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Synthesis and Absolute Configuration of (+)-*threo*-1-Hydroxy-2-(isopropylamino)-[10]-paracyclophane

Sanji Hagishita and Kaoru Kuriyama

Shionogi Research Laboratory, Shionogi & Co., Ltd.[1]

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threo-1-Hydroxy-2-(isopropylamino)-[10]-paracyclophane (**1**) was prepared and resolved into one enantiomer. The absolute configuration of **1** was deduced from the analysis of circular dichroism (CD) spectra using Snatzke's sector rule and induced CD of $Cu(su)_2(ip)_2$ and $Pr(DPM)_3$. Intrinsic sympathomimetic activity of **1** and *threo*- and *erythro*-1-(4-tolyl)-2-isopropylamino-1-propanol were tested on the isolated guinea pig heart.

The β-adrenergic mechanism of drug-receptor interaction has been extensively studied in recent years.[2] The agonist drug-receptor complex has been described in terms of architectural features. However, there is no complete agreement about the interaction of the receptor with the main reaction centers, *i.e.*, the aromatic moiety, side chain hydroxy group and amino group.

Stereochemical relationships for agonist and antagonist actions are known to exist between ephedrine and pseudo ephedrine.[3] In order to study further the steric requirement, a number of conformationally rigid analogs of β-phenethanol amines have been reported in indan, tetralin,[4] decaline,[5] decahydroisoquinoline,[6] octahydrophenanthrene[7] and benzobicyclo-[2.2.2]octene systems.[8] A comparative study of the conformation and reactivity in a nonrigid system has also been reported recently.[9]

In this study, we prepared *threo*-1-hydroxy-2-(isopropylamino)-[10]-paracyclophane (**1**). This has the three main reactive centers but direct interaction of the aryl moiety with the receptor is hindered at one side of the aromatic moiety by the methylene bridge and other centers have comparatively fixed orientations, because of the impossibility of internal rotation of the benzene ring.

Synthesis

Bromination of [10]-*para*-cyclophane (**2**)[10] with one equivalent of N-bromosuccinimide afforded a mixture of momo- and di-bromides (**4** and **3**, respectively) and recovery of **1**. The mixture could not be separated in pure form but after being treated with sodium acetate in

1) Location: *Fukushima-ku, Osaka, 553, Japan.*
2) J.H. Biel and B.K.B. Lum, *Progr. Drug Res.*, **10**, 46 (1966); B.M. Bloom and I.M. Goldman, *Advan. Drug Res.*, **3**, 121 (1966); B. Belleau, *Ann. N. Y. Acad. Sci.*, **139**, 541 (1967); E.J. Ariens, *ibid.*, **139**, 606 (1967).
3) J.B. Lapidus, A. Tye, P. Pail, and B.A. Modi, *J. Med. Chem.*, **6**, 76 (1963).
4) F. Meyer, H.-J. Rimek, and F. Zymalkovski, *Pharmazie*, **20**, 333 (1965); H.-J. Rimek, T. Yupraphat, and F. Zimalkovski, *Ann*, **725**, 116 (1969); R.I. Thrift, *J. Chem. Soc., C*, **1967**, 288.
5) E.E. Smissman and W.H. Gastrock, *J. Med. Chem.*, **11**, 860 (1968); E.E. Smissman and S. El-Antably, *ibid.*, **14**, 30 (1971).
6) E.E. Smissman and G.S. Chappell, *J. Med. Chem.*, **12**, 429 (1969).
7) W.L. Nelson and D.D. Miller, *J. Med. Chem.*, **13**, 807 (1970).
8) G.L. Grunewald, J.A. Ruth, T.R. Kroboth, and B.V. Kamder, The 169th National Meeting of the American Chemical Society, Division of Medicinal Chemistry, Philadelphia, April 6–11, 1975, Abstracts of papers, Medi. No. 56.
9) C. Petrogolo, J. Tomasi, B. Maccia, and F. Maccia, *J. Med. Chem.*, **17**, 501 (1974).
10) D.J. Cram and H.U. Daeniker, *J. Am. Chem. Soc.*, **76**, 2743 (1954); D.J. Cram and M. Cordon, *ibid.*, **77**, 4090 (1955); D.J. Cram and M. Goldstein, *ibid.*, **85**, 1063 (1963).

