STEREOCHEMICAL STUDIES. LIX.*

"FLATTENED" CHAIR AND TWIST-BOAT CONFORMATIONS IN *cis*-2-DIMETHYLAMINOCYCLOHEXANOLS

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Separation of the bands in the 3 μ region of the infrared spectra of a number of *cis*-2-dimethylaminocyclohexanols and *trans*-decalols confirms and extends our earlier tentative proposal that the $N(CH_3)^e_2OH^e$ compounds exist as a mixture of three conformers: a "flattened" chair (N—CH_3 "inside", N···HO bonded), a "normal" chair (N—CH_3 "outside", OH-free) and a very small amount of a twist boat (N···HO bonded). An argument is given showing that in *cis*-2-dimethylaminocyclohexanol the equilibrium is almost completely in favour of the $N(CH_3)^e_2OH^a$ form.

In Part XXIV[1] of this series we considered ways by which an axially substituted cyclohexane can attain strain relief through ring deformation, and showed that infrared spectroscopic intramolecular hydrogen bond determination on suitable model compounds represents a good method for following such deformations.

Thus, the spectra of the *cis*-2-dimethylaminocyclohexanol derivatives *Ib* and *IIb*, and the decalyl derivative *IIIb* were found to exhibit a bonded hydroxyl band at unusually low wave numbers (strong hydrogen bond) and also a relatively large free hydroxyl band, again an unusual feature for a 2-dimethylaminocyclohexanol. These findings were interpreted as showing that compounds such as *Ib*, *IIb* and *IIIb* exist as mixtures of at least two rotameric species of the types (A) and (B) (Scheme 1), the former existing as a strongly flattened chair and giving rise to the bonded OH band, the latter as a normal chair and being responsible for the free OH band.

In the present study spectra of additional *cis*-2-dimethylamino alcohols have been examined which confirm and further extend our earlier conclusions. Separation of the bands[2–5] enabled us to identify minor peaks and to assign these to different conformers.

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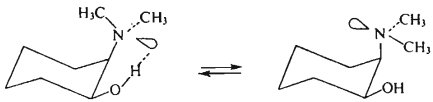
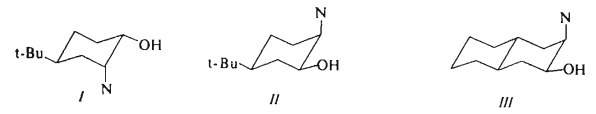


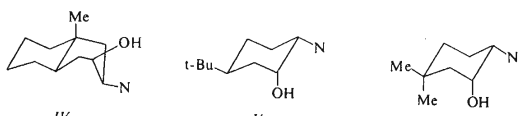
N-Me Inside (A) ⇌ N-Me Outside (B)

SCHEME 1

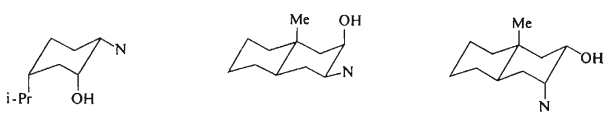
In our previous paper[1] we assigned the band at 3382 cm^{-1} in compounds *Ib* and *IIIb* to a flattened chair conformer. Our present data, and, in particular, the spectrum of the decalyl derivative *IV* enable us now to put forward unequivocal evidence in favour of this view. The spectrum of *IVb*, like that of *IIb* and *IIIb*, exhibits two bonded OH bands, the one in the region of 3380 cm^{-1} and the other in the region of 3500 cm^{-1} (Table I). However, in *IVb* the ratio of intensities of the two bands is very different from that in *IIb* and *IIIb*: while in *IIb* and *IIIb* the band at around 3500 cm^{-1} is very small (detected only by band separation), in *IVb* it becomes the major band. Since the 1,3-*syn*-axial interactions between the methyl and dimethylamino group in *IVb* must seriously destabilize the chair form even



