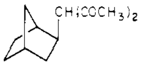
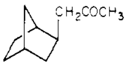
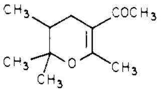
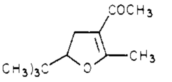
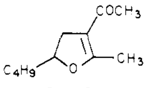
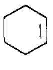
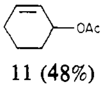
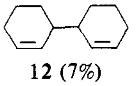
Table I. Benzophenone-Sensitized Photoreduction of $Cu(acac)_2$ in the Presence of Various Olefins

	 2 (24%)	 3 (6%)
$(CH_3)_3CCH{=}CH_2$	$(CH_3)_3CCH_2CH_2CH(COCH_3)_2$ 4 (35%)  5 (11%)	$(CH_3)_2C{=}C(CH_3)CH_2CH(COCH_3)_2$ 6 (3%)  7 (12%)
$C_4H_9CH{=}CH_2$	$C_4H_9CH_2CH_2CH(COCH_3)_2$ 8 (16%)  10 (13%)	$C_3H_7CH{=}CHCH_2CH(COCH_3)_2$ 9 (4%)
	 11 (48%)	 12 (7%)

by the triplet signal of the methine proton. The formation of **5** and **6** suggests the intervention of carbenium ion intermediates[10] by electron transfer as shown in eq 10: $Cu(OAc)_2$ is known to be a better oxidizing species[3] than $Cu(acac)_2$.

The product pattern indicates that, besides abstracting a hydrogen, the acetylacetonyl radical also adds to π bonds regiospecifically and exclusively as the C radical. This is in good agreement with the report that 77% of the spin density in the acetylacetonyl radical resides at C_3 and the O-radical structure is unimportant.[6] With poor hydrogen-donating substrates such as norbornene and neohexene the acetylacetonyl radical attacks the double bonds without showing any sign of hydrogen abstraction. The cyclohexenyl radical is much more easily oxidized than the acyclic radical to the corresponding carbenium ion under the reaction conditions, and the 2-norbornyl radical is surprisingly resistant to the oxidation. In view of the ease of solvolytic formation of norbornyl cations,[11] the tendency for radical oxidation must be related to, among other factors, the extent of the s character of the orbital containing the unpaired electron. The oxidative addition, as represented by eq 2 and 6–8, involves reduction to copper(I) and then to copper metal, which would slowly retard the photoreaction. Owing to the reduction process, the addition reaction of the acetylacetonyl radical cannot be schemed into a catalytic cycle at the present stage.

Acknowledgment. We are grateful to the Natural Sciences and Engineering Research Council of Canada for generous operating grants. Y.L.C is much indebted to Professor A. Rassat and his colleagues of LEDSS, Université Scientifique et Médicale de Grenoble, for lively discussion and hospitality.

Registry No. 1, 77350-15-3; *exo*-**2**, 81769-99-5; *exo*-**3**, 25121-32-8; **4**, 81770-00-5; **5**, 81770-01-6; **6**, 81770-02-7; **7**, 81770-03-8; **8**, 64122-32-3; **9**, 81770-04-9; **10**, 81770-05-0; **11**, 14447-34-8; **12**, 1541-20-4; $(CH_3)_3CCH{=}CH_2$, 558-37-2; $C_4H_9CH{=}CH_2$, 592-41-6; $Cu(acac)_2$, 46369-53-3; benzophenone, 119-61-9; 2-norbornene, 498-66-8; cyclohexene, 110-83-8; acetylacetonyl radical, 17374-75-3; 2-nitroso-2-methylpropane, 917-95-3.

Supplementary Material Available: Photolysis conditions and isolation of the products and the NMR, IR, and MS data of products **2–11** (5 pages). Ordering information is given on any current masthead page.

---

(10) Kochi, J. K.; Bemis, A.; Jenkins, C. L. *J. Am. Chem. Soc.* **1968**, *90*, 4038. Cekovic, Z.; Green, M. M. *Ibid.* **1974**, *96*, 3000.

(11) Berson, J. A. In "Molecular Rearrangements", de Mayo, P., Ed.; Interscience: New York, 1963; part one, p 111.