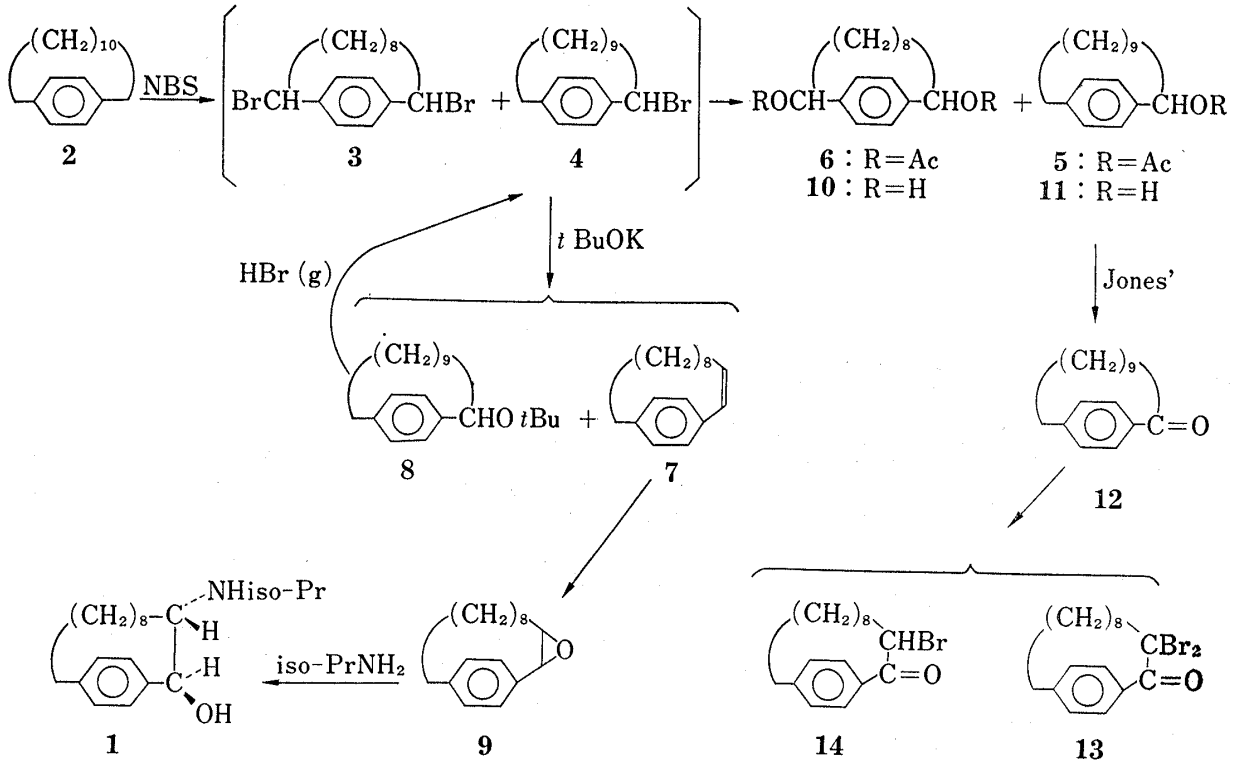


Chart 1

acetic acid, it was separated by TLC into the acetate (**5**) and a mixture of *cis*- and *trans*-diacetates (**6**). The *cis*- and *trans*-diacetate (**6**) could not be separated from each other but the ratio was shown to be *ca.* 1:1 by analysis of the nuclear magnetic resonance (NMR) spectrum. The yields of **2**, **5** and **6** were 26.5, 57.7 and 10.7%, respectively. The mixture of the bromides was treated with potassium *t*-butoxide to give [10]-paracyclophene (**7**) and 1-*t*-butyl [10]-paracyclophane (**8**). Pure 1-bromo[10]-paracyclophane (**4**) was obtained in high yield by introduction of hydrogen bromide gas to **8**. The reaction using the pure bromide (**4**) gave 48.8 and 15.3% of **7** and **8**, respectively. The olefin (**7**) was converted into the epoxide (**9**) by treatment with *m*-chloroperbenzoic acid. Opening of **9** with isopropylamine as nucleophile at 150° gave a product with a ring opening at the C(β)-O position and only one peak in vapar phase chromatography (VPC) analysis. The NMR spectra of the hydrochloride salt of **1** showed a doublet at τ 5.40, J=9.5 Hz, and a multiplet at τ 6.43. Therefore the product (**1**) was the *threo*-isomer as expected from the reaction mechanism.

Another route *via* 1-keto-2-bromo-[10]-paracyclophane (**14**) was tried, as indicated in Chart 1, but neither gabriel nor urotoropine methods with **14** gave the expected amino ketone derivatives.

The enantiomorph of the cyclophane (**1**) was separated by recrystallization of the dibenzoyl tartaric acid salt from methanol to constant rotation, then made alkaline with aq. ammonia to give the (+)-isomer, $[\alpha]_D^{24}$ +98.0.

