A New Regio- and Stereo-selective Functionalization of Allylic and Homoallylic Alcohols

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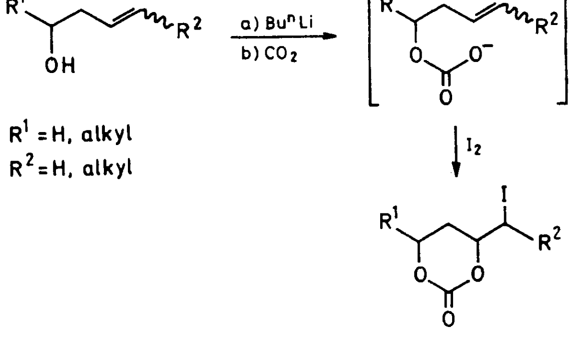
Summary A new, highly regio- and stereo-selective synthesis of cyclic iodocarbonates of allylic and homoallylic alcohols involving cyclofunctionalization of the corresponding alcohol carbonates is described.

FOR the synthesis of biologically active natural products, *e.g.* macrocyclic antibiotics, there is considerable interest in the stereoselective introduction of chiral centres.[1] The iodolactonization reaction has often been used to functionalize double bonds in a regio- and stereo-selective manner in cyclic[2] and acyclic[3] systems, the experimental conditions being suitable for a wide variety of such systems.[4] In connection with our interest in reactions involving iodonium intermediates,[5] we report a new synthesis of five- and six-membered cyclic iodocarbonates. For this synthesis we utilized carbonates obtained from allylic and homoallylic alcohols, which are smoothly prepared in quantitative yield by bubbling CO_2 into a tetrahydrofuran (THF) solution of the corresponding alcoholates. Cyclofunctionalization with iodine in THF afforded the corresponding cyclic iodocarbonates in good yield (Scheme). We have studied the applicability of this reaction towards primary, secondary, and tertiary allylic and homoallylic alcohols, and some results are reported in the Table. The functionalization of the double bond is highly regioselective; while allylic alcohols give five-membered rings, homoallylic alcohols give six-membered rings. The equatorial stereochemistry of the iodo-derivative (**4c**) was established from its ^{1}H n.m.r. spectrum, which revealed J(ax–ax) 11·5 Hz between H_A and H_X and J(eq–ax) 3 Hz between H_B and H_X.[6]



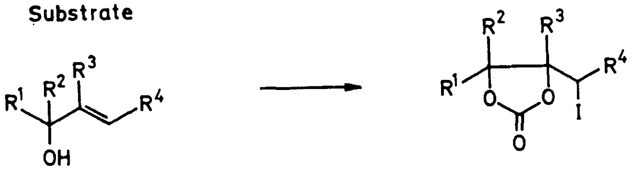
SCHEME

The coupling constants in the ^{1}H n.m.r. spectrum of the cyclic carbonate (**5**), obtained by treatment of (**4c**) with tributyltin hydride,[7] were in full agreement with a *cis*-dimethyl substitution: δ ($CDCl_3$) 1·3 (d, 6H, CH_3, J 6 Hz), 1·3 (d of t, 1H, H_A, J_{AB} 14, J_{AX} 12 Hz), 1·9 (d of t, 1H, H_B, J_{AB} 14, J_{BX} 3 Hz), and 3·8—4·5 (complex m, 2H, –CH–O). Basic hydrolysis of (**5**) afforded the *erythro*-diol (**6**), as

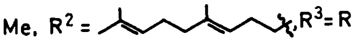
TABLE. Reaction of allylic and homoallylic alcohol carbonates with I_2.

Substrate

Product and yield^a /%



(1) (2)

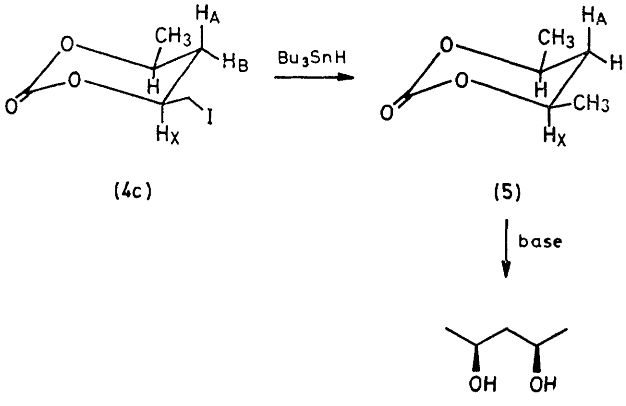
Substrate	Product and yield^a /%
a; $R^1 = R^2 = R^3 = R^4 = H$	70
b; $R^1 = R^2 = R^4 = H$, $R^3 = Me$	70
c; $R^1 = Me$, $R^2 =$ , $R^3 = R^4 = H$	90
d; $R^1, R^4 = -[CH_2]_3-$, $R^2 = R^3 = H$	60

(3) (4)

Substrate	Product and yield^a /%
a; $R^1 = R^3 = H$, $R^2 = Me$	75
b; $R^1 = R^2 = H$, $R^3 = Et$	72
c; $R^1 = Me$, $R^2 = R^3 = H$	80

[a] Yields refer to pure compounds isolated by silica gel chromatography. All compounds were fully characterized by i.r. and ^1H n.m.r. spectra and elemental composition.

confirmed by ^1H n.m.r. data which were in agreement with literature values.[8] G.l.c. analysis† of the corresponding diacetate revealed less than 5% of the *threo*-isomer.



(4c) (5) (6)

The same reaction sequence, carried out on cyclohex-2-en-1-ol, gave cyclohexane-*cis*-1,2-diol [δ ($CDCl_3$) 1·2—2·0 (m, 8H, CH_2), 3·15 (br s, 2H, OH), and 3·6—3·95 (m, 2H, C*H*OH)] showing that either a high 1,2 or 1,3 asymmetric induction may be obtained by this functionalization.

In a typical experimental procedure, Bu^nLi (6·6 ml of a 1·5 M solution in n-hexane) in dry THF (10 ml) was added to a solution of pent-4-en-2-ol (860 mg) in dry THF (15 ml) at room temperature. After 1 h, CO_2 was bubbled into the solution; to the carbonate so obtained 20 mmol of iodine in THF (40 ml) were added and the mixture was stirred for 12 h. The reaction mixture was then diluted with ethyl acetate, the organic layer was washed with aqueous $Na_2S_2O_8$, dried, and evaporated *in vacuo*. After silica gel chromatography (hexane–ethyl acetate, 8:2), (**4c**) was obtained in 80% yield, ν_{max}(neat) 1745 cm^{-1},‡ δ ($CDCl_3$) 1·45 (d, 3H, CH_3, J 6 Hz), 1·7 (d of t, 1H, H_A, J_{AB} 12·5, J_{AX} 11·5 Hz), 2·4 (d of t, 1H, H_B, J_{AB} 12·5, J_{BX} 3 Hz), 3·45 (d, CH_2I, J 5 Hz), and 4·2—4·5 (complex m, 2H, –CH–O).

We are grateful to the National Research Council (Centro di Studio per la Fisica delle Macromolecole) for financial support.

(*Received*, 23*rd February* 1981; *Com.* 197.)

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† The g.l.c. analysis was performed on a column of 15% Carbowax 20 M on Chromosorb G 80—100 mesh.

‡ The five-membered cyclic carbonates show the C=O stretching band at *ca.* 1805 cm^{-1}.

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