Tetrahedron Letters,Vol.28,No.43,pp 5079-5080,1987 0040-4039/87 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

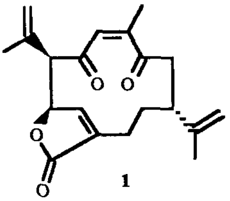
GERSOLIDE, A DITERPENOID WITH A NEW REARRANGED CARBON SKELETON FROM THE SOFT CORAL *GERSEMIA RUBIFORMIS*

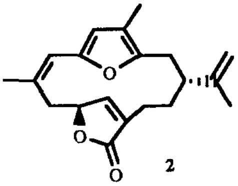
David E. Williams and Raymond J. Andersen*
Departments of Chemistry and Oceanography, University of British Columbia
Vancouver, B.C. CANADA V6T 1W5

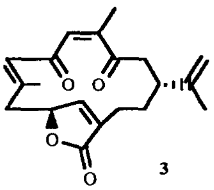
Laszlo Parkanyi and Jon Clardy*
Department of Chemistry - Baker Laboratory, Cornell University
Ithaca, New York USA 14853-1301

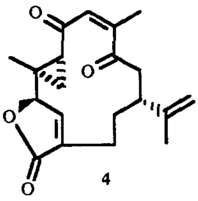
Abstract The structure of gersolide (**4**), a diterpenoid isolated from extracts of the soft coral *Gersemia rubiformis*, has been solved via single crystal x-ray diffraction analysis.

Soft corals are the richest marine source of diterpenoids. Many laboratories are finding functional group variants of well-known structures as well as new carbon skeletons.[1] We recently reported the isolation of gersemolide (**1**), rubifolide (**2**), and epilophodione (**3**) from the soft coral *Gersemia rubiformis* collected in the cold temperate waters of coastal British Columbia.[2] Our continuing investigations of the minor components of *G. rubiformis* extracts have now resulted in the isolation of gersolide (**4**), a diterpenoid with a new rearranged carbon skeleton[3], whose structure we now wish to report.


1


2


3


4

G. rubiformis metabolites were extracted and purified as previously described.[2] Gersolide (**4**), obtained as white needles from methanol [yield 1x10^{-4}% of dry wt., mp 176-178° C, $[\alpha]_D$ -51.9° (c 0.31, CH_2Cl_2)], gave a parent ion at m/z 328.1674 daltons in the EIHRMS suggesting a molecular formula of $C_{20}H_{24}O_4$ (ΔM -0.1mmu). A series of double resonance and difference nOe ^{1}H NMR experiments enabled us to identify methyl substituted ene-dione (δ5.96,s,1H; 2.07,s,3H), α,γ-disubstituted-α,β-unsaturated-γ-lactone (δ5.14,bs,1H; 6.77,bs,1H), and isopropenyl (δ5.23,bs,1H; 4.96,bs,1H; 1.72,s,3H) residues in gersolide (**4**).[4] The two degrees of unsaturation not accounted for by the identified functionality had to be carbocyclic rings, and a ^{1}H NMR resonance at δ1.30 (s) required a methyl substituent at one of the ring junctions. No known diterpenoid carbon skeleton could accommodate the above features, so the structure of gersolide (**4**) was solved by a single crystal x-ray diffraction analysis.

Gersolide (**4**) crystallized in the orthorhombic space group $P2_12_12_1$ with **a**=6.864(1), **b**=15.984(2), and **c**=16.158(2) Å and one molecule in the asymmetric unit. All diffraction maxima with $2\Theta < 114^{\circ}$ were collected using variable speed 1° ω-scans. Of the 1405 reflections measured, 1186 (84%) were judged observed $(|F_o|>3\sigma(F_o))$.[5] A phasing model was found using direct methods and refined using block diagonal least-squares techniques. The final x-ray model is shown in Figure 1. The α,β-unsaturated-γ-lactone fragment is planar within experimental error, and the C4,C5 double bond is not coplanar with either the C6 or the C3 carbonyl groups.[6]

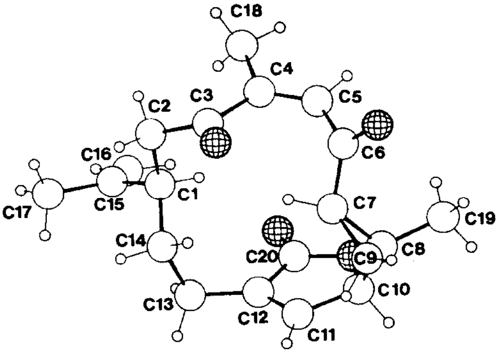


Fig.1 Computer-generated perspective drawing of gersolide **4**.

The gersolane skeleton of **4**, like the pseudopterane skeleton of **1**[7], appears superficially to have been formed by the coupling of two geranyl units. Since *G. rubiformis* contains similarly functionalized diterpenoids having cembrane, pseudopterane, and gersolane skeletons, it seems most plausible that the latter two skeletons arise from rearrangements of a cembrane precursor[2,7].

Acknowledgement We thank Mike LeBlanc for assisting the collection of *G. rubiformis*. Financial support at UBC was provided by grants to RJA from NSERC and the National Cancer Institute of Canada. The Cornell authors thank the New York State Sea Grant and NIH CA24487 for financial support. L. Parkanyi is on leave from the Central Research Institute of Chemistry of the Hungarian Academy of Sciences, Budapest, Hungary.

References

1. a) Tursch,B.; Braekeman,J.C.; Daloze,D.; Kaisin,M. In *Marine Natural Products, Chemical and Biological Perspectives*; Scheuer,P.J., Ed.; Academic Press: N.Y., **1978**; Vol. II, Chapt. 4. and b) Faulkner, D.J. *Nat. Prod. Rep.* **1984**, *1*, 551.
2. Williams, D.; Andersen, R.J.; Van Duyne, G.; Clardy, J. *J. Org. Chem.* **1987**, *52*, 332.
3. We propose the name "gersolane" for the new diterpenoid carbon skeleton of gersolide.
4. Additional ^1H NMR resonances are at: ($CDCl_3$, 400MHz) δ 0.97, dd, J= 6, 8Hz (H9a); 1.42, t, J= 6Hz (H7); 1.84, dd, J= 6, 8Hz (H9b); 2.81, d, J= 14Hz (H2) ppm.
5. All crystallographic calculations were done on a PRIME 9950 computer operated by the Cornell Chemistry Computing Facility. Principal programs employed were: FOBS86, by G. Van Duyne, Cornell University, 1986; MULTAN 80 and RANTAN 80, by P. Main, S.E. Hull, L. Lessinger, G. Germain, J.P. Declercq, and M.M. Woolfson, University of York, England, 1980; BLS78A, by K. Hirotsu, and E. Arnold, Cornell University, 1980; PL1PLOT, by G. Van Duyne, Cornell University, 1984; TABLES, by G. Van Duyne, Cornell University, 1986.
6. Atomic coordinates for this structure have been deposited with the Cambridge Crystallographic Data Centre. They can be obtained on request from The Director, Cambridge Crystallographic Data Centre, University Chemical Laboratory, Lensfield Road, Cambridge, CB2 1EW, U.K. Please give a complete literature citation when ordering.
7. Bandurraga, M.M.; Fenical, W.; Donovan, S.F.; Clardy, J. *J. Amer. Chem. Soc.* **1982**, *104*, 6463.

(Received in USA 26 June 1987)