In order to compare the pharmacological activity between **1** and open chain homologs, *erythro*-1-(4-tolyl)-2-isopropylamino-1-propanol (**15**) was prepared according to literature,[11] then the *threo*-isomer was prepared from it following Chart 2.[12]

NMR data for the hydrogen-hydrogen interaction on the adjacent asymmetric centers of **15**·HCl and **16**·HCl, 3.0 and 9.0 Hz, were close to those for ephedrine and pseudo-ephedrine, 2.8 and 9.0 Hz, and for isoetharine and inverted isoetharine, 3.0 and 8.0 Hz,[11] all respectively. The configuration of isomer **16** was confirmed to be *threo*.

11) H. Corrodi, H. Persson, A. Carlson, and J. Roberts, *J. Med. Chem.*, **6**, 751 (1963).
12) M.J. Mardle, H. Smith, and B.A. Spicer, *J. Med. Chem.*, **17**, 513 (1974).

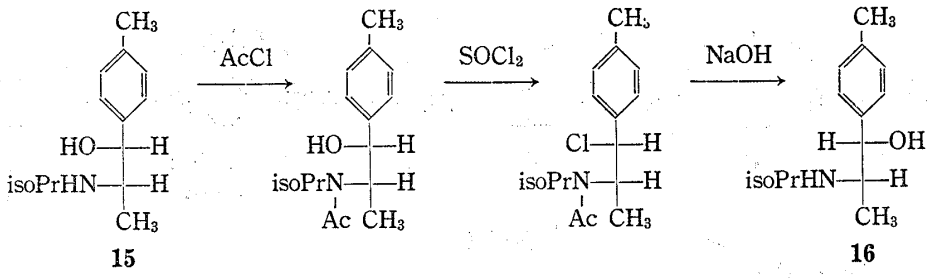


Chart 2

CD and Absolute Configuration

Circular dichroism (CD) and ultraviolet (UV) spectra are shown in Fig. 1. Positive Cotton effects were observed in both the B_{2u} and B_{1u} transitions in **1** and its hydrochloride salt. We tried to apply the sector rule, proposed by Snatzke[13] based on the nodal plane of the benzene ring and Platt's spectroscopic moment,[14] for correlation of the sign of the Cotton effect of the B_{2u} transition with the absolute configuration of (+)-**1**. It has been reported that the configuration of the hydroxy group at the C-1 position, which is closest to the aromatic ring, dominates the spectrum and determines the overall sign of the Cotton effect in the B_{2u} region, while the configuration of the C-2 position has an effect on the amplitude in nonrigid systems such as ephedrine and pseudoephedrine.[15]

The sign of the B_{2u} and B_{1u} transitions of tetraline and indan systems mainly depends on the configuration of the C-2 position.[16] Inspection of the model of **1** shows that both hydroxy and amino groups contribute to the Cotton effect of the B_{2u} transition of the same sign and the rule predicts it to be (+)-(1*S*,2*S*)-**1**. But it has been reported that *o*- and *p*-substituted

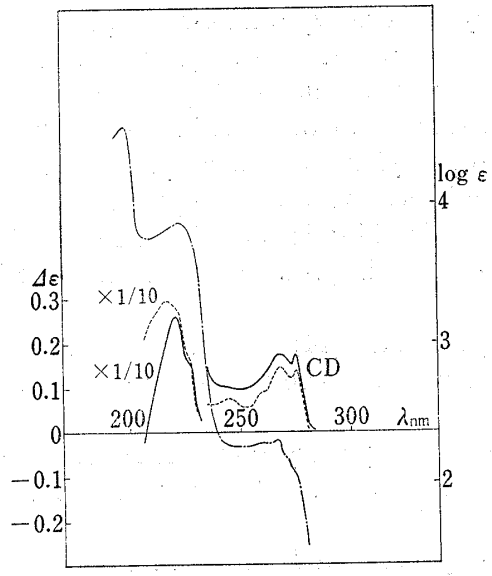


Fig. 1. UV (————) and CD (----------) Spectra of **1**·HCl and CD (————) Spectrum of **1** in Methanol

