

Table I. The Antimicrobial Spectra of Negamycin and Its Antipode on 0.5% Peptone Agar

Test organisms	Minimum inhibitory concentration, $\mu\text{g/ml}$	
	Negamycin	Antipode of negamycin
<i>Staphylococcus aureus</i> FDA 209P	12.5	50
<i>Escherichia coli</i> K-12	3.1	100
<i>Escherichia coli</i> K-12 ML1629	1.6	100
<i>Shigella sonnei</i> 191-66	6.3	200
<i>Salmonella typhi</i> T-63	3.1	100
<i>Klebsiella pneumoniae</i> PCI 602	3.1	100
<i>Pseudomonas aeruginosa</i> A3	6.3	100
<i>Pseudomonas aeruginosa</i> No. 12	6.3	100

trideoxy-D-arabino-hex-1-enopyranose (**12**) was obtained in excellent yields from **3** by the usual methods. Methanol was added to **12** in the presence of HCl to afford **13**. The primary alcohol was tosylated and replaced by azide with NaN_3 in DMF to give **15**. The secondary alcohol at C-4 was subjected to mesylation and then treated with potassium thiolacetate, affording **16**: mp 160–163°; $[\alpha]_D^{20} + 167^\circ$ (c 0.9, CHCl_3); $J_{3,4} = 4$ and $J_{4,5} = 2.5$ Hz, in a fair yield. The azide and *S*-acetyl groups were reduced with Raney Ni in methanol at the same time. After acetylation of the primary amino group, methyl 3,6-diacetamido-2,3,4,6-tetra-deoxy- α -D-threo-hexopyranoside (**17**), mp 192–193°, $[\alpha]_D^{20} + 137^\circ$ (c 0.8, H_2O), was obtained in a good yield. Hydrolysis of **17** followed by oxidation with bromine-water afforded a crystalline lactone of (3*S*,5*S*)-3,6-diacetamido-5-hydroxyhexanoic acid (**18**), mp 183–185°, $[\alpha]_D^{25} + 8.7^\circ$ (c 2.3, H_2O).

The total syntheses of negamycin and the antipode have been completed using the δ -hydroxy- β -lysines⁸ obtained from **11** and **18**, respectively.^{1,9}

The antimicrobial spectra of negamycin and its antipode are shown in Table I, showing that the latter has generally far weaker activity against a variety of organisms than that of the former, but it is noteworthy that the antipode still has a definite biological activity.

Acknowledgment. We wish to express our deep gratitude to Professor S. Umezawa, Keio University, for his encouragement through the course of this work.

(8) These hydroxy amino acids were obtained by acid hydrolysis of the lactones **11** and **18** followed by purification with resin chromatography of Amberlite CG-50, respectively.

(9) Satisfactory elemental analyses were obtained for all the compounds for which melting point or $[\alpha]_D$ values were given. All the compounds cited showed reasonable spectral data.

Seiji Shibahara,* Shinichi Kondo, Kenji Maeda, Hamao Umezawa
Institute of Microbial Chemistry
Shinagawa-ku, Tokyo, Japan

Masaji Ohno
Basic Research Laboratories, Toray Industries, Inc.
Kamakura, Japan

Received February 3, 1972

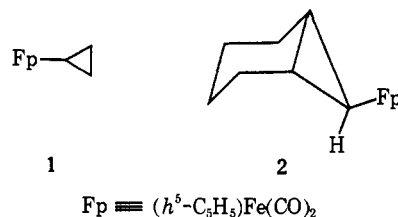
Cationic Metal-Carbene Complexes in Cycloaddition Reactions. Synthesis and Reactions of Iron-Cyclopropyl Complexes

Sir:

Although numerous cyclopropyl derivatives of the main group elements are known,¹ no transition metal

complexes having a σ -bonded cyclopropane ring have been reported.² Our interest in the nucleophilic properties of transition metal-allyl complexes⁴ in metal-assisted cycloaddition reactions prompted us to re-examine the synthesis of the isomeric cyclopropyl derivatives with a view toward comparing their chemistry.

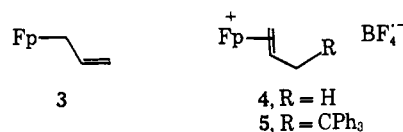
We wish now to report the preparation of two such complexes (**1** and **2**) and their reactions with electro-



philic reagents. Each may be prepared in moderate yield by treatment of the requisite cyclopropyl bromide⁵ with $(h^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{Na}$, while the first may also be obtained by alkylation of $(h^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{Br}$ with cyclopropyllithium.⁶

The parent complex **1** is an air-stable amber oil, which may be distilled at room temperature under high vacuum without decomposition.⁷ The comparative electronegativity of the cyclopropyl group is manifest in the carbonyl stretching frequencies of **1** (2014 and 1961 cm^{-1}) and of a typical secondary alkyl derivative $(h^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2(i\text{-C}_3\text{H}_7)$ (2006, 1952 cm^{-1}). Its nmr spectrum, taken in CS_2 , exhibits two high-field multiplet absorptions at τ 9.48 (three protons) and 10.12 (two protons) assignable to protons trans and cis, respectively, to the carbon-metal bond.

Gaseous hydrogen chloride reacts with **1** to give $(h^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{Cl}$ and a mixture of cyclopropane and propene. The compound reacts rapidly with fluoroboric acid and with trityl fluoroborate, as does the isomeric *h*¹-allyl complex **3**, to give the propene complexes **4**⁸ and **5**,⁷ respectively.



The formation of **4** with fluoroboric acid does not proceed as might be anticipated, through cleavage of $\text{C}_2\text{-C}_3$ with metal migration. Thus, treatment of the 1-deuterio derivative **1-d** with fluoroboric acid gave the

(1) For a list of references to these, see A. H. Cowley, J. L. Mills, T. H. Loehr, and T. V. Long, *J. Amer. Chem. Soc.*, **93**, 2151 (1971).

(2) Several attempts to prepare such derivatives of manganese, rhenium, iron, and iridium by decarbonylation of the related acyl-metal complexes were unsuccessful.³

(3) M. I. Bruce, M. Z. Igbal, and F. G. A. Stone, *J. Organometal. Chem.*, **20**, 161 (1969).

(4) W. P. Giering and M. Rosenblum, *J. Amer. Chem. Soc.*, **93**, 5299 (1971).

(5) D. Seyferth, *et al.*, *ibid.*, **87**, 4259 (1965); D. Seyferth, H. Yamazaki, and D. L. Alleston, *J. Org. Chem.*, **28**, 703 (1963). The norcarane complex **2** was obtained from the mixture of stereoisomeric halides formed in the reduction of the corresponding dibromide. The Fp group is assigned as exo since models show that the alternative endo form would be prohibitively crowded.

(6) In view of the low reactivity of cyclopropyl halides in $\text{S}_{\text{N}}2$ reactions, it seems likely that the former synthesis involves an initial metal-halogen exchange reaction.

(7) An acceptable C and H analysis was obtained for this compound.

(8) M. L. H. Green and P. L. I. Nagy, *J. Chem. Soc.*, 189 (1963).