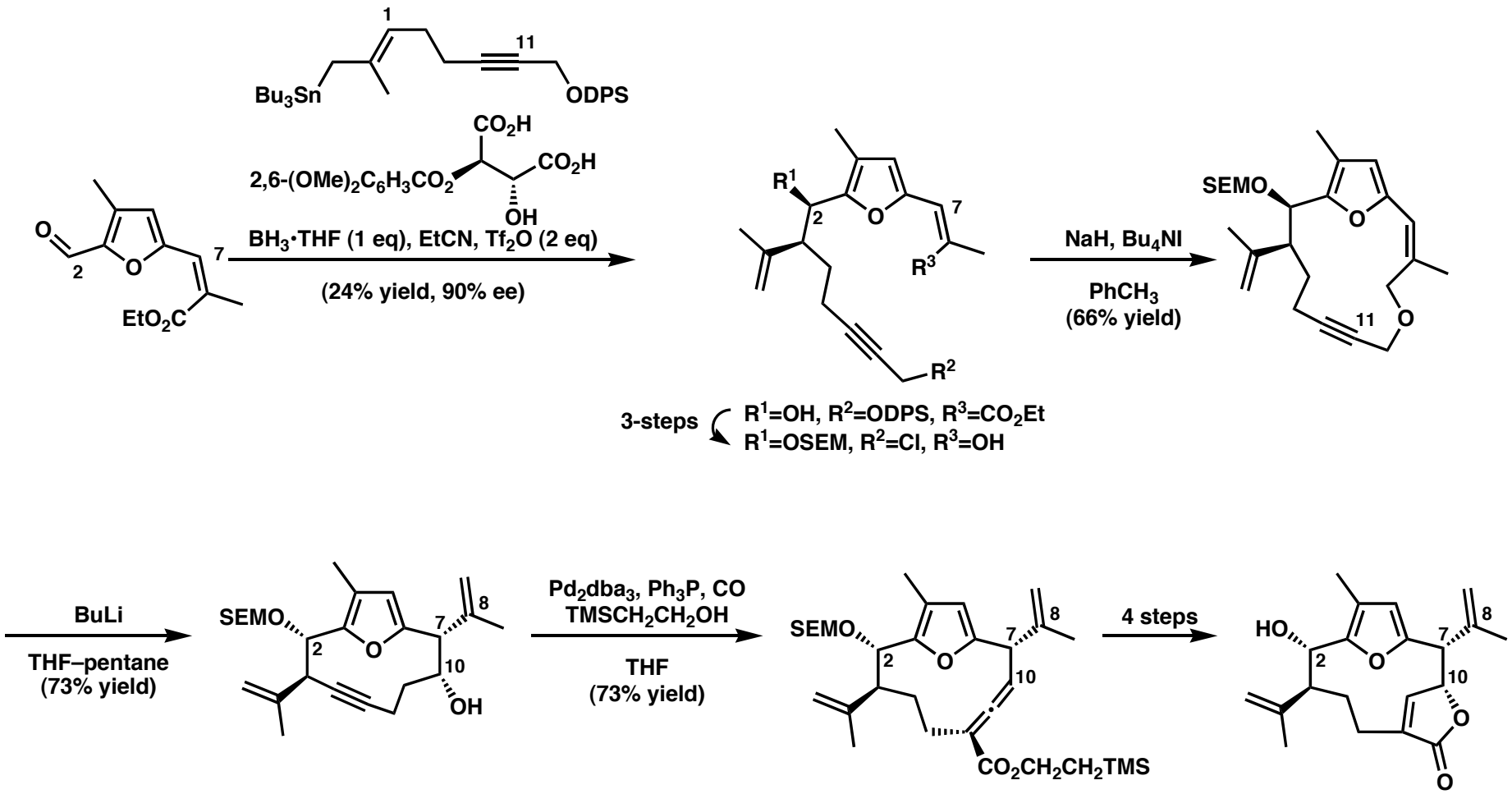
Enantioselective Total Synthesis of unnatural Rubifolide





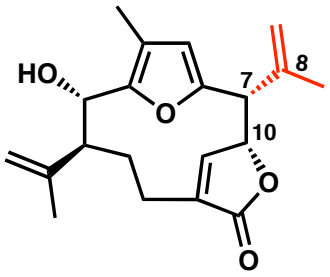
Enantioselective total synthesis of unnatural rubifolide: Marshall, J. A. *et al. J. Org. Chem.* **1997**, *62*(13),4313-4320.

Enantioselective Total Synthesis of Kallolide A

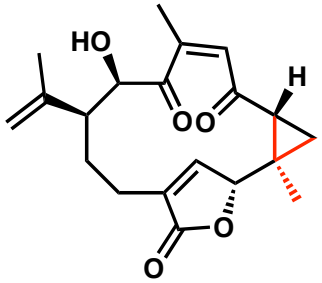


Enantioselective total synthesis of kallolide A: Marshall, J. A. *et al. J. Org. Chem.* **1998**, *63*(17), 5962-5970.