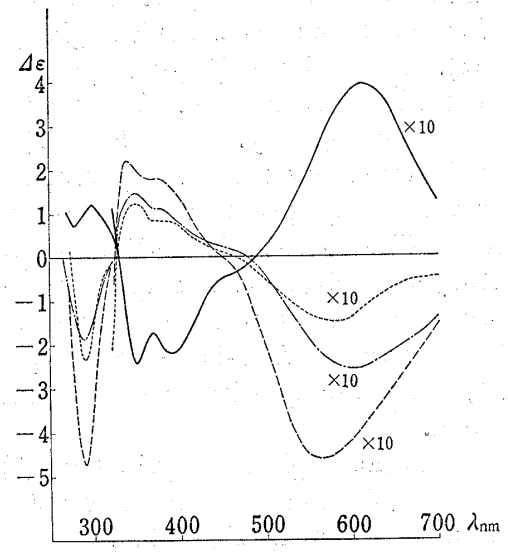
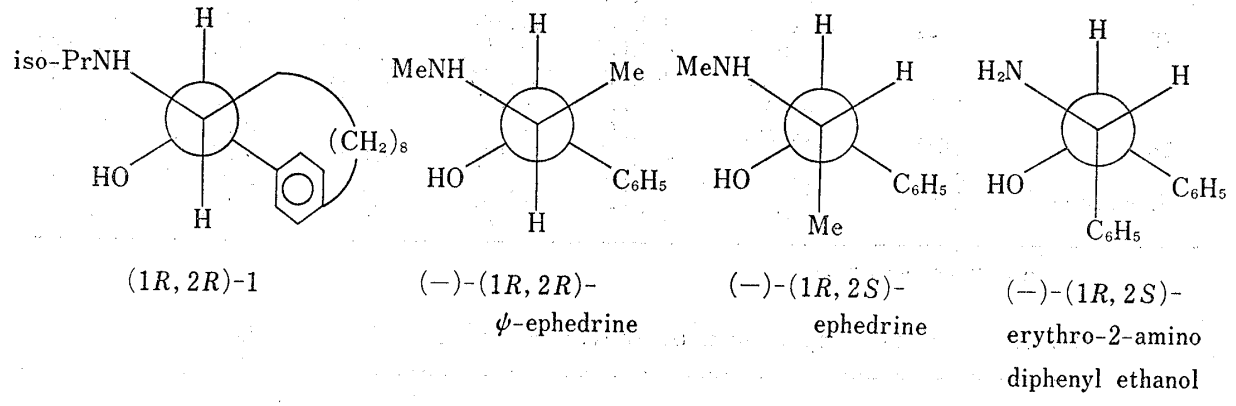


Fig. 2. CD spectra of $[Cu(su)_2(ip)_2]$ with (+)-**1** (————), (1*R*, 2*S*)-(−)-ephedrine (————), (1*R*, 2*R*)-(−)-pseudo Ephedrine (----------) and (1*R*,2*S*)-(−)-*erythro*-2-aminodiphenyl Ethanol (— — — —) in Methylene Chloride

13) G. Snatzke, M. Kajtar, and F. Welner-Zamojska, *Tetrahedron*, **28**, 281 (1972).
14) J.C. Platt, *J. Chem. Phys.*, **19**, 263 (1951); J. Petruska, *ibid.*, **34**, 1120 (1961).
15) L.A. Mitscher, F. Kautz, and J. Lapidus, *Can. J. Chem.*, **47**, 1957 (1969).
16) E. Dornhege and G. Snatzke, *Tetrahedron*, **26**, 3059 (1970).

mandelic acids do not agree with the prediction,[17] and the B_{2u} transition is very sensitive to substitution at the aromatic ring and many substituents invert the sign of the multiple Cotton effect.[18] Therefore the absolute configuration could not be determined directly using only the sector rule. Thus we measured the induced CD of $[Cu(su)_2(ip)_2]$.[19,20] Although studies of some amino alcohols have proved correlation of the configuration with the sign of the Cotton effect, we measured some other phenethanol amines, (−)-(1*R*, 2*S*)-ephedrine, (−)-(1*R*,2*R*)-pseudo ephedrine and (−)-(1*R*,2*S*)-*erythro*-2-amino-diphenyl ethanol,[21] to verify these



(1*R*, 2*R*)-1 (−)-(1*R*, 2*R*)-*ψ*-ephedrine (−)-(1*R*, 2*S*)-ephedrine (−)-(1*R*, 2*S*)-erythro-2-amino diphenyl ethanol

Fig. 3. The Most Favorable rotamers of the Phenethanol Amines

methods. These results are shown in Fig. 2 together with that of **1**. Pseudo-ephedrine seems to be an exception from the chirality of only the asymmetric center of the C-2 position, as the amino group with stronger nucleophilicity than the hydroxy group would mainly contribute to forming a complex with Cu(II). But the amino-alcohol chirality is the same in the most favorable rotamer of these three amino-alcohols (Fig. 3). The favorable rotamer of **1** resembles closely those of ephedrine, pseudoephedrine and *erythro*-2-amino-diphenyl ethanol (Fig. 3), but the amino alcohol chirality is enantiomorphic because the CD curve of **1** is antipodal to others. Further the CD curve of $Pr(DPM)_3$[22] induced by **1** shows a positive to negative pattern from longer wavelength (Fig. 4), which is characteristic of positive amino-alcohol chirality. Based on both Snatzke's sector rule and the induced CD spectra using $[Cu(su)_2(ip)_2]$ and $Pr(DPM)_3$, (+)-**1** can be said to have a (1*S*,2*S*) configuration.