I *II* *III*



IV *V* *VI*



VII *VIII* *IX*

a) N = NH_2 *b*) N = NMe_2

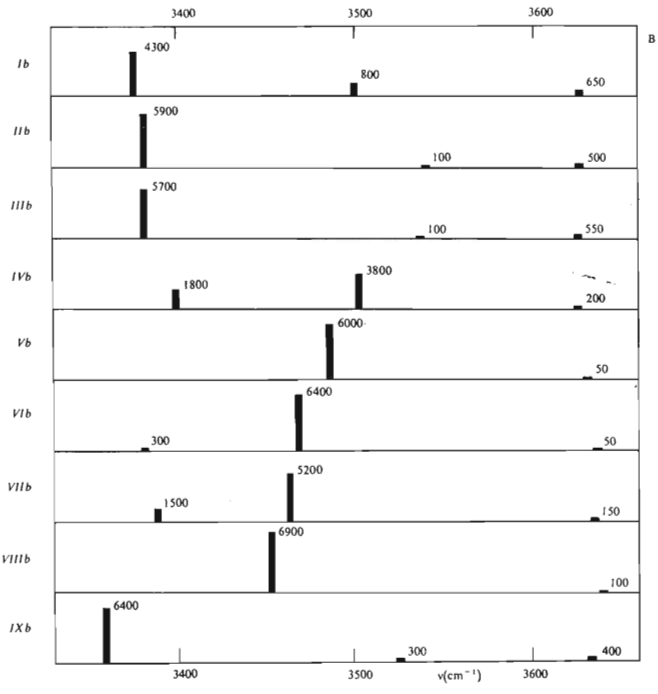
All compounds are shown in the most stable conformation.

when it is flattened (conformation *A*), there is good reason to assign the major band (*i.e.* that in the 3500 cm^{-1} region) to a boat conformer. This assignment is further supported by the following considerations.

The torsion angle between the OH and the $N(CH_3)_2$ group in the boat conformer of *IVb* may be considered to be 60° or somewhat larger (depending on the angle of twist). The torsion angle would hence be similar to (or somewhat larger than)

TABLE I

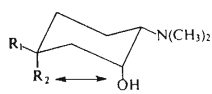
Infrared Maxima (ν_{max}) and Apparent Molar Integrated Intensities (B) of the Separated Hydroxyl Bands in the Dimethylamino Alcohols *Ib*—*IXb* (30°C, tetrachloroethylene)

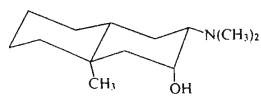


that in the chair form of compounds such as *Vb*. In fact, the bonded band in *IVb* (assigned to the boat form) is located at 3503 cm^{-1}, while the bonded band in the spectrum of *Vb* is found in the same region, *i.e.* at 3486 cm^{-1}.

If follows that the bands in the region of 3380 cm^{-1} belong to a conformer in which the torsion angle between the two vicinal groups is smaller than 60°: such an arrangement in our compounds is possible only in a flattened chair conformation, with a rotameric arrangement of the $N(CH_3)_2$ group as in (*A*) (Scheme 1). The assignment made in our earlier paper is thus supported by independent evidence.

Some further aspects of chair flattening in the $OH^aN(CH_3)_2^e$ species are illustrated by the spectra of the compounds *Vb*–*VIIIb*. In the compound *Vb* and in one of the chair conformations of *VIb* and *VII b*, the OH group is in a *syn*-axial relationship, respectively, to hydrogen, methyl or isopropyl (Scheme 2). These steric interactions can be reduced by ring flattening; it may be expected that the degree of flattening will increase with the bulk of the *syn*-axial group and this should result in a shift of the band towards lower wave-numbers. As may be seen from Scheme 2 this is indeed observed. In the decalyl derivative *VIIIb* annelation prevents this type of symmetrical flattening: if the same degree of separation between CH_3 and OH is to be achieved in *VIIIb* as in *VIb*, the OH will move closer to $N(CH_3)_2$, and this will result in stronger hydrogen bond in *VIIIb*; the value of ν(OH) found for *VIIIb* again confirms this prediction.





			ν(OH) cm^{-1}
Vb,	$R^1 = t\text{-}C_4H_9$,	$R^2 = H$	3486
VIb,	$R^1 = CH_3$,	$R^2 = CH_3$	3468
VIIb,	$R^1 = H$,	$R^2 = i\text{-}C_3H_7$	3463