Absolute Stereochemistries of 3-Furanocembranoids

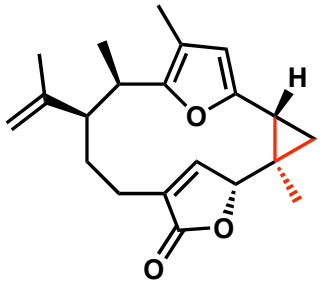


kallolide A
absolute stereochemistry



pinnatin C
absolute stereochemistry
by synthesis from bipinnatin J

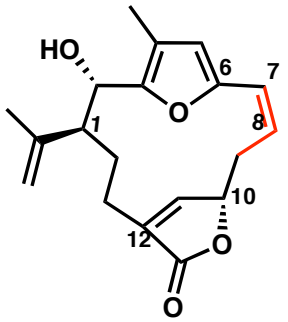
+



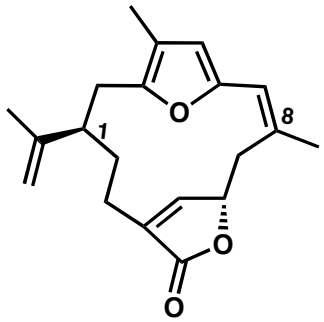
pinnatin A
absolute stereochemistry
by synthesis from kallolide A

h*ν*, 2 h
CH_3CN, 25 °C, 40%
1,3-allylic shift

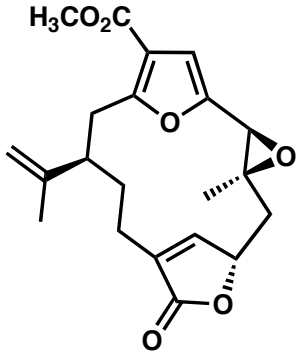
h*ν* (minor)
1,2-migration
(antarafacial)



bipinnatin J
absolute stereochemistry
by synthesis of kallolide A



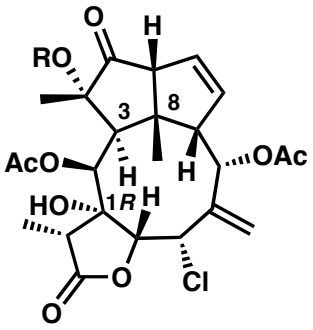
rubifolide
enantioselective total syntheses
Gersemia rubiformis



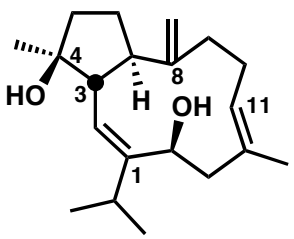
pukalide
Sinularia polydactyla
absolute configuration by synthesis of
unnatural enantiomer of deoxypukalide

Bipinnatin J–kallolide A cycloisomerization: Rodríguez, A. D. *et al. J. Org. Chem.* **1998**, *63*(3), 420-421.
Bipinnatin J–pinnatins cycloisomerization: Rodriguez, A. D. *et al. J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Enantioselective total synthesis of kallolide A: Marshall, J. A. *et al. J. Org. Chem.* **1998**, *63*(17), 5962-5970.
Enantioselective total synthesis of rubifolide: Marshall, J. A. *et al. J. Org. Chem.* **1997**, *62*(13),4313-4320.
Synthesis of deoxypukalide from pukalide and other: Marshall, J. A. *J. Org. Chem.* **2001**, *66*, 8037-8041.

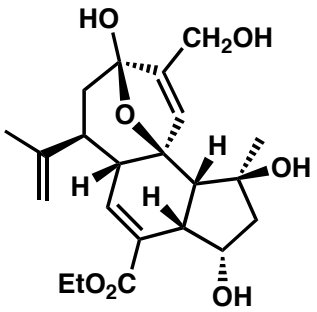
More Complex Cembranoids



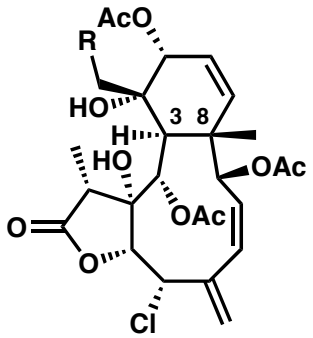
aquariolide A, R=H
Erythropodium caribaeorum
absolute stereochemistry (ROSEY, NMR)



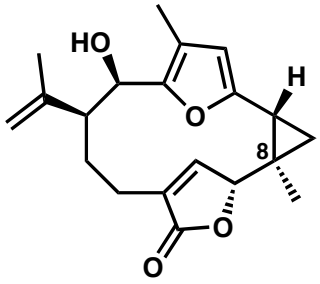
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry



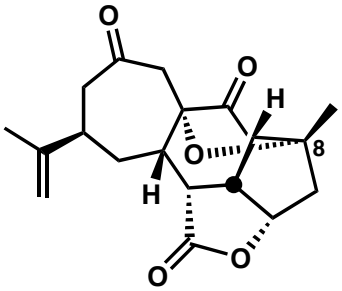
plumarellic acid



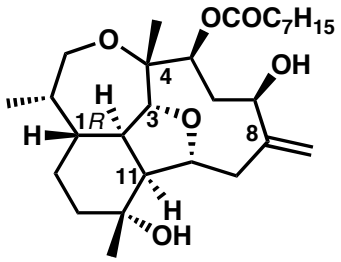
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*



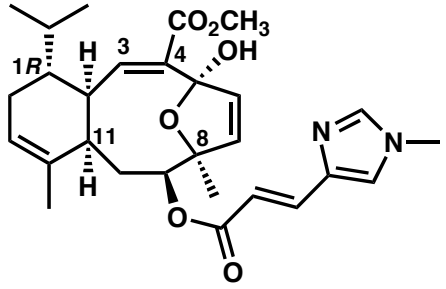
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J



sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)



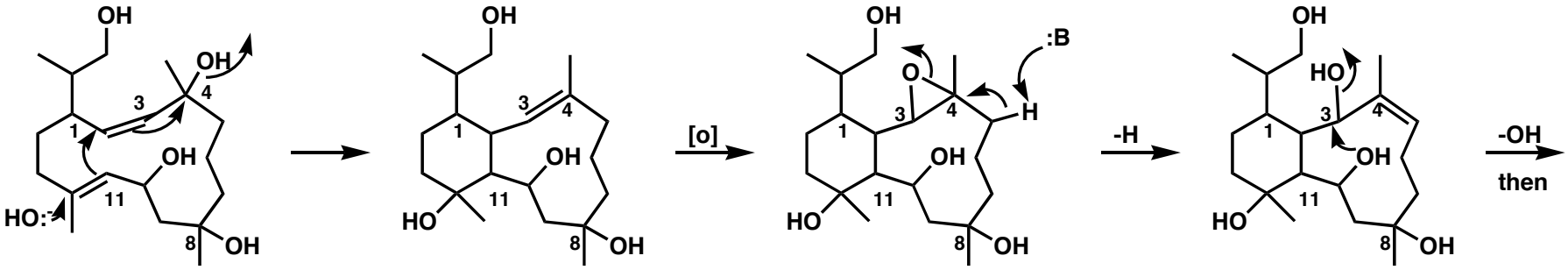
briarellin E
Briareum aspestinum
enantioselective total synthesis

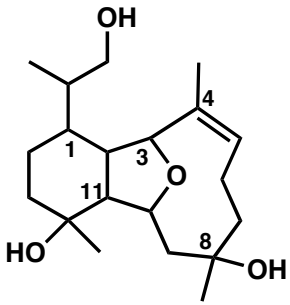


(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

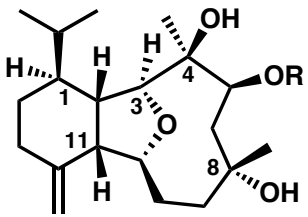
Aquariolide A: Andersen, R. J. *Org. Lett.* **2002**, *4*, 4085; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816;Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196.
Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331; Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368; Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

Cladiellins

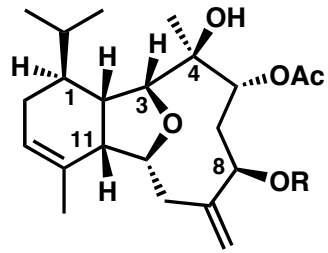




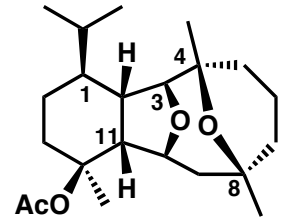
a hypothetical cladiellin



structures reassigned-
sclerophytin A, R=H
sclerophytin B, R=Ac



(alcyonin)
structure misassigned - R=H
Sinularia flexibilis
structure reassigned - R=OH
due to enantioselective synthesis

