

(1st to 8th stand) starting from the periphery. The intermediate stands (9th to 16th) had  $H$  in the range of 2.91 to 3.47. For the stands towards the core  $H$  ranged from 3.03 to 3.53. The values of  $H$  showed much greater fluctuations in stands towards the periphery than towards the core. Thus the diversity was maximum near the core which indicates that the disturbance in the core was enough for maximum diversity in the managed sal forests of the region.  $\beta$ -diversity, which shows the extent of species replacement<sup>22</sup> followed the reverse trend along the gradient (Table 2). It has been observed that diversity is lower in the absence of disturbance as well as in the presence of too much of disturbance<sup>23</sup>. Moderate levels of anthropogenic disturbances are compatible with maintenance of high biodiversity of landscape<sup>24</sup>.

From the above observations, it may be inferred that the disturbance must be contained at the intermediate level so as to have maximum plant diversity in these plantation forests. Also, a few disturbance-friendly species like *Mallotus* and *Clerodendron* may be spared from complete destruction in peripheral stands (where high disturbance is inevitable) in order to have minimum herbage cover for conserving forest soil and to provide niches for understory biota adapted to high disturbance zone. A threshold level of disturbance may, thus, be determined which can permit the extraction of resources without significant loss to the biodiversity of the region.

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## A novel synthesis of bicyclo (3.1.0.) hexane system from Carvone

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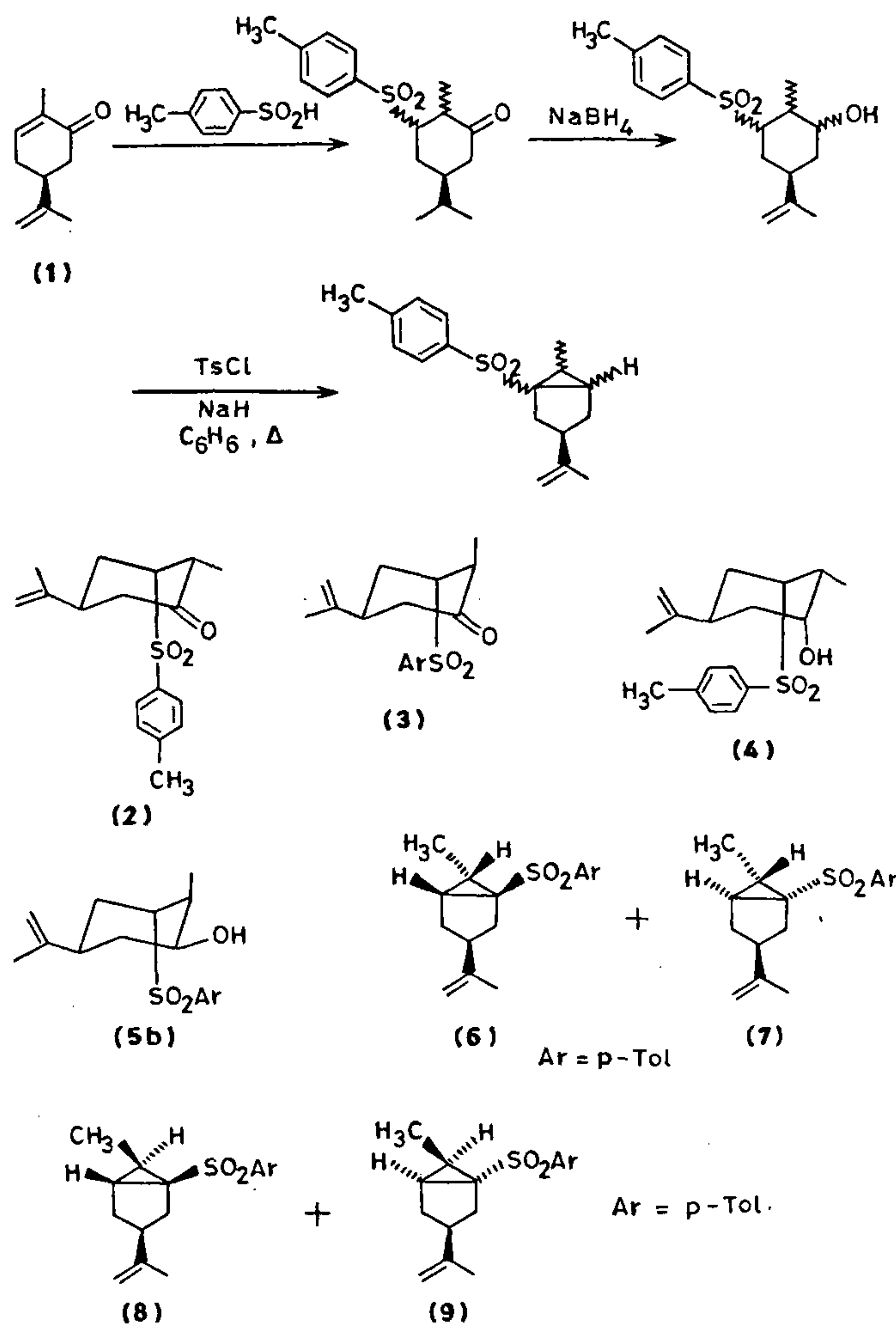
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**Bicyclo (3.1.0.) hexanes have been synthesized starting with carvone, a monoterpene. The methodology involves cyclization of  $\gamma$ -hydroxy sulphones with *p*-toluene sulphonyl chloride (TsCl) and sodium hydride (NaH). These  $\gamma$ -hydroxy sulphones were obtained by sodium borohydride (NaBH<sub>4</sub>) reduction of  $\gamma$ -ketosulphones which in turn were prepared by Michael addition of *p*-toluene sulphonic acid on carvone. Two sets of hitherto unknown bicyclo (3.1.0) hexane were isolated in 60% and 72% yield, respectively. The reaction sequence for the above methodology is shown in the scheme.**