VIIIb, ν(OH) = 3452 cm^{-1}

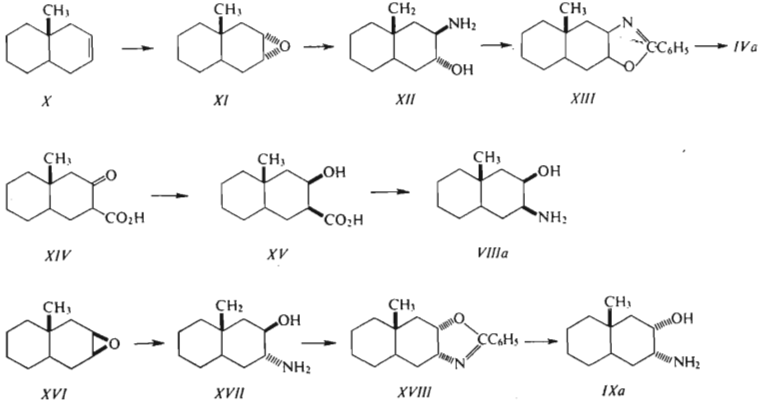
SCHEME 2

The assignment of the bands in the "biased" compounds *IIb*, *IIIb* and *Vb* enables us to look more closely onto the conformational situation in "mobile" *cis*-2-aminocyclohexanols. The presence of the bands in the 3380 cm^{-1} and in the 3480 cm^{-1} regions in the spectra of *VI b* and *VIIb* indicates the presence of both a $N(CH_3)_2^aOH^e$ and a $N(CH_3)_2^eOH^a$ conformer. The free OH band is due predominantly to the $N(CH_3)_2^aOH^e$ conformer. Taking the band at 3383 cm^{-1} in compound *IIb* as a standard for the $N(CH_3)_2^aOH^e$-chair conformer and the band at 3486 cm^{-1} in compound *Vb* as a standard for the $N(CH_3)_2^eOH^a$-chair conformer, one can show that

VIb is present almost exclusively and *VIIb* predominantly in the $N(CH_3)_2^eOH^a$ conformation. We thus see that the 1,3-*syn*-axial interactions between methyl or isopropyl and hydroxyl are more readily accomodated than the axial dimethylamino *versus* equatorial hydroxyl gauche interactions. One may deduce from this that *cis*-2-dimethylaminocyclohexanol itself will exist practically exclusively in the $N(CH_3)_2^eOH^a$ conformation. This falls in line with the observation by Stolow[6] that vicinal interactions of the type axial isopropyl group *vs* equatorial hydroxyl are very large. A feature which additionally favours the $N(CH_3)_2^eOH^a$ conformer in our case is that the rotameric arrangement which makes hydrogen bonding possible in the $N(CH_3)_2^aOH^e$ conformer places a methyl group into the very unfavourable "inside" conformation. On the other hand, in the $N(CH_3)_2^eOH^a$ conformer no such unfavourable position is necessary for a rotameric arrangement which allows intramolecular hydrogen bonding.

Synthesis

The compounds *Ia,b*, *IIa,b*, *IIIa,b* and *Va* are already known[1,7]. Compound *IVa* was synthesized by the usual inversion reaction[1,7] from the 2β-amino-3α-hydroxy-9β-methyl-*trans*-decalin (*XII*) (Scheme 3). The compound *XII* was prepared by reaction of ammonia with 2,3α-epoxy-9β-methyl-*trans*-decalin (*XI*) which in turn was



Scheme 3

prepared from 9β-methyl-*trans*-$\Delta^{2,3}$-octalin (*X*) (ref.[8]) by stereoselective epoxidation with perphthalic acid. Clarke-Eschweiler methylation of the amino alcohol *IVa* gave the desired dimethylamino derivative *IVb*, together with approximately the same amount of another compound which apparently was the cyclic oxazolidine derivative[9] because reduction of the product of methylation with lithium aluminium hydride afforded as the sole product pure *IVb*, m.p. 44 – 44·5°C.

Compound *VIa* was prepared either from the methyl *cis*-2-hydroxy-4,4-dimethylcyclohexanecarboxylate, obtained from the corresponding, keto-ester by catalytic hydrogenation, or from the *trans*-2-amino-5,5-dimethylcyclohexanol by the inversion procedure[7] *via* an oxazoline derivative. The same inversion procedure was applied to the synthesis of compound *VIIa* from the *trans*-2-amino-*trans*-5-isopropylcyclohexanol[10].

For the synthesis of the decalyl derivative *VIIIa*, we set out from the keto-acid *XIV*; this on reduction with sodium borohydride gave the hydroxy-acid *XV*, m.p. 154 – 155·5°C. The acid was assigned the $OH^{a}COOH^{e}$ configuration since conformational considerations show that the hydride can much more readily approach the carbonyl moiety from the equatorial side; and since the spectrum of a dilute solution of the methyl ester of *XV* in the 3 μ region showed bonded-OH bands known[11] to be characteristic for the $OH^{a}COOCH_{3}^{e}$ arrangement. Curtius degradation of the acid *XV* afforded the amino alcohol *VIIIa*.