Carbenium-Carbonium Structures, $H_2C^+{-}CH_4^+$, for the Ethane Dication

Paul von Ragué Schleyer* and Alexander J. Kos

Institut für Organische Chemie
Friedrich-Alexander-Universität Erlangen-Nürnberg
8520 Erlangen, Federal Republic of Germany

John A. Pople

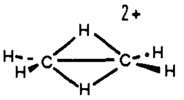
Department of Chemistry, Carnegie-Mellon University
Pittsburgh, Pennsylvania 15213

Alexandru T. Balaban

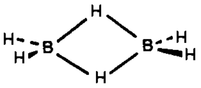
Department of Organic Chemistry
The Polytechnic, Bucharest, Rumania

Received February 11, 1982

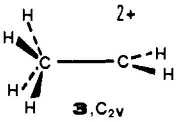
Olah and Simonetta's theoretical reexamination of the ethane dication, $C_2H_6^{2+}$, favored a doubly bridged form, **1** (D_{2h}), similar to **2**, the structure of the isoelectronic analogue diborane.[1] Despite being highly unstable electrostatically toward dissociation into two methyl cations, **1** was indicated to be a minimum on the potential-energy surface. As part of an extensive theoretical survey of dications,[2] we have also examined a variety of $C_2H_6^{2+}$ structures and states. The results extend the findings of Olah and Simonetta significantly. Surprisingly, the carbenium–carbonium dication geometry, **3**, is significantly more stable than **1**. We also conclude that $C_2H_6^{2+}$ might be observable experimentally, e.g., by charge-stripping mass spectroscopy.[3]



1, D_{2h}



2, D_{2h}



3, C_{2v}

Various fixed points on the $C_2H_6^{2+}$ potential-energy surface were first located and characterized by the number of negative eigenvectors in the force-constant matrix at the 3-21G//3-21G split valence ab initio basis set level (Table I).[4] Some of the geometries were further optimized with a d orbital augmented basis set (6-31G*//6-31G*).[5] Because of the importance of electron correlation in describing the dimerization of borane[6] and the bridging of the ethyl cation,[7] final calculations at the 6-31G* geometries were carried out at the fourth-order Møller–Plesset level (including all single, double, and quadruple excitations) with a larger basis set, including p-type polarization functions on hydrogen (MP4SDQ/6-31G**//6-31G*).[5,8] Correlation does decrease the energy of **1** relative to **3**, but not decisively (Table I). A large number of geometries were explored, but only the lowest energy forms are listed in Table I. In particular, triplet states were found not to be competitive, and singlet structures

---

(1) Olah, G. A.; Simonetta, M. *J. Am. Chem. Soc.* **1982**, *104*, 330–331. For an earlier calculational study, see: Peyerimhoff, S. D.; Buenker, R. J. *J. Chem. Phys.* **1968**, *49*, 312–325.

(2) This paper is the fourth in a series on dications. Part I: Chandrasekhar, J.; Schleyer, P. v. R.; Krogh-Jespersen, K. *J. Comput. Chem.* **1981**, *2*, 356–360. Part II: Pople, J. A.; Frisch, M. J.; Raghavachari, K.; Schleyer, P. v. R. *Ibid.* **1982**, *3*, in press. Part III: Pople, J. A.; Tidor, B.; Schleyer, P. v. R. *Chem. Phys. Lett.*, in press.

(3) Ast, T.; Porter, C. J.; Proctor, C. J.; Beynon, J. H. *Bull Soc. Chim. Beograd* **1981**, *46*, 135–151 *Chem. Phys. Lett.* **1981**, *78*, 439–444. Proctor, C. J.; Porter, C. J.; Ast, T.; Bolton, P. D.; Beynon, J. H. *Org. Mass Spectrosc.* **1981**, *16*, 454–458.

(4) The Gaussian 80 CMU program was employed: Binkley, J. S.; Whiteside, R.; Krishnan, R.; Seeger, R.; Schlegel, H. B.; DeFrees, D. J.; Pople, J. A. For the 3-21G basis set, see: Binkley, J. S.; Pople, J. A.; Hehre, W. J. *J. Am. Chem. Soc.* **1980**, *102*, 939–947.

(5) Hariharan, P. C.; Pople, J. A. *Mol. Phys.* **1974**, *27*, 209–213.