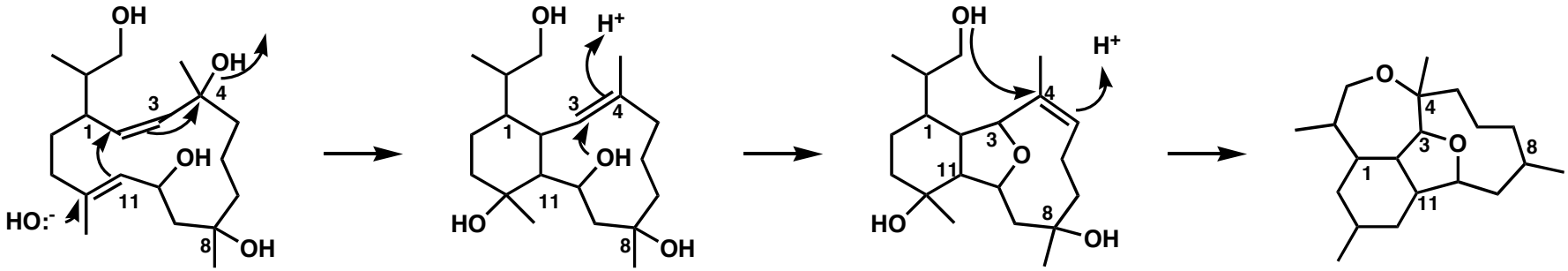


polyanthellin A
Briareum polyanthes
[also isolated ***ent*-polyanthellin A]**

Hypothetical biosynthetic pathway extrapolated from: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141.
Sclerophytins: Paquette, L. A. *J. Nat. Prod.* **2002**, *65*, 126; Paquette, L. A. *The Chemical Record*, **2001**, *1*, 311.
Alcyonin misassigned: Kakisawa, H. *Chem. Lett.* **1988**, 1077; reassigned: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650.
Polyanthellin A: Rodríguez, A. D. *J. Nat. Prod.* **2003**, *66*, 357; enantiomer: Rodríguez, A. D. *et al. Tetrahedron* **1995**, *51*, 6869.

Disclaimer: Pathway from second structure purely my own guess based on very little evidence.

Cladiellins and Asbestinins

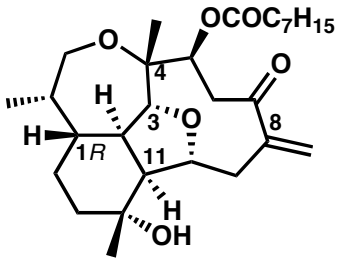


a hypothetical cembranoid (enzyme catalyzed, stepwise)

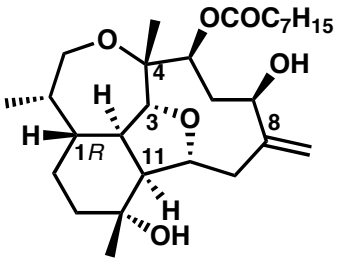
a hypothetical cembranoid

a hypothetical cladiellin

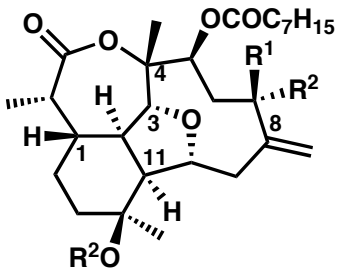
a hypothetical asbestinin



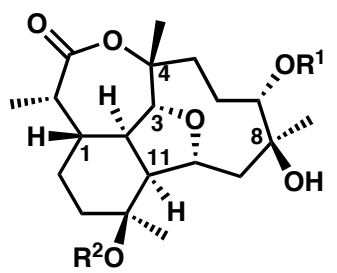
briarellin F
Briareum aspestinum
enantioselective total synthesis



briarellin E
Briareum aspestinum
enantioselective total synthesis



structure reassigned - briarellin A, R^1=H, R^2=OOH
structure misassigned - briarellin A, R^1=OH, R^2=H
Briareum polyanthes

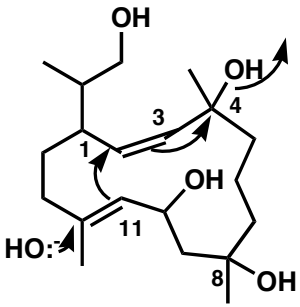


briarellin M, R^1=H, R^2=Ac
briarellin N, R^1=CH_3, R^2=Ac
briarellin O, R^1=H, R^2=CO*n*-Pr
briarellin P, R^1=CH_3, R^2=CO*n*-Pr
Briareum polyanthes

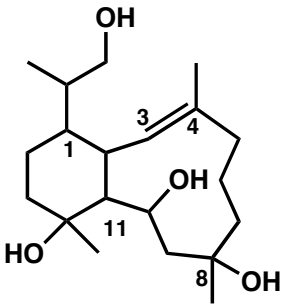
Briarellin E, F enantioselective syntheses: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650 ; isolation: Rodríguez, A. D. *Chem. Pharm. Bull.* **1995**, *43*, 1853; briarellin A original: Rodríguez, A. D. *Tetrahedron* **1995**, *51*, 6869; reassigned: Coll, J. C. *Aust. J. Chem.* **1989**, *42,* 1705; briarellin M-P: Rodríguez, A. D. *J. Nat. Prod.* **2003**, *66*, 357.

Disclaimer: Pathway from second structure purely my own guess based on very little evidence.

Cladiellins, Asbestinins and Sarcodictyins, Oh my!