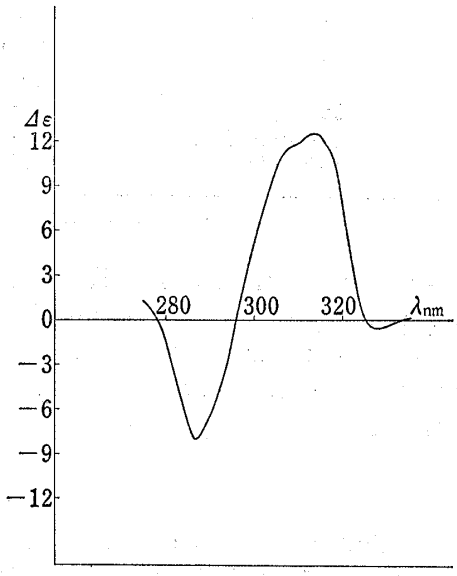


Fig. 4. CD Spectrum of $Pr(DPM)_3$ with (+)-**1** in Carbon Tetrachloride

Pharmacological Screening

Three compounds, **1**, **15** and **16**, were tested with isolated guinea pig right artium for any reduction in the response to isoproterenol and for intrinsic sympathomimetic activity. The

17) O. Korver, *Tetrahedron*, **26**, 5507 (1970).
18) G. Gottarelli and B. Samori, *J. Chem. Soc., B*, **1971**, 2418; M. Legrand and R. Viennet, *Bull. Soc. Chim. France*, **1966**, 2798.
19) su: succinimidato, ip: isopropylamine.
20) F. Kerek and G. Snatzke, *Angew. Chem. Internat. Edit.*, **14**, 109 (1975).
21) Gift from Professor M. Nakazaki, Osaka Univ.; M. Nakazaki, *Bull. Chem. Soc. Jap.*, **36**, 1204 (1963).
22) K. Nakanishi and J. Dillon, *J. Am. Chem. Soc.*, **93**, 4058 (1971); **96**, 4057, 4059 (1974).

Table I. β-Receptor Blocking Activity on Isolated Guinea Pig Right Atrium

Compd.	Conc. (g/ml)	Maximum response Induced by isoprotenerol (5×10^{-10} g/ml)					
		Positive inotropic (g)		action	Positive chrontropic (beat/min)		action
1	10^{-5}	before	+0.22	65.0%	before	+35.0	27.3%
		after	+0.22	89.5%	after	+28.5	26.6%
15	10^{-5}	before	+0.26	74.3%	before	+56.5	44.8%
		after	+0.025	9.05%	after	+2.0	1.85%
	2×10^{-6}	before	+0.42	121.7%	before	+54.0	43.2%
		after	+0.22	54.2%	after	+26.5	20.8%
16	10^{-5}	before	+0.25	58.6%	before	+45.5	35.7%
		after	+0.22	66.5%	after	+27.5	24.4%
Propranolol	10^{-7}	before	+0.26	39.9%	before	+37.0	27.9%
		after	+0.06	11.3%	after	+13.0	10.1%

+: increase −: decrease

Table II. Intrinsic Sympathomimetic Activity on Isolated Guinea Pig Right Atrium

Compd.	Conc. (g/ml)	Maximum response (%)	
		Inotropic action (%)	Chrontropic action (%)
1	10^{-5}	−35.6(10′)	−10.8(10′)
15	10^{-5}	−21.0(10′)	−6.5(10′)
	2×10^{-6}	+2.1 (1′)	+1.6 (8′)
16	10^{-5}	−18.8 (9′)	−9.8 (9′)
Physiological Salt soln.	0.9% 0.3 ml	−1.6 (7.5′)	+2.4 1/2(10′) −2.4 1/2(10′)

+: increase −: decrease

results are summarized in Tables I and II. A methylene bridge lowered the β-receptor blocking potency of the compound giving one which produced a negative inotropic action. As a longer alkyl chain in the *para*-position shows a similar relationship,[11] it is not clear at present whether the effects are caused by the hindrance of one side of the benzene plane by a methylene bridge.