Further confirmation for the correctness of the configurational assignment to *VIIIa* follows from its non-identity with other "*cis*"-amino alcohol, *IXa*, prepared by a stereospecific route from the epoxide *XVI*, as indicated in the Scheme 3.

EXPERIMENTAL

Spectral Measurements and Band Separation

The spectra were measured on a Perkin-Elmer 621 spectrometer at 3250 – 3700 cm^{-1} at 30°C in tetrachlorethylene under essentially the same conditions as described in Part LVII[10]. Numerical separation of the bands was carried out on an Elliott 503 computer under assumption of Lorentzian (Cauchy) type of bands, using the damped least squares method[2-4]. The pertinent program[5] was written in Elliott Algol 503 Mk 1. In some cases, the computations gave bonded hydroxyl bands located close to the maxima of the principal bands and of intensities lower than 2% of the main band. These bands were disregarded, also because they might be artefacts produced by the computer in order to compensate for deviations from ideal Lorentzian behaviour of bands in the actual spectra. In the case of compound *VIb* the separation did not fit well the strictly Lorentzian-type bands giving a wide margin of possible values; the method of graphical separation was therefore used.

9-Methyl-*trans*-$\Delta^{2,3}$-octalin (*X*)

This compound was prepared essentially according to Yanagita and Yamakawa[8]. A mixture of 2α-hydroxy-3β-bromo-9β-methyl-*trans*-decalin[12] (5·2 g), zinc powder (15 g) and acetic acid (40 ml) was refluxed for 2 hours, the warm reaction mixture decanted, and the residual zinc was

TABLE II

Infrared Maxima, ν_{max} (cm^{-1}), and Molar Extinction Coefficients, ε ($l\,cm^{-1}\,mol^{-1}$) (in parentheses) of the Bonded Hydroxyl Bands in the *cis*-Amino Alcohols *Ia*–*IXa* (30°C, tetrachloroethylene). (Taken from the spectra without band separation).

Compound	Free OH	Bonded OH	Compound	Free OH	Bonded OH
Ia	3 626 (22·7)	3 491 (36·2)	*VIa*	3 624 (16·3)	3 487 (40·9)
IIa	3 624 (23·1)	3 493 (36·7)	*VIIa*	3 615 (21·5)	3 483 (30·6)
IIIa	3 625 (21·8)	3 490 (32·5)	*VIIIa*	3 635 (9·9)	3 477 (14·8)
IVa	3 629 (14·6)	3 467 (18·0)	*IXa*	3 625 (22·9)	3 480 (30·2)
Va	3 623 (10·7)	3 490 (44·8)			

triturated with acetic acid. The combined acetic acid solutions were poured into water, extracted with pentane and the organic layer taken down leaving a residue which contained about 30% of 9-methyl-*trans*-2-decalone as a by-product. In order to remove the ketone, the residue was treated with hydroxylamine hydrochloride and sodium acetate in methanol and after 2 hours' standing extracted between water and pentane. The product was distilled, yielding 1·8 g (57%) of pure *X*, b.p. 85–87°C/20 Torr. For $C_{11}H_{18}$ (150·2) calculated: 87·92% C, 12·08% H; found: 88·23% C, 12·03% H.

2,3α-Epoxy-9β-methyl-*trans*-decalin (*XI*)

Epoxidation of *X* with perphthalic acid in ether gave the crude epoxide, b.p. 98–100°C/15 Torr, in 90% yield. This product contained, in addition to small amount of starting olefin, about 5% of the epimeric 2,3β-epoxide, as evidenced by vapour phase chromatographic analysis and comparison with an authentic specimen of the 2,3β-epoxide[12]. For $C_{11}H_{18}O$ (166·2) calculated: 79·46% C, 10·92% H; found: 79·91% C, 10·82% H.

