reaction of the resulting hydroxymethyl radical could then lead to the observed products.

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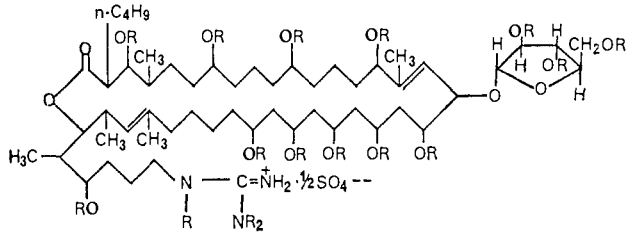
Primycin[1]

Sir:

The antibiotic primycin was first isolated in 1954[2] from cultures of actinomycetes from the intestinal tract of the wax moth. It has activity against gram-positive pathogens and human and bovine *M. tuberculosis*. We have found primycin to consist of a number of closely related structures, and report here the structure of the major constituent.[3]

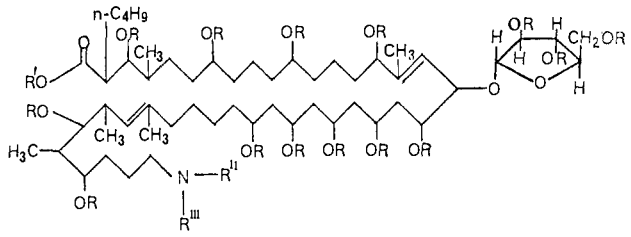
Primycin (**1**, R = H) is a white microcrystalline



1

powder. It is a guanidine sulfate and these two functions are responsible for all the sulfur and nitrogen contained in the molecule.[4] It is unsaturated but shows no evidence of conjugation in the ultraviolet. Mild acid hydrolysis gave D-(−)-arabinose.[5]

Alkaline hydrolysis (5 *N* KOH at 135°) gave the amino acid (**2**, R = R′ = R″ = R‴ = H). The corre-



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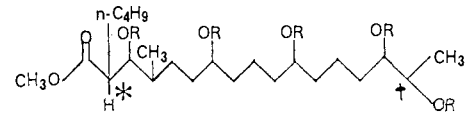
sponding polyether (**2**, R = R′ = R″ = Me; R‴ = Ac), $C_{72}H_{137}NO_{19}$ (mol wt calcd, 1319; found, 1319[6]), was the largest moiety volatile enough for molecular weight determination by mass spectrometry.[7] The spectrum also revealed the presence of much weaker peaks at higher mass which were homologous. The polyacetate (**2**, R = R‴ = Ac; R′ = Me; R″ = H) on ozonolysis followed by sodium borohydride reduction and reacetylation gave secoprimycin A acetate (**3**, R = Ac), $C_{21}H_{38}(OAc)_5COOMe$, secoprimycin B acetate (**4**,



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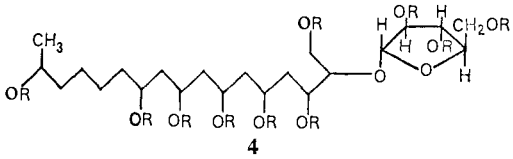

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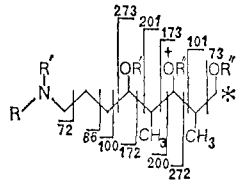
R = Ac), $C_{22}H_{34}O_2(OAc)_{10}$, and secoprimycin C acetate (**5**, R = H; R′ = R″ = Ac), $C_{10}H_{18}(OAc)_3NHAc$.



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The structure of secoprimycin C acetate (**5**, R = H; R′ = R″ = Ac) could be determined entirely from nmr data since double irradiation revealed the contiguity of all the relevant atoms. Independent, and also complete, structure proof came from the mass spectrometric fragmentation pattern.[8] Some of the primary cleavages are indicated in the formula. Replacement of sodium borohydride by the borodeuteride gave a deuterium at the asterisked carbon. This, therefore, represented the site of attachment of secoprimycin B.