Experimental

Melting points are uncorrected. Infrared (IR) spectra were taken on a JASCO Model DS 402 G double monochromatic spectrophotometer. Optical rotations were measured on a Perkin-Elmer polarimeter Model 141 using a 1-dm cell. CD spectra were taken with a JASCO Model ORD/UV-6 and NMR spectra with a Varian A-60 spectrometer in $CDCl_3$ using tetramethyl silane (TMS) as internal standard, unless otherwise noted. UV spectra were taken on a Hitachi Model EPS-3T spectrometer, and mass spectra on a Hitachi RUM-6 single focusing mass spectrometer.

1-Acetoxy [10]-paracyclophane (5) and 1,10-Diacetoxy [10]-paracyclophane (6)——A mixture of [10]-paracyclophane[9] (2.56 g), N-bromosuccinimide (2.11 g) and carbon tetrachloride (300 ml) was heated under reflux for 7 hr. The cold solution was filtered to remove succinimide. The filtrate was concentrated. To the residue, a solution of anhydrous sodium acetate (4.0 g) in glacial acetic acid (100 ml) was added. The mixture was heated under reflux for 16 hr. The solvent was removed by distillation under reduced pressure. Water was added and the mixture was extracted with ether. The ether solution was washed with aq. sodium bicarbonate and water then dried over anhydrous sodium sulfate. The residue was removed by distillation and chromatographed on a thick layer of silica gel (Merck Co., GF_{254}) in benzene–ethyl acetate (95: 5). The fraction with the largest *Rf* value was recovered (**2**, 678 mg). The fraction with the next largest *Rf* value was distilled at 170° (bath temp.) at 0.3 mm giving a colorless oil (1.873 g, 57.7%). IR ν_{max}^{film} cm^{-1}: 1740, 1237. NMR τ: 7.91 (s), 7.32 (t, J=6.5 Hz), 6.32 (d, d, J=5.0, 8.5 Hz). *Anal.* Calcd. for $C_{18}H_{24}O_2$: C, 78.79; H, 9.55. Found: C, 78 80; H, 9.45. The third fraction was distilled at 200° at 0.3 mm to give the diacetate (417 mg, 10.7%). NMR τ: 4.26 (d, d, J=5.0, 7.5 Hz), 4.34 (d, d, J=5.0, 9.0 Hz), *ca.* 1: 1. *Anal.* Calcd. for $C_{20}H_{26}O_4$:

C, 72.70; H, 7.93. Found: C, 72.52; H, 8.53.

1-[10]-Paracyclophene (7)——a) To a crude mixture of **3** and **4**, prepared from (**2**, 5.60 g), N-bromosuccinimide (4.86 g) and carbon tetrachloride (170 ml), was added a solution of potassium *t*-buthoxide (potassium 9.0 g and *t*-buthanol 200 ml). This solution was heated under reflux for 18 hr with stirring, poured into water and extracted with ether. The ether solution was washed with water, dried over anhydrous sodium sulfate and concentrated. The residue was distilled giving the 1st fraction at 122—124° at 1.5 mm (3.70 g) and the 2 nd fraction at 160—162° at 2.0 mm (1.25 g). These were further chromatographed on a thick layer of silica gel (Merck Co., GF_{254}) in *n*-hexane. The fraction with larger *Rf* value was distilled at 110° at 0.25 mm to give pure 1-[10]-paracyclophene. IR ν_{max}^{film} cm^{-1}: 720. UV $\lambda_{max}^{cyclohexane}$ nm (ε): 239 (7650), 201.5 (18500). NMR (CCl_4) τ: 7.35 (t, J=6.0 Hz), 4.17 (m), 3.35 (d, J=11.0 Hz). *Anal.* Calcd. for $C_{16}H_{22}$: C, 89.65; H, 10.35. Found: C, 90.15; H, 10.02.

The fraction with the smaller *Rf* value was distilled at 140° (bath temp.) at 0.25 mm to give pure 1-*t*-buthoxy-[10]-paracyclophane. IR ν_{max}^{film} cm^{-1}: 1194, 1057. NMR (CCl_4) τ: 8.85 (s), 7.38 (t, J=6.0 Hz), 5.63 (d, d, J=5.0, 8.0 Hz). *Anal.* Calcd. for $C_{20}H_{32}O$: C, 83.27; H, 11.18. Found: C, 83.82; H, 11.01.

b) From the pure bromide (**4**), the yields of **7** and **8** were 48.8 and 15.3%, respectively.