2β-Amino-3α-hydroxy-9β-methyl-*trans*-decalin (*XII*)

A solution of the crude epoxide (2·3 g) synthesized as indicated above in ethanol (80 ml) was saturated with ammonia at 0°C, the solution was heated to 180°C for 5 hours, the reaction mixture taken down *in vacuo* and the residue extracted between diluted hydrochloric acid and ether. The product was liberated by addition of sodium hydroxide solution to the aqueous layer, extracted into ether and distilled at 0·1 Torr. Two crystallisations from ligroin, followed by two from ethyl

acetate, afforded 1·0 g (39%) of the amino alcohol, melting at 100—101°C, uniform according to vapour phase chromatography. For $C_{11}H_{21}NO$ (183·3) calculated: 72·08% C, 11·55% H, 7·64% N; found: 72·12% C, 11·56% H, 7·64% N.

N-*Benzoyl derivative*, m.p. 157—158°C (ethanol–water). Prepared by the Schotten-Baumann procedure in 78% yield. For $C_{18}H_{25}NO_2$ (287·4) calculated: 75·22% C, 8·77% H, 4·87% N; found: 75·66% C, 8·59% H, 4·70% N.

2β-Amino-3β-hydroxy-9β-methyl-*trans*-decalin (*IVa*)

The benzoyl derivative from the previous experiment (4·2 g) was converted to the corresponding oxazoline as described for *cis*-2-benzamido-*cis*-5-isopropylcyclohexanol. The oxazoline was isolated as the picrate, m.p. 163—164°C (6·2 g, 85%). For $C_{24}H_{26}N_4O_8$ (498·5) calculated: 57·83% C, 5·26% H, 11·24% N; found: 58·14% C, 5·35% H, 10·92% N. The oxazoline, m.p. 69·5—70·5°C (pentane, —30°C) was liberated from the picrate using lithium hydroxide, yield 3·3 g (98·6%). For $C_{18}H_{23}NO$ (269·4) calculated: 80·25% C, 8·61% H, 5·20% N; found: 80·30% C, 8·71% H, 5·40% N.

A solution of the oxazoline (3·1 g) in 50 ml dilute hydrochloric acid (4 : 1) and 20 ml ethanol was refluxed for 10 hours, then taken to dryness, the residue extracted between ether and water, the aqueous layer made alkaline and the separated base taken up in ether. The ethereal extracts afforded 1·7 g of the amino alcohol *IVa*, m. p. 68—74°C, unchanged after sublimation and successive crystallisations from ligroin and ethyl acetate. For $C_{11}H_{21}NO$ (183·3) calculated: 72·08% C, 11·55% H, 7·64% N; found: 71·96% C, 11·34% H, 7·53% N.

The compound was converted into its N-benzoyl derivative which melted sharply at 190 to 190·5°C (ethyl acetate). For $C_{18}H_{25}NO_2$ (287·4) calculated: 75·22% C, 8·77% H, 4·87% N; found: 75·02% C, 8·61% H, 5·01% N.

Hydrolysis of the benzoyl derivative (2·0 g) was accomplished by refluxing with 25 ml dilute hydrochloric acid (4 : 1) and 20 ml ethanol for 12 hours thus giving the alcohol *IVa* which has the same melting point as before benzoylation. Further sublimation and crystallisations did not change or narrow its melting point.

3β-Hydroxy-2β-dimethylamino-9β-methyl-*trans-decalin* (*IVb*)

The Clarke-Eschweiler methylation of the amino alcohol *IVa* afforded two compounds in a 1 : 1 ratio, as shown by vapour phase chromatography. Reduction of the product with lithium aluminium hydride in ether (reflux for 2 hours) gave a single base *IVb*, m.p. 44—44·5°C (pentane) which corresponded to the second peak in the vapour phase chromatogram of the Clarke-Eschweiler product. This indicates that the methylation reaction is accompanied by substantial cyclisation to an oxazolidine[9] which upon reduction affords the desired N,N-dimethylamino alcohol *IVb*. For analytical data *cf.* Table III.

Methyl *cis*-2-Hydroxy-4,4-dimethylcyclohexanecarboxylate

The carboxylation of 3,3-dimethylcyclohexanone[13] (24·0 g) was carried out using triphenylmethyl potassium in ether by the same procedure as reported by us previously for the carboxylation other substituted cyclohexanones[1,7]. The crude keto-acid was esterified with diazomethane and the resulting methyl 4,4-dimethyl-2-cyclohexanonecarboxylate distilled, b.p. 99—100°C/8 Torr. Yield 10·0 g (28·6%). For $C_{10}H_{16}O_3$ (184·2) calculated: 65·19% C, 8·75% H; found: 65·67% C, 8·92% H.