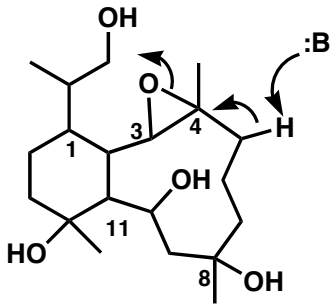


a hypothetical cembranoid (enzyme catalyzed, stepwise)



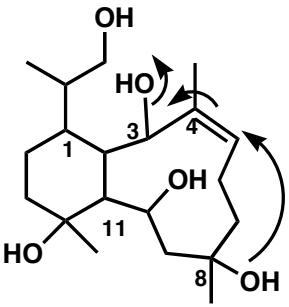
a hypothetical cembranoid

[o]



a hypothetical cembranoid (enzyme catalyzed, stepwise)

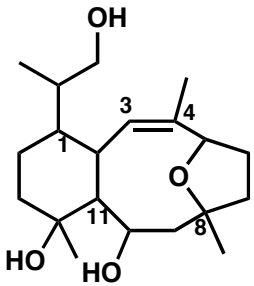
-H



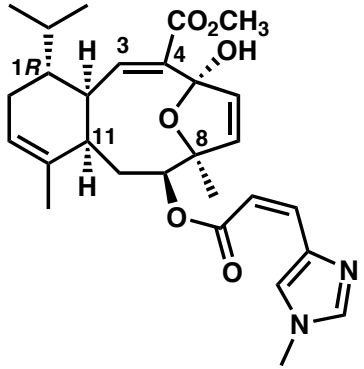
a hypothetical cembranoid (enzyme catalyzed, stepwise)

-OH

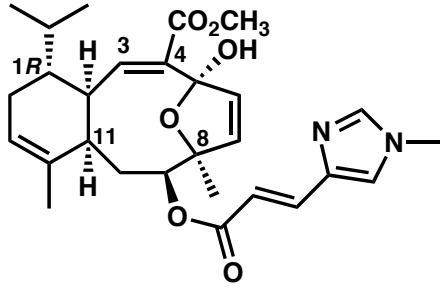
then



a hypothetical sarcodictyin



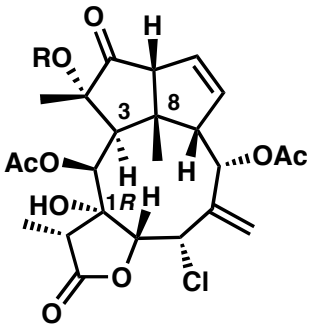
sarcodictyin A



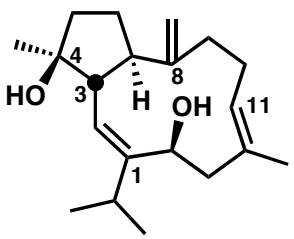
(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via* transesterification to sarcodictyin A

Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.
Hypothetical biosynthetic pathway extrapolated from: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141 (review).
Disclaimer: Pathway from second structure purely my own guess based on very little evidence.

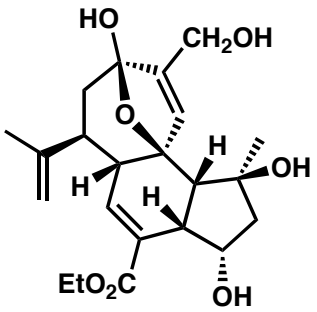
More Complex Cembranoids



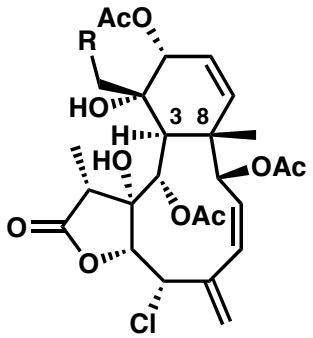
aquariolide A, R=H
Erythropodium caribaeorum
absolute stereochemistry (ROSEY, NMR)



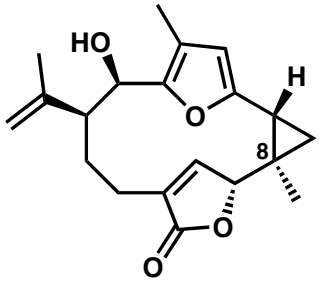
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry



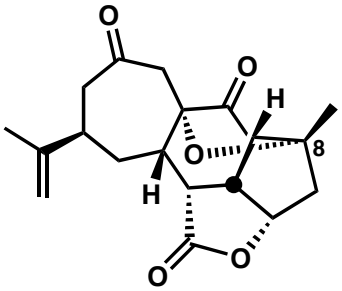
plumarellic acid



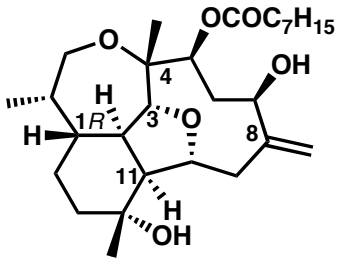
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*



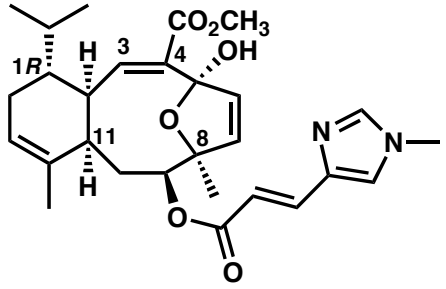
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J



sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)