It has been reported that addition of KCN<sup>1,2</sup>, PhSH<sup>3,4</sup> and PhSeH<sup>5</sup> to carvone furnished, with high stereoselectivity, the isomer having the nucleophilic group axial at C-6, the equatorial isomers or the C-1 epimer<sup>1,2</sup> obtained in only minor amounts. Reaction of carvone (1) (see scheme) with *p*-toluene sulphonic acid (generated *in situ* from the sodium salt) in ether at 0–5°C gave a product (yield 78%), gummy in nature and homogeneous on thin layer chromatography (TLC). Based on spectral charac-

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teristics, it was identified to be a mixture of two compounds, the  $\gamma$ -ketosulphones (2) and (3). Since attempts to separate the mixture of  $\gamma$ -ketosulphones were unsuccessful, it was directly used for reduction.

Reduction of the above mixture with sodium borohydride ( $\text{NaBH}_4$ ) in ethanol was carried out at room temperature. TLC indicates the formation of two products (overall yield 85%). The mixture was, therefore, subjected to column chromatography (silica gel 7:3 pet = ether-ethylacetate) to furnish two pure products, the faster moving alcohol (4) with axial hydroxyl group and the slower moving (5), which in turn was the mixture of two isomers containing an equatorial hydroxyl group. The structures of these alcohols were elucidated by spectral (IR, PMR) and elemental analysis. The results were similar to those obtained from the lithium aluminium hydride reduction of 6-thiophenyl ketone obtained from carvone<sup>4</sup>.

The faster moving alcohol (4) was subjected to cyclization using *p*-toluene sulphonyl chloride and sodium hydride in dry benzene (reflux, 24 h) and progress of the reaction was followed on TLC. The product obtained

