

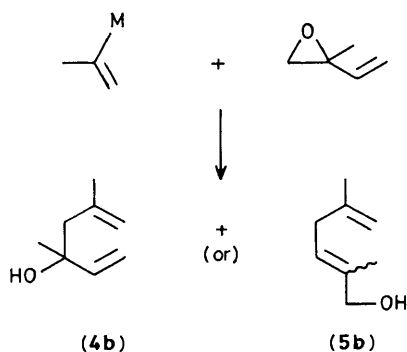
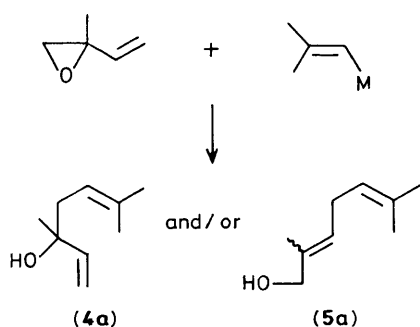
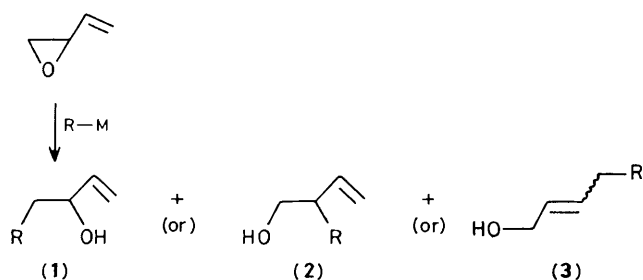
S_N -Opening of Allylic Epoxides by Vinylic-type Organometallic Derivatives

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Hexa-1,5-dien-3-ols are selectively obtained in the reaction of allylic epoxides with lithium trialkylalkynylborates.

The reaction of organometallic species with allylic epoxides creates problems because of the presence of three electrophilic sites; generally lithio compounds and Grignard reagents undergo simultaneously S_N and S_N' processes leading to a mixture of alcohols (1), (2), and (3) in different ratios

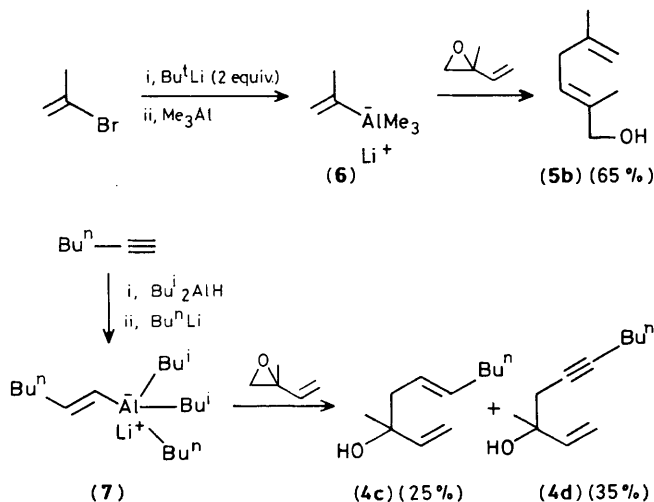


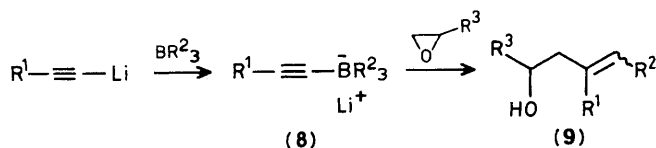
depending on the experimental conditions while cuprates and copper(I) reagents cause S_N' opening producing alcohols (3) with high regioselectivity.^{1,2}

In the course of our continuing interest in the oxy Cope transposition³ we tried to develop a new method for the synthesis of diversely substituted hexa-1,5-dien-3-ols, which could be eventually used for obtaining such alcohols in an optically active form. The reaction of vinylic metallic species with allylic epoxides seemed to offer a solution to this problem in spite of the fact that the only reported results⁴ have shown that either alcohol (5a), or mixtures of alcohols (4a) and (5a), were obtained when isoprene epoxide was treated respectively with cuprates, and with lithio or Grignard reagents.