1-Bromo-[10]-paracyclophane (4)——A dry hydrobromide gas was introduced into the butyl ether (**8**, 440 mg) at 80—90° for 5 hr. Dichloromethylene was added, then the solution was washed with water, dried over anhydrous sodium sulfate and concentrated. The residue was distilled at 140° (bath temp.) at 0.15 mm to give a colorless oil (410 mg, 91.0%). *Anal.* Calcd. for $C_{16}H_{23}Br$: C, 65.09; H, 7.85; Br, 27.06. Found: C, 65.30; H, 7.78; Br, 26.88.

[10]-Paracyclophane 1,2-Oxide (9)——A solution of *m*-chloroperbenzoic acid (80%, 2.2 g) in chloroform (100 ml) was added to a mixture of cyclophane (**2**) and the cyclophene obtained by only distillation (2.76 g). The solution was allowed to stand at room temperature overnight, washed with aq. sodium bicarbonate and water, dried over anhydrous sodium sulfate and concentrated. The residue (1.86 g) was chromatographed on a thick layer of silica gel (Merck Co., GF_{254}) in benzene *n*-hexane (1: 1). The fraction with the smallest *Rf* value, the oxide, was distilled at 150° (bath temp.) at 0.2 mm to give a colorless oil (593 mg), 16.3% from **2**. In another run, the yield reached 43.1%. IR ν_{max}^{film} cm^{-1}: 788, 753. UV $\lambda_{max}^{n\text{-heptane}}$ nm (ε): 278 (227), 269 (327), 261 (328), 254[i] (385), 228 (9750), 200 (35400), 197.5 (35400). NMR τ: 7.1—7.7 (m), 6.8—7.1 (m), 4.04 (d, J=4.0 Hz). *Anal.* Calcd. for $C_{16}H_{22}O$: C, 83.43; H, 9.63. Found: C, 83.49; H, 9.57.

***threo*-1-Hydroxy-2-isopropylamino-[10]-paracyclophane (1)**——A mixture of the epoxide (592.5 mg), isopropylamine (2 ml) and a few drops of water was heated at 150° in a sealed glass tube for 2 days. The volatile materials were removed by distillation under reduced pressure. The residue[23] was dissolved in ether, and a dry hydrochloride gas was introduced into the solution. The precipitate was collected by filtration and recrystallized from methanol–benzene (580.8 mg). mp 260—262° free amine mp 102—102.5°. IR ν_{max}^{Nujol} cm^{-1}: 3300, 1582. NMR (CD_3OD) τ: 8.59 (d, d, J=2.0, 6.5 Hz), 7.23 (m), 6.43 (m), 5.40 (d. J=9.5 Hz). UV λ_{max}^{MeOH} nm (ε): 275 (122), 266 (196), 260 (188), 227[i] (6290), 223 (7380), 215 (6290), 198 (36700), 195.5 (34300). Mass Spectrum *m/e*: 289 (M^+) *Anal.* Calcd. for $C_{19}H_{31}ON \cdot HCl$: C, 70.02; H, 9.90; N, 4.30. Found: C, 69.53; H, 9.79; N, 4.31.

Optical Resolution of 1——A mixture of the amine (214 mg) and dibenzoyl tartaric acid (265 mg) was dissolved in ethanol. The solvent was replaced by ethyl acetate. The crystals were collected by filtration and recrystallized from ethanol three times, $[\alpha]_D^{24}$ +5.0±1.1 (c=0.418, EtOH). The salt (66.5 mg) was shaken with a mixture of ether and dil. ammonium hydroxide. The ether solution was washed with water, dried over anhydrous potassium carbonate and concentrated. The residue was crystallized from *n*-hexane. mp 51—53°. $[\alpha]_D^{24}$ +98.0±4.0 (c=0.346, MeOH). CD λ_{max}^{MeOH} ($\Delta\varepsilon$): 275 (+0.169), 267 (+0.171), 245 (+0.105), 227 (+1.67), 220 (+2.60).

1-Hydroxy-[10]-paracyclophane (11)——A solution of the acetate (**5**, 1.543 g) in abs. ether (100 ml) was added to a slurry of lithium aluminum hydride (0.5 g) in ether (20 ml) at 0° with stirring. The mixture was further stirred for 1 hr. Excess lithium aluminum hydride was decomposed by adding a solution of methanol in ether and then dil. hydrochloric acid. The organic phase was separated and the aq. phase was extracted with ether. The combined ether solution was washed with water and dried over anhydrous sodium sulfate. After evaporation of the solvent, the residue was distilled at 141—145° at 1.2 mm to give a colorless oil which crystallized on standing at room temperature. Yield 1.215 g (93.0%). IR ν_{max}^{Nujol} cm^{-1}: 3220, 1035, 815. NMR τ: 7.32 (t, J=6.0 Hz), 5.29 (d, d, J=4.5, 8.0 Hz). *Anal.* Calcd. for $C_{16}H_{24}O$: C, 82.70; H, 10.41. Found: C, 82.59; H, 10.39.