Hydrogenation of the keto-ester (19·3 g) on Adams' catalyst (2·0 g) in acetic acid (50 ml) afforded 17·0 g (87%) of methyl *cis*-2-hydroxy-4,4-dimethylcyclohexanecarboxylate, b.p. 108°C/10 Torr, n_D^{20} 1·4613, which was free from the *trans*-isomer, as evidenced by vapour phase chromatography. IR-spectrum ($5 . 10^{-3}$M, tetrachloromethane): 3 545 cm^{-1} (s), 3 615 cm^{-1} (i). For $C_{10}H_{18}O_3$ (186·2) calculated: 64·49% C, 9·74% H; found: 64·14% C, 9·64% H.

cis-2-Hydroxy-4,4-dimethylcyclohexanecarboxylic acid, m.p. 97—98°C (benzene) was prepared by shaking the ester with 8% aqueous sodium hydroxide at 40°C for 10 minutes followed by the usual isolation procedure. For $C_9H_{16}O_3$ (172·2) calculated: 62·76% C, 9·36% H; found: 63·05% C, 9·34% H.

Methyl *trans*-2-Hydroxy-4,4-dimethylcyclohexanecarboxylate

The distilled hydrogenation product of methyl 4,4-dimethyl-2-cyclohexanonecarboxylate (14·0 g) (*vide supra*) was refluxed with ethanolic sodium ethoxide (from 2 g sodium and 150 ml ethanol) for 2 hours. The mixture of esters was chromatographed on alumina (grade III). Elution with benzene afforded 2·5 g of an ester, b.p. 128—130°C/60 Torr, n_D^{20} 1·4672, IR spectrum: ν(CO) conjug. 1 716 cm^{-1}, ν(C=C) conjug. 1 654 cm^{-1}, no OH absorption. For $C_{10}H_{16}O_2$ (168·2) calculated: 71·40% C, 9·59% H; found: 71·44% C, 9·51% H. Saponification of this ester afforded an acid, the melting point of which (123—124°C) was identical with that reported for 4,4-dimethyl-1-cyclohexenecarboxylic acid[15]. Elution with ether gave a small amount of the *cis*-hydroxy-ester; the *trans*-hydroxy-ester (6·8 g) was eluted with methanol, b.p. 108°C/10 Torr, n_D^{20} 1·4602. IR spectrum ($5 . 10^{-3}$M, tetrachloromethane): 3 615 cm^{-1} (i), 3 595 cm^{-1} (s), 3 560 cm^{-1} (i). For $C_{10}H_{18}O_3$ (186·2) calculated: 64·49% C, 9·74% H; found: 64·64% C, 9·70% H. The *trans*-2-hydroxy-4,4-dimethylcyclohexanecarboxylic acid, m.p. 130·5—131·5°C (ether–light petroleum) was obtained by alkaline saponification of the ester. For $C_9H_{16}O_3$ (172·2) calculated: 62·76% C, 9·36% H; found: 62·96% C, 9·47% H.

trans-2-Amino-5,5-dimethylcyclohexanol

Methyl *trans*-2-hydroxy-4,4-dimethylcyclohexanecarboxylate was transformed into the amino alcohol by the usual sequence of reactions: *Hydrazide*, m.p. 169—171°C (ethanol) (97% yield). For $C_9H_{18}N_2O_2$ (186·2) calculated: 58·03% C, 9·74% H, 15·04% N; found: 57·91% C, 9·48% H, 15·13% N. *Cyclic urethane*, m.p. 109—111°C (ligroin) (75% yield). For $C_9H_{15}NO_2$ (169·2) calculated: 63·88% C, 8·94% H, 8·28% N; found: 63·88% C, 9·01% H, 8·36% N. Alkaline hydrolysis of the urethane gave the desired trans-*2-amino-5,5-dimethylcyclohexanol*, b.p. 103—104°C/10 Torr, m.p. 74—75°C (ligroin) in 83% yield. For $C_8H_{17}NO$ (143·2) calculated: 67·09% C, 11·96% H, 9·78% N; found: 67·27% C, 12·10% H, 9·70% N.