(6) See: (a) Redmon, L. T.; Purvis, G. D., III; Bartlett, R. J. *J. Am. Chem. Soc.* **1979**, *101*, 2856–2862. (b) Dill, J. D.; Schleyer, P. v. R.; Pople, J. A. *Ibid.* **1975**, *97*, 3402–3409.

(7) Raghavachari, K.; Whiteside, R. A.; Pople, J. A.; Schleyer, P. v. R. *J. Am. Chem. Soc.* **1981**, *103*, 5649–5657.

(8) Krishnan, R.; Pople, J. A. *Int. J. Quant. Chem.* **1978**, *14*, 91–100.

0002-7863/82/1504-3771$01.25/0

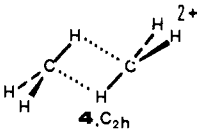
Table I. Calculated Total (au) and Relative Energies (kcal/mol, in Parentheses)

species	3-21G//3-21G	6-31G*//6-31G*	MP2/6-31G*//6-31G*	MP4SDQ/6-31G**//6-31G*
1, D_{2h}	−77.762 15 (34.0)[a]	−78.231 51 (15.8)[a]	−78.475 66 (9.7)	−78.553 03 (9.0)
3, C_{2v}	−77.816 26 (0.0)[a]	−78.256 70 (0.0)	−78.491 17 (0.0)	−78.567 35 (0.0)
4, C_{2h}	−77.757 23 (37.0)[b]	−78.213 94 (26.8)		−78.524 62 (26.8)
5, C_{2v}	−77.759 00 (35.9)[c]			
6, C_{2v}	−77.815 07 (0.7)[b]	−78.255 28 (0.9)	−78.488 69 (1.6)	
$2CH_3^+$	−78.018 26 (−126.8)	−78.461 28 (−128.4)	−78.650 28 (−99.8)	−78.734 74 (−105.0)
$C_2H_5^+ + (H^+)$	−77.872 60 (−35.3)	−78.311 23 (−34.2)	−78.551 84 (−38.1)	−78.620 65 (−33.4)
C_2H_6	−78.793 95 (−613.5)	−79.228 75 (−610.0)	−79.494 74 (−629.7)	
7, C_{2v}	−65.314 54 (0.0)	−65.692 60 (0.0)[d]	−65.896 21 (0.0)[d]	
8, C_{2v}	−65.263 09 (32.3)	−65.634 18 (36.7)[d]	−65.849 32 (29.4)[d]	
$BH_3 + CH_3^+$	−65.246 43 (42.7)	−65.620 65 (45.1)	−65.789 38 (67.0)	
$CH_4 + BH_2^+$	−65.295 42 (12.0)	−65.665 97 (16.7)		
2, D_{2h}	−52.497 81 (0.0)	−52.812 40 (0.0)	−52.992 82 (0.0)[e]	
9, C_{2v}	−52.387 42 (69.3)	−52.691 20 (76.1)[d]	−52.882 97 (68.8)[d]	
$2BH_3$	−52.474 60 (14.6)	−52.780 02 (20.3)	−52.928 46 (40.4)[e]	

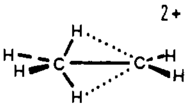
[a] No negative eigenvalues in the force constant matrix. [b] One negative eigenvalue. [c] Two negative eigenvalues. [d] 3-21G geometries. [e] MP2/6-31G* geometries.

based on ethane-like symmetries (D_{3d} or D_{3h}) dissociated upon geometry optimization.

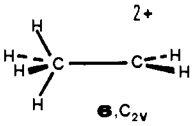
In agreement with Olah and Simonetta, the diborane-like geometry (**1**) was found to be a local minimum (no negative eigenvalues) on both the 3-21G and the 6-31G* potential-energy surfaces. A transition structure for dissociation of **1** into two methyl cations (**4**, C_{2h}, with one negative eigenvalue) was 17.8 kcal/mol higher in energy (MP4SDQ/6-31G**//6-31G*). However, a C_{2v} geometry (**5**), only 2.0 kcal/mol higher in energy than **1**, characterizes a process whereby the two bridging hydrogens move simultaneously[9] to give the carbenium–carbonium dication, **6**, which is substantially more stable than **1** at all levels studied. With one negative eigenvalue, **6** is not a local minimum but rather the transition structure for rotation into a second C_{2v} form, **3**, the global $C_2H_6^{2+}$ minimum. The rotation barrier is small.[10]