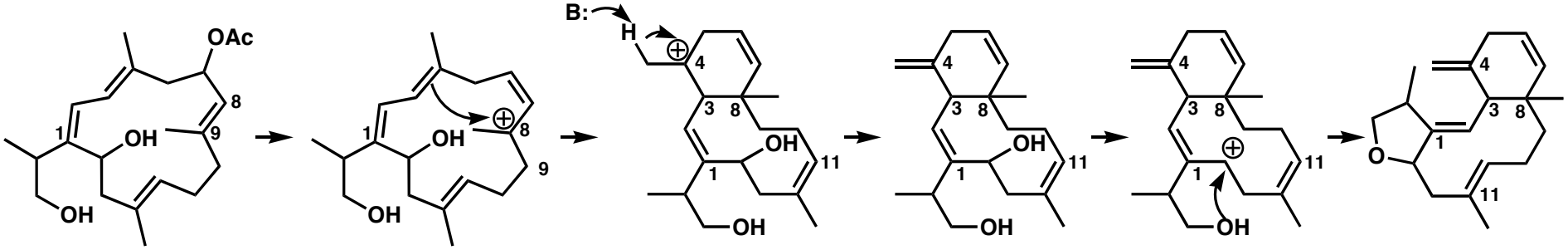
briarellin E
Briareum aspestinum
enantioselective total synthesis



(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

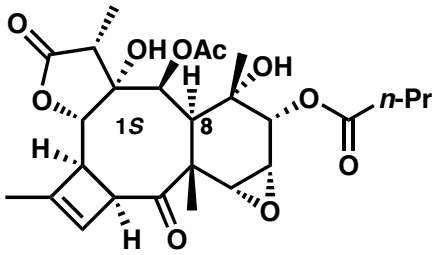
Aquariolide A: Andersen, R. J. *Org. Lett.* **2002**, *4*, 4085; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816;Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196.
Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331; Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368; Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

Briaranes

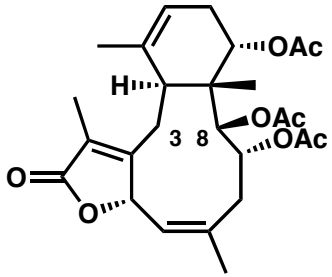


hypothetical cembrane

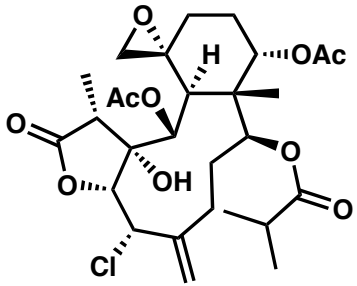
hypothetical briaran



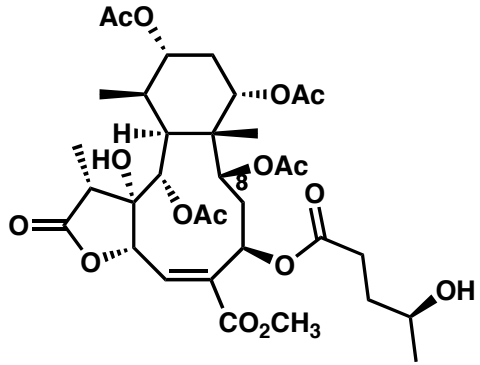
cyclobutenebriarein A
absolute configuration by analogy and proposed biogenesis



brianthein A
absolute stereochemistry



juncenolide A
absolute stereochemistry

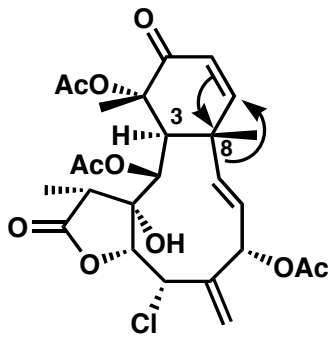


erythrolide S
absolute stereochemistry by Mosher method

Hypothetical biosynthetic pathway extrapolated from: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141.
Cyclobutenebriarein A: González, N. *J. Org. Chem.* **2002**, *67* (15), 5117-5123.
Brianthein A - Mosher: Kobayashi, M. *Tetrahedron*, **2001**, *57*, 8951.
Juncenolide A - X-ray: Shen, Y. C. *J. Nat. Prod.* **2002**, *65*, 54.
Erythrolide S - Mosher: Andersen, R. J. *Org. Lett.* **2002**, *4*, 3515.

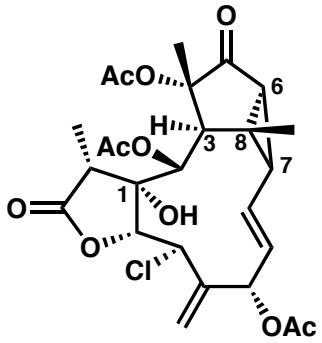
Disclaimer: Second ring closure hypothesis without evidence or source other than my own brief consideration.

