It is estimated that the polar structures of compounds I, II and III reduce the double bond characters of the central double bonds, and that the polar structures are held stably by localization the π-electrons on moieties including the carbonyl groups.

It may be considered that when an electron is supplied from an electrode or alkali metal, it is attracted by the positive-charged moieties of the molecules, so that the radical molecules have stable twisting structures with decreased double bond characters.

Although the twisting structure is not expected from the calculated π-electronic energies, which increase with increase in the twisting angle of the central double bond, the anion radicals of compounds IV and V are also twisted.[5] It may be considered that the reduction of the double bond character of the central double bonds allows the anion radicals to twist, but the polarity of the molecules is small (Fig. 3), and thus the radicals are twisted, but not perpendicularly.

In conclusion, simi-empirical MO calculations by using the PPP approximation reflect the relations between the conformations and the polarities of the molecules, It was found that the PPP–MO calculation could give a simple, satisfactory interpretation of the twisting structure of the anion radicals of thermochromic ethylenes. MO calculations including all valence electrons are under way, so that more quantitative data may shortly be available for conformational analysis.

Acknowledgement The authors wish to thank Mrs. H. Kitamura for the elemental analyses and Mr. M. Uchida for the mass spectrometric analyses. Thanks are also due to the staff of the Shizuoka Prefectural Government Computer for making computer time available for this work.

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[Chem. Pharm. Bull. 29(11)3378—3381(1981)]

Synthesis of 8α,9α- and 8β,9β-Epoxyhexahydrocannabinols

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(Received January 24, 1981)

8α,9α- (IIa) and 8β,9β-epoxyhexahydrocannabinol (IIIa) were prepared from Δ^8-tetrahydrocannabinol (Ia) by three reaction steps. Epoxidation of acetylated Ia with

m-chloroperbenzoic acid gave a mixture of 8α,9α- and 8β,9β-epoxyacetates. By treatment of the mixture with lithium aluminum hydride, IIa and IIIa were prepared in 27.3 and 18.2% yields, respectively. Mass and proton nuclear magnetic resonance spectra data for IIa and IIIa are also presented.

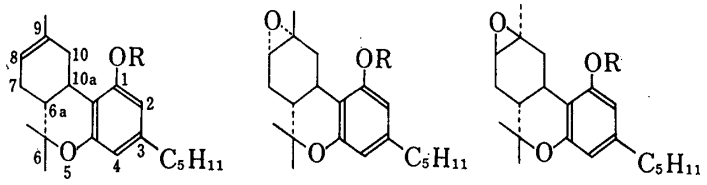
Keywords——Δ^8-tetrahydrocannabinol; 8α,9α-epoxyhexahydrocannabinol; 8β,9β-epoxyhexahydrocannabinol; *m*-chloroperbenzoic acid; lithium aluminum hydride; spectra (UV, ^{1}H-NMR and MS)

In the course of our pharmacological and metabolic studies of Δ^8-tetrahydrocannabinol (Δ^8-THC), it became important to prepare 8α,9α- and 8β,9β-epoxyhexahydrocannabinol (EHHC) because they are active metabolites of Δ^8-THC.[1]

As regards epoxy compounds of Δ^8-THC, two groups[2] have synthesized 8β,9β-EHHC according to the method of Mechoulam *et al.*[3] However, they have not given detailed analytical data. On the other hand, Petrzilka and Demuth have pointed out that the compound synthesized by the above method was a mixture of 8α,9α- and 8β,9β-EHHC acetates.[4] Therefore, there is still no established method to prepare pure 8α,9α- and 8β,9β-EHHCs.

We thus planned to isolate the pure 8α,9α- and 8β,9β-EHHCs. By the procedure described below or in the experimental section, each epoxy compound was isolated in pure form as a pale yellow oil.

Δ^8-THC (Ia in Fig. 1) was prepared from Δ^9-THF as reported previously[5] and then acetylated according to the conventional method, giving Δ^8-THC acetate (Ib). Ib was then subjected to epoxidation with *m*-chloroperbenzoic acid in chloroform. The reaction mixture was subjected to preparative layer chromatography (PLC), giving a pale yellow oil. The mass and proton nuclear magnetic resonance (^{1}H-NMR) spectra of the product agree fairly well with those of a mixture of α- and β-epoxyacetates described by Petrzilka and Demuth.[4] However, we were unable to separate the components.