4, C_{2h}



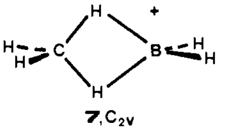
5, C_{2v}



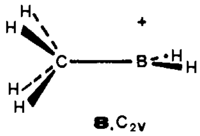
6, C_{2v}

While **3** still is unstable thermodynamically toward dissociation into two methyl cations (by 105 kcal/mol) or toward loss of a proton (by 38 kcal/mol), both these processes should require considerable activation. With the assumption that **4** is the transition structure for the dissociation of **3**, 26.8 kcal/mol activation would be needed to give two methyl cations. Preliminary calculations at the 3-21G level indicate that the loss of a proton from **3** would involve a large activation energy. In this respect, $C_2H_6^{2+}$ should be similar to CH_4^{2+},[2c] an experimentally observable carbodication.[3]

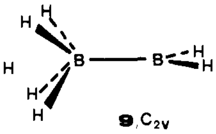
Structures for the isoelectronic BCH_6^+ cation, which models a species for which there is experimental evidence,[1] also were examined. In this case, the diborane-like geometry, **7**, the global minimum, was found to be 29.4 kcal/mol (MP2/6-31G*//3-21G) more stable than **8** (the form analogous to **3**). For B_2H_6, the similar energy difference favoring **2** over **9** increases to 69.2 kcal/mol at the same level.



7, C_{2v}



8, C_{2v}



9, C_{2v}

In contrast to $C_2H_6^{2+}$, CBH_6^+ is stable toward dissociation into CH_3^+ and BH_3 by 67.0 kcal/mol (MP2/6-31G*//3-21G). However, a second dissociation mode, to give BH_2^+ and CH_4, is somewhat less unfavorable (38.6 kcal/mol). For comparison at a similar theoretical level (MP2/6-31G*//MP2/6-31G*), the dissociation of diborane into two BH_3's requires 40.4 kcal/mol. This value is only a little above the best theoretical estimates.[6]

Why is the structural preference of $C_2H_6^{2+}$ so exceptional? What effects are responsible for the greater stability of **3** over **1**? In the first place, the B–B bond is inherently weaker than the C–C bond. Thus, the B···B distance in diborane, 1.77 Å,[6] is considerably longer than the standard B–B single bond length (1.64 Å),[6b] but the C–C distance in **1**, 1.563 Å, is only slightly longer than that of a typical C–C single bond (1.53 Å). In **3**, the shortened C–C distance, 1.477 Å, indicates hyperconjugative stabilization between the nominally vacant carbenium p orbital and the pyramidal CH_4 moiety.

The second effect is electrostatic. The population analysis indicates that the positive charges are primarily located on the *hydrogen* atoms, since hydrogen is more electropositive than carbon. In **3**, the hydrogens on the average are farther apart than in **1**, and intramolecular electrostatic repulsion is reduced.

Conclusions. 1. The structures of the two minima on the $C_2H_6^{2+}$ potential-energy surface can easily be understood as products of formal proton addition, either symmetrically to the bridged ethyl cation to give **1** or to the methyl group of the classical ethyl cation to give **3**.

2. Unlike the isoelectronic B_2H_6 and CBH_6^+ species, the unprecedented carbenium–carbonium dication structure for $C_2H_6^{2+}$, **3**, is preferred over the diborane-like alternative, **1**, which, at best, represents a shallow minimum easily converted into **3**. This preference is due to reduced electrostatic repulsion and stronger C–C bonding in **3**.

3. Although **3** is unstable thermodynamically, the rather high barriers toward loss of a proton or dissociation into two methyl cations should permit observation of $C_2H_6^{2+}$ under appropriate experimental conditions, e.g., by charge-stripping mass spectroscopy.[3,11]

Acknowledgment. This work was supported at Erlangen by the Fonds der Chemischen Industrie and at Pittsburgh by the National

---

(9) Since **5** has two negative eigenvalues, it is not the true transition structure separating the two minima **1** and **3**. The true transition structure, which cannot have C_{2v} symmetry, must have somewhat less energy than **5**.