Erythranoids, Aquarianes



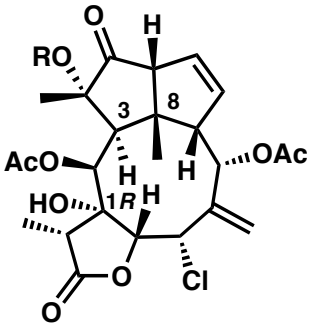
erythrolide B
(a briaran)

di-π-methane
rearrangement

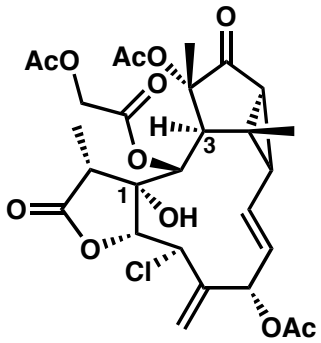


erythrolide A

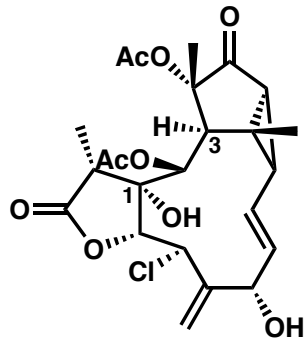
vinyl cyclopropane
rearrangement



aquariolide A, R=H
absolute stereochemistry (ROSEY, NMR)
aquariolide B, R=CH_3
aquariolide C, R=Ac



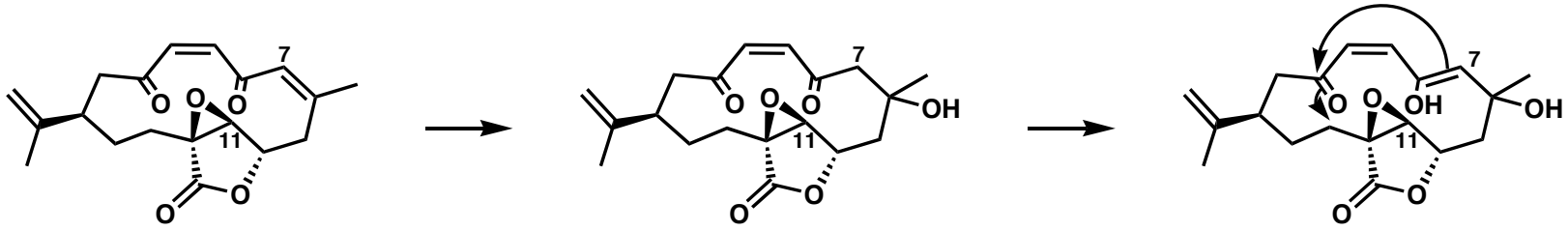
erythrolide L



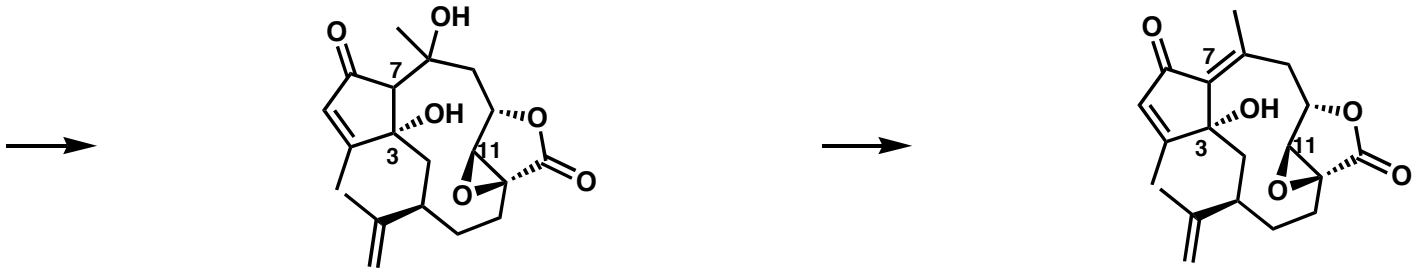
erythrolide V

Hypothetical biosynthetic pathway proposed in: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141.
Erythrolide L, aquarolides B, C, absolute stereochemistry of A: Andersen, R. J. *Eur. J. Org. Chem.* **2003**, 3515.
Erythrolide A, B, V, aquariolide A: Andersen, R. J. *Org. Lett.* **2002**, *4*, 4085.

Capnosanes



coralloidolide E

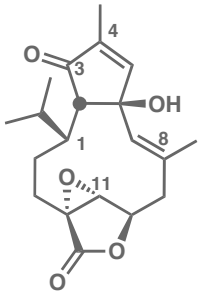


coralloidolide C

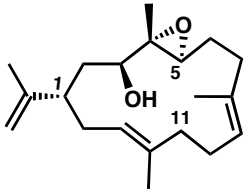
Hypothetical biosynthetic pathway proposed in: Wahlberg, I.; Eklund, A.-M. *Prog. Chem. Org. Nat. Prod.* **1992**, *60*, 1-141.