Ia : R=H
Ib : R=Ac

IIa : R=H
IIb : R=Ac

IIIa : R=H
IIIb : R=Ac

Fig. 1. Structures of Δ^8-THC (Ia), 8α,9α-EHHC (IIa), 8β,9β-EHHC (IIIa) and Their Derivatives

Subsequently, the mixture was deacetylated with equimolar quantities of lithium aluminum hydride ($LiAlH_4$) in dry ether, and deacetylated mixture was resubjected to PLC successfully to give 8α,9α-EHHC (IIa) and 8β,9β-EHHC (IIIa) in 27.3 and 18.2% yields, respectively.

Gas chromatography–mass spectrometry (GC–MS) revealed that the two compounds obtained were different in character (Table I). That is, IIa and IIIa each had a molecular ion *m/e* 330 and showed almost the same fragmentation, but the relative intensities and retention times on the gas chromatogram were clearly different.

The ^{1}H-NMR spectra of both compounds were almost the same except that the proton at C-8 appeared as a doublet at δ 3.14 in IIa, whereas it appeared as a broad singlet at δ 3.15 in IIIa (Table II).

In the case of 8α,9α-EHHC acetate (IIb) the bond angle between C-8β- and C-7β-proton is 28±4°, and therefore the C-8β-proton appears as a doublet which has a coupling constant of 3.7 to 4.8 Hz.[4] In addition, the C-8α-proton of 8β,9β-EHHC acetate (IIIb) should appear

Table I. GC–MS Data for IIa and IIIa

Compound	Retention time (min)	Major fragment ions (m/e)[a]
IIa	17.7	331(16), 330(M^+, 71), 315(72), 312(27), 297(20), 287(29), 272(30), 271(100), 245(20), 231(32)
IIIa	16.5	331(23), 330(M^+, 100), 315(14), 297(16), 287(24), 274(31), 271(33), 245(12), 231(51)

a) Numbers in parentheses refer to relative intensities.

Table II. ^{1}H-NMR Chemical Shifts of IIa and IIIa (in $CDCl_3$)[a]

Assignments	IIa	IIIa
C-4-H	6.17 (d, J=2 Hz)	6.18 (d, J=2 Hz)
C-2-H	6.10 (d, J=2 Hz)	6.09 (d, J=2 Hz)
C-1-OH	5.78 (s)	5.70 (s)
C-10α-H	3.40 (dd, J=14.7 Hz, J=3.8 Hz)	3.21 (dd, J=14.7 Hz, J=3.8 Hz)
C-8-H	3.14 (d, J=4.5 Hz)	3.15 (bs, 6 Hz for half-width value[b])
C-6β-CH_3	1.39 (s)	1.42 (s)
C-9-CH_3	1.33 (s)	1.36 (s)
C-6α-CH_3	0.97 (s)	1.06 (s)
ω-CH_3	0.88 (t)	0.88 (t)

a) The following abbreviations are used; singlet (s), doublet (d), double doublet (dd), triplet (t) and broad (b).
b) Partly overlapped with a signal of C-10α-H.

as a triplet with a width of 2.8 to 4 Hz theoretically, but in practice, the C-8α-proton signal appears as a broad singlet whose half-width value is 4 Hz.[4] In the spectrum of IIa, the doublet C-8β-proton signal had a coupling constant of 4.5 Hz, and in the case of IIIa a broad singlet due to the C-8α-proton partly overlapped with a double doublet due to the C-10α-proton which was shifted downfield by deacetylation of the C-1 position, and therefore, the half-width value of the broad singlet was 6 Hz. Additionally, the ^{1}H-NMR spectrum of each epoxide after reacetylation was superimposable on that of Petrzilka and Demuth.[4]

From these results, it is concluded that IIa and IIIa obtained here undoubtedly correspond to 8α,9α- and 8β,9β-EHHCs, respectively.

Experimental

Optical rotations were determined on a JASCO DIP-4 digital polarimeter. Ultraviolet (UV) spectra were measured on a Union SM-401 spectrophotometer, and ^{1}H-NMR spectra on a JEOL MH-100 spectrometer at 100 MHz with tetramethylsilane as an internal standard. GC–MS was conducted on JEOL JGC-20K and JMS-D100 instruments at 20 eV. The conditions were as follows: column, 3% OV-17 on Gas Chrom Q (60—80 mesh, 1 m); column temperature, 245°C; carrier gas, He; and injector temperature, 270°C. PLC was carried out on plates (20×20 cm, 0.5 mm thick) coated with a fluorescent silica gel mixture of Wako gel B-5–Wako gel B-5FM (4: 1) using solvent systems as follows: A, benzene–acetone (95: 5, v/v); B, $CHCl_3$–acetone (40: 1, v/v).