(10) In general, semiempirical calculations perform tolerably well. MNDO, known to disfavor bridged forms (Dewar, M. J. S.; Thiel, W. *J. Am. Chem. Soc.* **1977**, *99*, 4899, 4907), finds **6** to be about 35 kcal/mol more stable than **1**. MINDO/3 gives the opposite stability order but a smaller energy difference (ca. 5 kcal/mol). Association of the 2-propyl cation and BH_3 to give $(CH_3)_2CH_2BH_2^+$ (see **7**)[1] is 9.4 kcal/mol exothermic (MNDO). M. J. S. Dewar (private communication) also has examined $C_2H_6^{2+}$ at these semiempirical levels.

(11) There is one report of the fleeting experimental observation of $C_2H_6^{2+}$ by Auger spectroscopy: Spohr, R.; Bergmark, T.; Magnusson, N.; Werme, L. O.; Nordling, C.; Siegbahn, K. *Phys. Scr.* **1970**, *2*, 31–37. However, the reported dissociation energy (into $C_2H_5^+$ and H^+), about −8 eV, for $C_2H_6^{2+}$, is in gross disagreement with our calculated value (−1.6 eV, Table I). The calculated double ionization potential of C_2H_6, 27.3 eV at MP2/6-31G*, likewise is far less that the reported experimental value, 34.8 ± 0.8 eV. $C_2H_6^{2+}$ has not been observed by electron impact; see: Jones, B. E.; Abbey, L. E.; Chatham, H. L.; Hanner, A. W.; Teleshefsky, L. A.; Burgess, E. M.; Moran, T. F. *Org. Mass Spectrosc.* **1982**, *17*, 10; Meyerson, S.; Ihrig, P. J., private communication.

Science Foundation (Grant CHE-79-01061) and was facilitated by a NATO grant. We thank Professor Olah for a preprint of ref 1 and are indebted to Professor Beynon and Professor Ast for helpful information.

Registry No. 1, 81702-60-5; **2**, 19287-45-7; **3**, **5**, **6**, 81643-07-4; **4**, 80181-26-6; $C_2H_5^+$, 14936-94-8; H^+, 12184-88-2; BH_3, 13283-31-3; CH_3^+, 14531-53-4; CH_4, 74-82-8; BH_2^+, 15194-16-8.

Oxidative Addition of Unactivated Epoxides to Iridium(I) Complexes. Formation of Stable *cis*-Hydridoformylmethyl and -Acylmethyl Complexes[†]

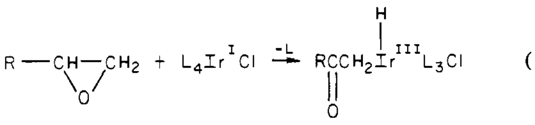
D. Milstein* and J. C. Calabrese

Central Research & Development Department
Experimental Station
E. I. du Pont de Nemours and Company
Wilmington, Delaware 19898

Received February 25, 1982

Despite the large number of transition-metal homogeneously catalyzed transformations of epoxides reported and their considerable synthetic utility,[1] little is known about the mechanism of interaction of transition-metal complexes with epoxides. Intermediates resulting from such reactions, although highly desirable for mechanistic understanding, are exceedingly scarce and have been isolated only with the very electron-deficient tetracyanoethylene oxide[2] and in two cases where ligand-initiated reactions take place leading to complexes that are stabilized by carbonylation to the corresponding acyl complexes.[3]

We have recently found that a series of stable Ir(III) *cis*-hydridoacylmethyl complexes can be easily obtained from reactions of epoxides with Ir(I) trimethylphosphine complexes (eq 1). In



$$R{-}\underset{\backslash O/}{CH{-}CH_2} + L_4Ir^{I}Cl \xrightarrow{-L} R\underset{\underset{O}{\|}}{C}CH_2\overset{\overset{H}{|}}{Ir^{III}}L_3Cl \qquad (1)$$

addition to providing the first examples of unassisted oxidative addition of simple epoxides to transition-metal complexes, the reaction sheds more light on the mechanism of the transition-metal-catalyzed transformations of epoxides and leads to formation of complexes that are of interest in their own right.