Skeletal Terms

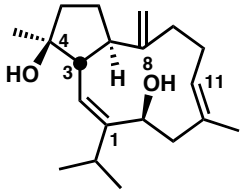
examples



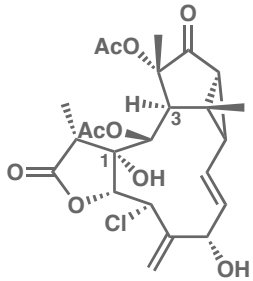
coralloidolide F
Alcyonium coralloides



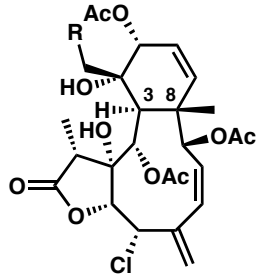
(–)-13-hydroxy-11,12-epoxyneocembrene
absolute stereochemistry
(total synthesis)
Sinularia trocheliophorum



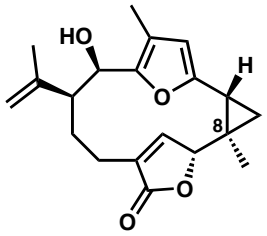
sarcophytol L
Sarcophyton glaucum
absolute stereochemistry



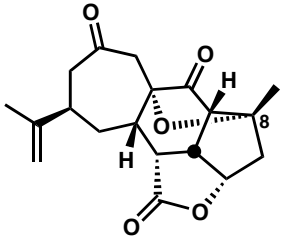
erythrolide V
Erythropodium caribaeorum



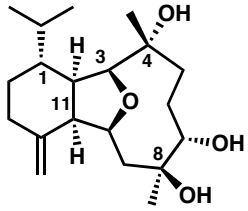
minabein-4, R=H
absolute stereochemistry (X-ray)
identical to other isolate
R=OAc, *Ellisella*



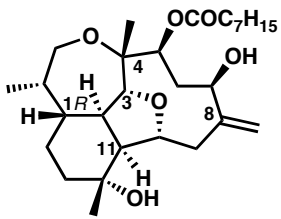
pinnatin A
absolute stereochemistry
by synthesis from bipinnatin J



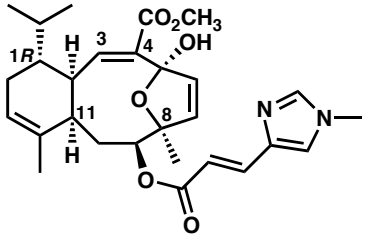
sinulochmodin C
Sinularia lochomodes
absolute configuration *via*
analogy (Mosher)



sclerophytin A
total syntheses



briarellin E
Briareum aspestinum
enantioselective total synthesis

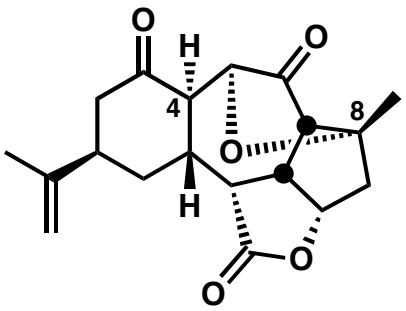


(*Z*)-sarcodictyin A
Bellonella albiflora
absolute stereochemistry *via*
transesterification to sarcodictyin A

Coralloidoilide F: D'Ambrosio, M.A. *et al. Helv. Chim. Acta*, **1990**, *73*, 804-807; pinnatin A: Rodríguez, A. D. *J. Org. Chem.* **1998**, *63*(13), 4425-4432.
Cembrene: Zhang, T. *et al. Synthesis* **2001**, *3*, 393; sinulochmodin C: Tseng, Y. J. *et al. Org. Lett.* **2005**, *7*(17), 3813-3816.
Sarcophytol L: Kobayashi, M.; Osabe, K. *Chem. Pharm. Bull.* **1989**, *37*, 1192-1196; Sclerophytin A: Paquette, L. A. *Org. Lett.* **2000**, *2*, 1879; Uchio, Y. *Tetrahedron Lett.* **1989**, *30*, 3331;
Overmann, L. E. *Org. Lett.* **2001**, *3*, 135; Pennington, L. D. *J. Am. Chem. Soc.* **2001**, *123*, 9033; Paquette, L. A. *J. Am. Chem. Soc.* **2001**, *123*, 9021.
Erythrolide V: Andersen, R. J. *et al. Eur. J. Org. Chem.* **2003**, 3515.
Briarellin E enantioselective total synthesis: Overman, L. E. *J. Am. Chem. Soc.* **2003**, *125*, 6650 ; isolation: Rodríguez, A. D. *Chem. Pharm. Bull.* **1995**, *43*, 1853.
Minabein-4 absolute stereochemistry: (60) Molinski, *J. Nat. Prod.* **2004**, *67*, 2130; other identical isolate: Scheuer, P. J. *Heterocycles* **1996**, *42*, 325; Acetate: Higa, T. *J. Nat. Prod.* **2004**, *67*, 1368.
Sarcodictyin A: Nakao, Y. *et al. J. Nat. Prod.* **2003**, *66*, 524.

Acknowledgements

Y'all



ineleganolide
Sinularia inelegans