1-Oxo-[10]-paracyclophane (12)——The Jones' reagent was added to a solution of the alcohol (**11**, 1.215 g) in acetone (20 ml) at 0° until the persistent orange brown coloration appeared (1.3 ml). After 5 min, water was added and the mixture was extracted with ether, washed with water, dried over anhydrous sodium sulfate and evaporated. The crystalline residue was recrystallized from ether–*n*-pentane. Yield 1.016 g (84.4%). IR ν_{max}^{Nujol} cm^{-1}: 1673. NMR τ: 2.72 (d, J=8.0 Hz), 2.37 (d, J=8.0 Hz). *Anal.* Calcd. for $C_{16}H_{22}O$: C, 83.43; H, 9.63. Found: C, 83.13; H, 9.46.

23) The VPC of the residue showed only one peak measured with a 4 mm×1.5 m glass column of 1% OV-1 on a Gas Chrom Q at 206°.

1-Oxo-2-bromo-[10]-paracyclophane (14) and 1-Oxo-2,2-dibromo-[10]-paracyclophane (13)——A solution of bromine (0.226 ml) in glacial acetic acid (5 ml) was added to a solution of the ketone (1.016 g) in glacial acetic acid (10 ml) with stirring. After the bromine color had disappeared completely (*ca.* 30 min), the solvent was removed by distillation under reduced pressure. The concentrated residue (1.44 g) was chromatographed on a thick layer of silica gel (Merck Co., GF_{254}) in benzene. The fraction with the larger *Rf* value was recrystallized from *n*-pentane (204 mg, 11.9%). mp 78—80°. IR ν_{max}^{Nujol} cm^{-1}: 1694, 1603. NMR τ: 2.71 (d, J=8.2 Hz), 2.08 (d, J=8.2 Hz). *Anal.* Calcd. for $C_{16}H_{20}Br_2O$: C, 49.51; H, 5.19; Br. 41.17. Found: C, 49.68; H, 5.26; Br, 40.89.

The fraction with the smaller *Rf* value was recrystallized from benzene *n*-pentane (726.7 mg, 53.3%). mp 97—98°. IR ν_{max}^{Nujol} cm^{-1} 1682. NMR τ: 5.46 (d, d, J=6.0, 10.0 Hz). *Anal.* Calcd. for $C_{16}H_{21}BrO$: C, 62.14; H, 6.84; Br, 25.84. Found: C, 61.82; H, 6.78; Br, 25.97.

CD and UV spectra of complex and amino-alcohols

1) $[Cu(su)_2(ip)_2]$ (1.764 mmoles/liter) (+)-(**1**) (3.219 mmoles/liter)

CD(CH_2Cl_2)		UV(CH_2Cl_2)	
λnm	$\Delta\varepsilon$	λnm	ε
612	+0.319	585	48.1
392	−0.218	384	483
352	−0.232		
298	+1.19		

2) $[Cu(su)_2(ip)_2]$ (3.462 mmoles/liter) ephedrine (3.169 mmoles/liter)

CD(CH_2Cl_2)		UV(CH_2Cl_2)	
λnm	$\Delta\varepsilon$	λnm	ε
564	−0.467	644	50.5
378	+0.180	377	230
344	+0.221		
290	−4.70		

3) $[Cu(su)_2(ip)_2]$ (3.298 mmoles/liter) pseudo ephedrine (3.345 mmoles/liter)

CD(CH_2Cl_2)		UV(CH_2Cl_2)	
λnm	$\Delta\varepsilon$	λnm	ε
580	−0.152	652	42.5
380	+0.088	382	200
349	+0.130		
291	−2.35		

4) $[Cu(su)_2(ip)_2]$ (2.185 mmoles/liter) (−)-(1R,2S)-erythro-2-amino-diphenyl ethanol (7.031 mmoles/liter)

CD(CH_2Cl_2)		UV	
λnm	$\Delta\varepsilon$	λnm	ε
604	−0.261	604	43.7
346	+0.142	366	209
292	−1.89		

5) $Pr(DPM)_3$ (1.601 mmoles/liter) (+)-(**1**) (1.562 mmoles/liter)

CD(CCl_4)	
λnm	$\Delta\varepsilon$
328	−0.690
314	+12.6
309	+11.9
287	−2.28