Similar degradation of **1** (R = Me) gave **5** (R = $CONMe_2$; R′ = Me; R″ = Ac). The chemical shift of the methine proton geminal to the methoxyl was readily detected. The hydroxyl group indicated with a dagger, protected from methylation in **1** (R = Me), was that involved, therefore, in lactone formation.

Secoprimycin B acetate (**4**, R = Ac) on hydrolysis gave the free alcohol **4** (R = H), and this on mild acid hydrolysis gave D-(−)-arabinose and the alcohol $C_{17}H_{36}O_8$. The presence of the grouping R-CH(OH)-CH(OH)CH_2OH was shown by periodate oxidation and that of the function $CH_3CH(OH)$- from nmr data. Isolation of the corresponding fragment from permethylated primycin gave, after hydrolysis of the arabinose and periodate oxidation, an aldehyde ($C_{21}H_{42}O_7$). The structure of this substance (**6**, R = Me) followed

(1) The work in London was supported by Grant No. RO1-A106649 from the U. S. National Institute of Allergy and Infectious Diseases and at McMaster by a grant from the National Research Council of Canada.

(2) T. Vályi-Nagy, J. Uri, and I. Szilágyi, *Nature (London)*, 174, 1105 (1954); T. Vályi-Nagy and B. Kelentei, *Arch. Int. Pharmacodyn.*, 124, 466 (1960); J. J. Blum, *Arch. Biochem. Biophys.*, 111, 635 (1965).

(3) In the work described only the most essential data are reported.

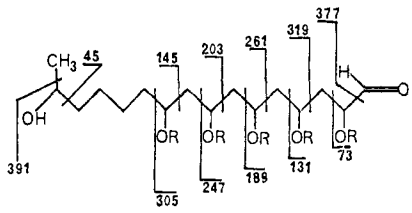
(4) Titration with barium perchlorate gave an equivalent weight of 1143 ± 2 (calcd, 1127). The sulfate ion was identified (infrared) as barium sulfate and all the sulfur was removed from the molecule by ion exchange. The base had pK_a = 11.2 (MeOH) and gave ammonia with hot alkali. It gave a positive Sakaguchi test.

(5) Identified as the *p*-nitrophenylhydrazone, by comparison with an authentic specimen.

(6) We are very much indebted to Dr. B. C. Das (Gif-sur-Yvette) for this most valuable determination.

(7) Although our evidence renders it unlikely, it is not absolutely excluded that a small fragment may have been lost in the conversion of 1 to compounds of type 2.

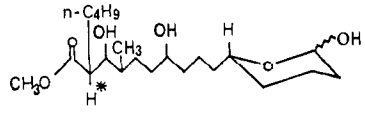
(8) The masses of the primary fragment ions of the seco compounds were determined by high-resolution mass spectrometry and agreed with the calculated values within acceptable limits.



6

from its fragmentation pattern (partly indicated). The results also allowed the placing of the arabinose moiety. The point at which secoprimycin B was attached to C was determined by partial ozonolysis of **1** (R = Me) (at the double bond joining fragments B and C), sodium borohydride reduction, hydrolysis, and oxidation of the only free alcohol function to an acetyl group, recognized by its nmr signal.

Secoprimycin A acetate (**3**, R = Ac) was converted to the corresponding alcohol **3** (R = H), which was cleaved with sodium periodate to give the aldehyde **7**



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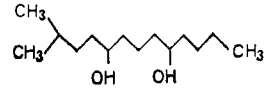
(as hemiacetal) and acetaldehyde. Huang-Minlon reduction gave caproic acid and the diol **8** in almost



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equivalent amounts and in high yields. These substances are believed to be formed by a reverse aldol-type reaction followed by reduction. The structure of **7** was shown by its fragmentation pattern. The presence of the asterisked single proton (indicating the branching) was shown by a signal at 2.7 ppm in the nmr spectrum. In addition, treatment of **3** (R = Ac) with mild base gave the corresponding α,β-unsaturated ester, albeit in small yield. These data together with the fact that secoprimycin A has *three* C-methyl groups establishes its structure.[9] The point of attachment of secoprimycin A to secoprimycin B was shown by a borodeuteride experiment. The deuterium was introduced at the position marked with a dagger in **3**.