Addition of excess ethylene oxide to an orange solution of $Ir(C_8H_{14})(PMe_3)_3Cl$[4,5] (**1**) under N_2 at −10 °C followed by warming to room temperature over 45 min results in decoloration. Removal of the solvent and excess epoxide and crystallization of the resulting oil from toluene by the vapor diffusion of hexane yield the *cis*-hydridoformylmethyl complex **2** (Chart I) in 85% yield as white needles.[6] Since the hydrido ^1H NMR signal is consistent only with a structure containing a trimethylphosphine ligand trans to the hydride ligand and having two identical cis-trimethylphosphine ligands, the hydrido and formylmethyl ligands have to be in mutually cis positions. This structural assignment of **2** has been confirmed by a single-crystal X-ray diffraction study, shown in Figure 1.[7]

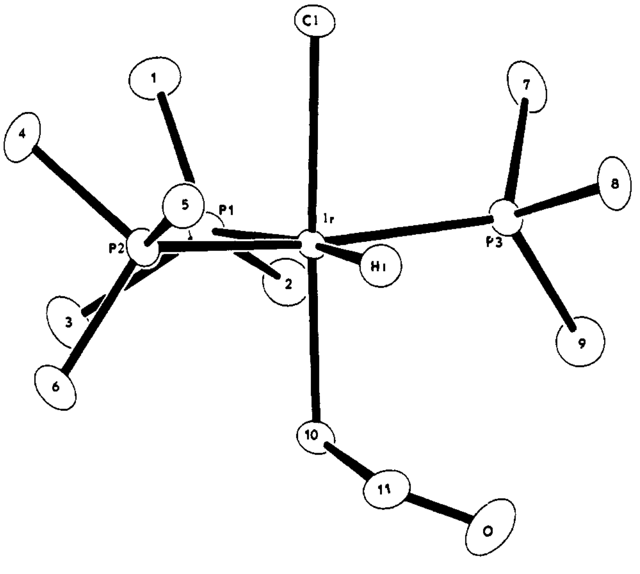
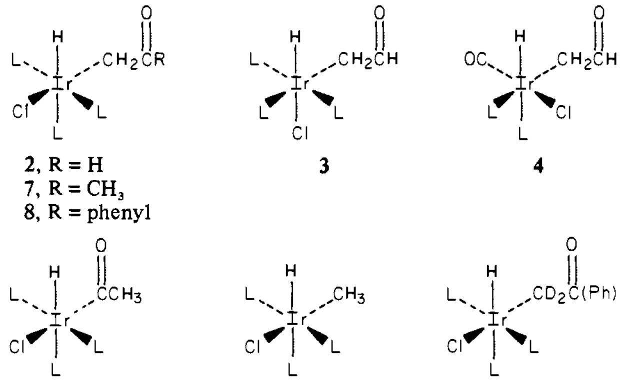


Figure 1. ORTEP drawing of a molecule of **2** showing thermal ellipsoids at 25% probability level. Selected bond distances (Å) and angles (deg) are as follows: Ir–Cl, 2.467 (1); Ir–H, 1.64 (6); $Ir–P_1$, 2.337 (1); $Ir–P_2$ 2.309 (1); $Ir–P_3$, 2.312 (1); $Ir–C_{10}$, 2.127 (6); $C_{10}–C_{11}$, 1.478 (8); $Ir–C_{10}–C_{11}$, 106.7 (4); $Cl–Ir–C_{10}$, 176.1 (2); $P_2–Ir–P_3$, 163.7 (1).

Chart I[a]



2, R = H
7, R = CH_3
8, R = phenyl

3

4

5

6

11

[a] L = PMe_3.

Coordination about the iridium is octahedral with expected deviations arising from the decreased steric bulk of the hydride ligand. The C(10)–C(11) bond length of 1.478 (8) Å is slightly shorter than a normal C–C bond because of the expected β effect.[8] The Ir–P trans to the hydride is 0.03 Å longer than the Ir–P bond cis to it, thus reflecting the large trans effect exerted by the hydride

---

[†] Contribution No. 3022.