(60% yield) had the following characteristics: IR spectrum showed absence of hydroxy group ( $-\text{OH}$ ), intact  $\text{C}-\text{SO}_2\text{Ar}$  ( $1310, 1150 \text{ cm}^{-1}$ ) and  $\text{C}=\text{CH}_2$  ( $1650, 1600 \text{ cm}^{-1}$ ). Its 90 MHz PMR spectrum revealed that the product was a mixture of cyclopropanes, since the methyl region showed two doublets, one at  $1.05 \delta$  and the other at  $1.45 \delta$  (each doublet,  $J = 6 \text{ Hz}$ ). This region showed the presence of an additional multiplet at  $1.30 \delta$ , other characteristic signals appeared at  $1.60 \delta$  (broad singlet,  $=\text{C}-\text{CH}_3$ ),  $2.43 \delta$  (singlet,  $\text{ArCH}_3$ ),  $3.00 \delta$  (multiplet),  $4.60 \delta$  (broad singlet,  $\text{C}-\text{CH}_2$ ),  $7.30 \delta$  (doublet,  $J = 8 \text{ Hz}$ ,  $\text{Ar}-\text{H}$  *ortho* to  $-\text{SO}_2-$ ),  $7.75 \delta$  and  $7.77 \delta$  (each doublet,  $J = 8 \text{ Hz}$ ,  $\text{Ar}-\text{H}$  *ortho* to  $-\text{SO}_2-$  of the two isomers (6) and (7).

As the two bicyclo (3.1.0) hexanes are formed from the faster moving alcohol, the geometry of the isopropenyl and secondary methyl group remains *trans* and 5,3 fusion of the bicyclo ring remains *cis*.

In (6) the secondary methyl appeared as a doublet at  $1.05 \delta$  being *trans* with respect to *p*-toluene sulphonyl group, whereas in (7) it appeared deshielded ( $1.45 \delta$ ) being *cis* to *p*-toluene sulphonyl group.



The slower moving alcohol (5) was further purified by column chromatography (silica gel) and a pure product (5b) was obtained. The PMR spectrum displayed signals at 7.82  $\delta$ , 7.40  $\delta$  (each 2H, doublet,  $J = 8$  Hz, ArH meta and *ortho* to  $-\text{SO}_2-$  group, respectively), 4.70  $\delta$  (2H, broad singlet,  $\text{C}=\text{CH}_2$ ), 3.66  $\delta$  (1H, multiplet, width at half height  $W = 30$  Hz, CH, OH) 3.20  $\delta$  (1H, multiplet  $W = 36$  Hz, CH,  $\text{SO}_2$  Ar), 2.95  $\delta$  (1H, broad multiplet exchangeable with  $\text{D}_2\text{O}$ ,  $-\text{OH}$ ), 2.82  $\delta$  (1H, multiplet  $W = 20$  Hz, allylic proton), 1.66  $\delta$  (3H, broad singlet  $=\text{C}-\text{CH}_3$ ), 1.11  $\delta$  (3H, doublet,  $J = 7$  Hz,  $\text{CH}_3$ ,  $-\text{CH}$ ).

Cyclization of (5b) under similar conditions as that of (4) afforded a product, (yield 72%) homogenous on TLC, but its spectral analysis proved it to be a mixture of (8) and (9). The IR features of the product showed intact  $\text{SO}_2\text{Ar}$  and  $\text{C}=\text{CH}_2$  groups (1310, 1150, 1650,  $1600\text{ cm}^{-1}$ ) and absence of  $-\text{OH}$  group. PMR spectrum showed that the product was indeed a cyclopropane. A careful examination showed that it had two secondary methyls at 0.96  $\delta$  and 1.38  $\delta$  (each doublet  $J = 6$  Hz) and two sets of doublets at 7.56  $\delta$  and 7.60  $\delta$  (each doublet  $J = 8$  Hz) for protons *ortho* to  $-\text{SO}_2-$ . The other signals were 1.20  $\delta$  (multiplet), 1.56  $\delta$  (singlet,  $=\text{C}-\text{CH}_3$ ), 2.34  $\delta$  (singlet,  $\text{ArCH}_3$ ), 2.76  $\delta$  (multiplet), 4.50  $\delta$

(broad singlet  $\text{C}=\text{CH}_2$ ) and 7.14  $\delta$  (doublet, ArH *ortho* to  $\text{CH}_3$ ).

The main feature of the products (8) and (9) was that the secondary methyl and isopropenyl groups bear a *cis* relation with respect to each other as they are obtained from the alcohol (5b), in which the two groups also have a *cis* geometry.

The position of methylene ( $-\text{CH}_2$ ) protons in the bicyclo (3.1.0) hexanes (6), (7), (8) and (9) was difficult to assign because of the complexity of the peaks between 1 and 2  $\delta$  in the PMR spectra.

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