Δ^8-Tetrahydrocannabinol (Ia)——Ia was prepared from Δ^9-THC according to the method reported previously[5] in a yield of 89.4%.

1-Acetyl-Δ^8-tetrahydrocannabinol (Ib)——Ia (257 mg) was acetylated with pyridine and acetic anhydride to give a colorless oil in a yield of 90.6% (264 mg). The MS and ^{1}H-NMR spectra were identical with those of Inayama *et al.*[6]

1-Acetyl-8α,9α-epoxyhexahydrocannabinol (IIb) and 1-Acetyl-8β,9β-epoxyhexahydrocannabinol (IIIb)——*m*-Chloroperbenzoic acid (160 mg) was added to a solution of Ib (162 mg) in 8 ml of $CHCl_3$, and the solution was stirred at 0°C for 2 h. After addition of sodium sulfite (160 mg) in H_2O (1 ml), the reaction mixture was stirred for a further 30 min. The organic layer was washed successively with 1% $NaHCO_3$

and H_2O, then concentrated *in vacuo*. The residue was subjected to PLC and developed with solvent system A. A band (*Rf* 0.44) was visualized under a UV lamp, scraped off and extracted with $CHCl_3$ to give a mixture of IIb and IIIb (a pale yellow oil, 146 mg, 78.1% from Ia). The MS and ^{1}H-NMR data of the mixture agreed with those of Petrzilka and Demuth.[4]

8α,9α-Epoxyhexahydrocannabinol (IIa)——A mixture of IIb and IIIb (140 mg) in dry ether (10 ml) was treated with an equimolar amount of $LiAlH_4$ (14.3 mg). It was stirred at room temperature for 30 min, then $LiAlH_4$ was filtered off and the filtrate was evaporated *in vacuo* under an N_2 stream. The residue was dissolved in a small amount of $CHCl_3$, and resubjected to PLC, developing twice with solvent system B. A band (*Rf* 0.52) was scraped off and extracted with $CHCl_3$, giving a pale yellow oil in a yield of 27.3% from Ia (48 mg). $[\alpha]_D^{20} = -188°$ (c=0.38, EtOH). UV λ_{max}^{EtOH} nm (ε): 211 (38100), 230 (sh), 277 (1170), 284 (1220). GC–MS and ^{1}H-NMR data are given in Tables I and II, respectively.

8β,9β-Epoxyhexahydrocannabinol (IIIa)——On the PLC plates for the preparation of IIa, a band located at *Rf* 0.63 was scraped off and extracted with $CHCl_3$, giving a pale yellow oil in a yield of 18.2% from Ia (32 mg). $[\alpha]_D^{20} = -191°$ (c=0.42, EtOH). UV λ_{max}^{EtOH} nm (ε): 211 (37400), 230 (sh), 277 (1270), 284 (1360). GC–MS and ^{1}H-NMR data are given in Tables I and II, respectively.

Acknowledgement We are greatly indebted to Prof. I. Nishioka and Dr. Y. Shoyama of Kyushu University for a generous gift of Δ^9-THC.

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[Chem. Pharm. Bull. 29(11)3381—3384(1981)]

Isolation of O-Methylmaritidine from Bulbs of *Narcissus tazetta* L.

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(Received April 3, 1981)

A new alkaloid, O-methylmaritidine, from *Narcissus tazetta* L. (Amaryllidaceae) has been assigned the structure (I) on the basis of the close correspondences of infrared, nuclear magnetic resonance, optical rotatory dispersion, ultra violet, and mass spectra to those of alkaloids of known structures.

Keywords——O-methylmaritidine; *Narcissus tazetta* L.; Amaryllidaceae; maritidine; buphanisine; dihydro-O-methylmaritidine

The alkaloid constituents of *Narcissus tazetta* L. (Amaryllidaceae) have been studied extensively.[1] We report in this paper the isolation of a new minor alkaloid, which was named O-methylmaritidine, from the bulbs of *N. tazetta* L.

The two alkaloidal fractions, chloroform-insoluble and chloroform-soluble, were obtained