(1) Transition-metal complexes have been reported to catalyze isomerization, hydrogenation, hydroformylation, carboxylation, carbonylation, hydrogenolysis, dimerization, and deoxygenation reactions of epoxides: (a) Milstein, D.; Buchman, O.; Blum, J. *J. Org. Chem.* **1977**, *42*, 2299 and references therein. (b) Blum, J.; Zinger, B.; Milstein, D.; Buchman, O. *Ibid.* **1978**, *43*, 2961. (c) Suzuki, M.; Oda, Y.; Noyori, R. *J. Am. Chem. Soc.* **1979**, *101*, 1623. (d) Suzuki, M.; Watanabe, A.; Noyori, R. *Ibid.* **1980**, *102*, 2095. (e) Fujitsu, H.; Shirahama, S.; Matsumura, E.; Takenshita, K.; Mochida, I. *J. Org. Chem.* **1981**, *46*, 2287. (f) Kamiya, Y.; Kawato, K.; Ohta, H. *Chem. Lett.* **1980**, 1549. (g) Hayashi, Y.; Schwartz, J. *Inorg. Chem.*, **1981**, *20*, 3473. (h) Thompson, D. T.; Whyman, R. In "Transition metals in Homogeneous Catalysis"; G. N. Schrauzer, Ed.; Marcel Deckker: New York, 1971.

(2) (a) Schlodder, R.; Ibers, J. A.; Lenarda, M.; Graziani, M. *J. Am. Chem. Soc.* **1974**, *96*, 6893. (b) Lenarda, M.; Ros, R.; Traverso, O.; Pitts, W. D.; Baddley, W. H.; Graziani, M. *Inorg. Chem.* **1977**, *16*, 3178.

(3) The two processes known are: (a) Addition of $HCo(CO)_4$ to epoxides, which is proton promoted: Heck, R. F. *J. Am. Chem. Soc.* **1963**, *85*, 1460. (b) The trimethylsilyl-initiated reaction of (trimethylsilyl)manganese pentacarbonyl with ethylene oxide: Brinkman, K. C.; Gladysz, J. *J. Chem. Soc., Chem. Commun.* **1980**, 1260. In both these reactions, stable product complexes could be obtained only after reaction with CO.

(4) Preparation of **1** and $[Ir(PMe_3)_4]^+Cl^-$ is reported by Herskovitz (Herskovitz, T. *Inorg. Synth.*, in press).

(5) The Ir(I) complexes employed are very oxygen sensitive, and all operations were carried out in a N_2 drybox using dry, degassed solvents.

(6) **2**: IR (Nujol) 2683 (m, ν_{OC-H}), 2015 (s, ν_{Ir-H}), 1663 cm^{-1} (s, $\nu_{C=O}$); ^1H NMR ($CDCl_3$) δ 1.40 (d, $J = 7$ Hz, 9 H, PMe_3), 1.56 (t, $J = 4$ Hz, 18 H, 2 PMe_3), 1.92 (pseudo quintet, $J = 6$ Hz, 2 H, CH_2–Ir), 8.76 (t, $J = 6$ Hz, 1 H, CHO), −11.3 (d of t, $J_{H-P,trans} = 152$, $J_{H-P,cis} = 19$ Hz, 1 H, Ir–H); $^{31}P\{^1H\}$ NMR ($CDCl_3$) δ −52.4 (t, $J = 21$ Hz, 1 P), −45.2 (d, $J = 21$ Hz, 2 P). Satisfactory C and H analyses were obtained for **2–4**, **6–8**, and **11**.

(7) Crystal data for **2**: $IrC_{11}H_{31}P_3Cl{\cdot}O$ space group $P2_1/c$, cell dimensions (−100 °C) $a = 13.691$ (3) Å, $b = 9.307$ (2) Å, c 15.184 (2) Å, $\beta = 99.29$ (1)°, $V = 1909$ Å^3, $Z = 4$, $R = 0.026$, $R_w = 0.034$ for 278 parameters, 3570 absorption corrected ($\mu = 73.441$ cm^{-1}) data with $I \geq 2\sigma(I)$. All details are included in the supplementary material.

(8) For a similar effect in (acylalkyl)manganese complexes, see: Engelbrecht, J.; Greiser, T.; Weiss, E. *J. Organomet. Chem.* **1981**, *204*, 79.

0002-7863/82/1504-3773$01.25/0