Methylation of secoprimycin B (**4**, R = H) gave the ether **4** (R = Me), which, on mild acid hydrolysis in methanol, gave the arabinose as the methyl-2,3,5-tri-*O*-methyl-D-arabofuranoside, identified by its mass spectrum.[10] That the sugar is attached as the α anomer is suggested by the presence of the acetal methine hydrogen as a singlet[11] at *ca.* 5.2 ppm in the spectrum of derivatives of secoprimycin B.

The above evidence requires that primycin be represented as **1** (R = H).

Acknowledgment. We wish to thank the Antibiotic Service of the Pharmaceutical Research Institute for the fermentation, at Budapest, of a new strain producing primycin (*Thermopolyspora galeriensis*).

(9) Secoprimycin A was not obtained in pure homogeneous form but contained small amounts of congeners.

(10) K. Heyns and H. Scharmann, *Tetrahedron*, 21, 507 (1965).

(11) J. D. Stevens and H. G. Fletcher, Jr., *J. Org. Chem.*, 33, 1799 (1968); L. D. Hall and P. R. Steiner, *Can. J. Chem.*, 48, 1155 (1970); K. L. Rinehart, W. S. Chilton, M. Hichens, and W. V. Phillipsborn, *J. Amer. Chem. Soc.*, 84, 3216 (1962).

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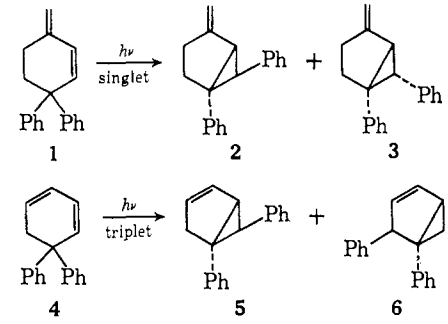
Photochemistry of 3,3-Diphenylcyclohexene. The Vinyl–Aryl Di-π-methane Rearrangement in a Nonconjugated System[1]

Sir:

Recently, much interest has been directed toward the study of the photochemical vinyl–aryl di-π-methane rearrangement in conjugated diene systems. For example, **1**, upon direct irradiation, gives **2** and **3** *via* a singlet path, whereas the triplet of **1** is unreactive.[2] On the other hand, the endocyclic isomer **4** gives **5** and **6** only under triplet-sensitized conditions.[3,4] The present study has investigated the photochemistry of **7**, the nonconjugated analog of this series, in order to determine the role conjugation plays in the rearrangement.



The olefin **7** (mp 31–32°) was synthesized in 90% yield from 2,2-diphenylcyclohexanone[5] *via* the *p*-toluenesulfonylhydrazone–methyllithium process.[6] When **7** was irradiated in pentane (Vycor filter), the yield of two major photoproducts was maximized when 21% of the starting material had reacted. The remaining starting material was removed by oxidative ozonolysis and the two photoproducts **8** and **9** were isolated by silica gel chromatography, each in 6% yield; **8** was a liquid and **9** was a solid (mp 66–68°). The nmr and mass spectra of these two compounds indicated that they were cis and trans isomers of 5,6-diphenyl-

(1) This work was supported, in part, by Grant No. AM-00709, from the National Institute of Arthritis and Metabolic Diseases of the U. S. Public Health Service.

(2) H. E. Zimmerman and G. E. Samuelson, *J. Amer. Chem. Soc.*, 89, 5971 (1967); 91, 5307 (1969).

(3) J. S. Swenton, A. R. Crumxine, and T. J. Walker, *ibid.*, 92, 1406 (1970).

(4) H. E. Zimmerman and G. A. Epling, *ibid.*, 92, 1411 (1970).

(5) H. E. Zaugg, M. Freifelder, and B. W. Horrom, *J. Org. Chem.*, 15, 1191 (1950).

(6) W. G. Dauben, M. E. Lorber, N. D. Vietmeyer, R. H. Shapiro, J. H. Duncan, and K. Tomer, *J. Amer. Chem. Soc.*, 90, 4762 (1968).