Therefore, we undertook a general study of the reaction using isoprene epoxide and metallic derivatives of 2-bromopropene; in every case, the reaction followed predominantly a S_N2' process giving mainly [M = Li, MgBr, Zn, or Zr(OBu)₃] or exclusively (M = AlMe₃) the alcohol (5b) in variable yield and as a mixture of *Z*- and *E*-isomers.

The orientation of attack giving (4b) was only observed with the lithio derivative by using tetrahydrofuran (THF) as solvent and by adding hexamethylphosphoramide (HMPA; 1 mol. equiv.), but the low yield of the reaction (<10%) precluded its use as a synthetic procedure. Nevertheless, this result gave the indication that an electrophilic assistance by lithium or magnesium bromide could be involved in the formation of





(5b). It was of interest to make the metallic species by a method other than that involving halogen-metal exchange. Since the majority of the organometallics mentioned here are made from 2-bromopropene *via* the lithio derivative, 1 mol equiv. of lithium bromide was always present in the reaction mixture.

This hypothesis was checked by using two types of vinylic aluminium derivatives; when isoprene epoxide was treated with a vinylalane (6) formed from 2-bromopropene, the only product was the alcohol (5b) (*E* only) while the alcohol (4c) was formed in the reaction of the same epoxide with the vinylalane (7) arising from the hydroalumination of hex-1-yne. In this reaction, (4c) was accompanied by the acetylenic alcohol (4d) resulting from the intervention of an aluminium acetylide.⁵

This result was confirmed by a study of the reaction of the lithium trialkylalkynylborates (8) with allylic epoxides; these reagents, previously used by Nozaki and co-workers⁶ are prepared by reaction of a lithium acetylide with a trialkylborane and are known to react with saturated epoxides giving alcohols (9).⁷

The reagent (8a) was prepared from hex-1-yne and triethylborane in THF as previously described^{6,7} and treated with the allylic epoxides (10a-c) (reflux 10 h; then treatment with an excess of acetic acid, reflux, 10 h). The products (Table 1) were isolated by flash chromatography; with isoprene epoxide (10a), only the alcohol (4) was formed; the alcohol (4) is the predominant product of the reaction of the two other epoxides but the presence of its isomer (11) arising from the attack of the metallic reagent on the central carbon atom of the epoxide is then noticeable. In none of these three cases were the alcohols (5) detectable, showing that the opening of the allylic epoxide by trialkylalkynylborates follows *exclusively* an S_N process. The same orientation was observed by using the borate (8b) prepared from phenylacetylene but the yields were low, the main product being the starting alkyne.

All the isolated alcohols (4) and (11) were mixtures of both isomers with a slight predominance (*E/Z* 1.2-1.5) for the *E* configuration.

In conclusion, these results concerning the regioselective S_N opening of allylic epoxide with trialkylalkynylborates complement those previously described⁴ for the formation of alcohols (5) by an S_N' process. The method permits the synthesis in fairly good yields and with a flexible degree of substitution of certain hexa-1,5-dien-3-ols which can be useful because of their ability to undergo [3.3] sigmatropic rearrangements.⁸

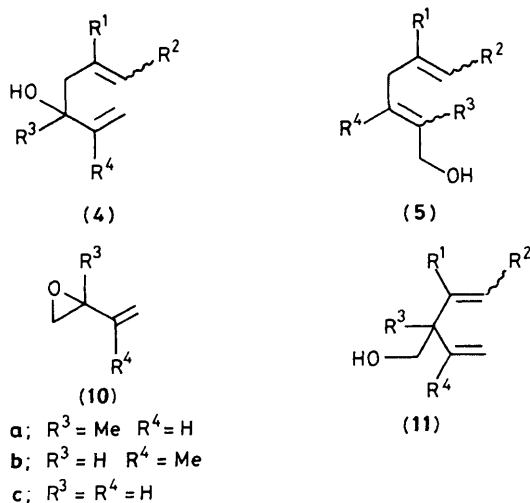


Table 1

Trialkylalkynylborate	Epoxide	Product
(8a), R ¹ = Bu, R ² = Et	(10a)	(4) (50%)
	(10b)	(4) (63%) + (11) (18%)
	(10c)	(4) (46%) + (11) (16%)
(8b), R ¹ = Ph, R ² = Et	(10a)	(4) (12%)
	(10b)	(4) (14%) + (11) (8%)
	(10c)	(4) (36%) + (11) (20%)

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