N-*Benzoyl derivative*, m.p. 164·5—165·5°C. For $C_{15}H_{21}NO_2$ (247·3) calculated: 72·84% C, 8·56% H, 5·66% N; found: 72·84% C, 8·52% H, 5·59% N.

cis-2-Amino-5,5-dimethylcyclohexanol (*VIa*)

a) *From the hydroxy-acid*: Heating of methyl *cis*-2-hydroxy-4,4-dimethylcyclohexanecarboxylate (2·1 g) with hydrazine hydrate (1·0 g) in ethanol (2 ml) for 5 hours gave the hydrazide, m.p. 98·5—99·5°C (2·0 g, 95%). The crude hydrazide (1·85 g) was converted to cyclic urethane using the Curtius procedure. The yield of urethane, m.p. 107—108°C (benzene) was 77·5%. For $C_9H_{15}NO_2$ (169·2) calculated: 63·88% C, 8·94% H, 8·28% N; found: 63·74% C, 8·94% H, 8·51% N. The cyclic urethane (1·2 g) was hydrolysed by boiling with aqueous ethanolic potassium hydroxide

for 4 hours. The usual isolation procedure afforded 0·9 g (88%) of the amino alcohol *VIa*, melting at 71—72°C (ligroin). For $C_8H_{17}NO$ (143·2) calculated: 67·09% C, 11·96% H, 9·78% N: found: 67·37% C, 11·96% H, 9·88% N.

b) *From* trans-2-*amino*-5,5-*dimethylcyclohexanol*: *trans*-2-Benzamido-5,5-dimethylcyclohexanol (0·4 g) was converted into the O-methanesulphonate, m.p. 148·5—149°C (ethyl acetate) by treatment with methanesulphonyl chloride in pyridine in 76% yield. For $C_{16}H_{23}NO_4S$ (325·4) calculated: 59·07% C, 7·13% H, 4·30% N; found: 58·89% C, 7·05% H, 4·87% N. The mesylate (326 mg) was heated with anhydrous potassium acetate (150 mg) in ethanol (15 ml) for 7 hours. After cooling, the separated potassium methanesulphonate was filtered off, washed with ethanol, the filtrate taken down and the residue extracted between ether and sodium carbonate solution. From the dried ethereal extract the picrate of the corresponding oxazoline, m.p. 157—158°C was precipitated (301 mg, 65·8%) by treatment with picric acid (230 mg) in ether. For $C_{21}H_{22}N_4O_8$ (458·4) calculated: 55·02% C, 4·84% H, 12·22% N; found: 55·06% C, 5·25% H, 12·18% N. The base was liberated from the picrate (285 mg) by lithium hydroxide solution and the isolated crude oxazoline was hydrolysed by 20 hours' boiling with a mixture of dilute (1 : 1) hydrochloric acid (15 ml) and ethanol (5 ml) thus giving the *cis*-amino alcohol *VIa*, m.p. 71—72°C (50 mg, 56%), identical in all respects with the sample obtained under *a*).

cis-2-Amino-*cis*-5-isopropylcyclohexanol (*VIIa*)

trans-2-Amino-*trans*-5-isopropylcyclohexanol[10] was benzoylated by the Schotten-Baumann procedure to give *trans*-2-benzamido-5-isopropylcyclohexanol, m.p. 141—141·5°C (benzene), in 80% yield. For $C_{16}H_{23}NO_2$ (261·3) calculated: 73·53% C, 8·87% H, 5·36% N; found: 73·82% C, 8·87% H, 5·42% N.

A solution of this benzamide (1·5 g) in thionyl chloride was allowed to stand for 1 hour, the reaction mixture taken to dryness *in vacuo* and the residue partitioned between a potassium carbonate solution and ether. The ethereal layer was dried, taken down and the product distilled yielding 1·3 g (93%) of the Δ^2-oxazoline, b.p. 140—141°C/0·3 Torr. For $C_{16}H_{21}NO$ (243·3) calculated: 78·97% C, 8·70% H, 5·76% N; found: 78·60% C, 8·74% H, 5·61% N. The oxazoline (1·25 g) was hydrolysed by boiling with a mixture of concentrated hydrochloric acid (10 ml) and ethanol (10 ml) for 10 hours, and the resulting amino alcohol *VIIa*, m.p. 104·5—105·5°C (ligroin), was isolated in the usual manner in 86% yield. For $C_9H_{19}NO$ (157·2) calculated: 68·74% C, 12·18% H, 8·91% N; found: 69·03% C, 12·20% H, 8·97% N.

2β-Hydroxy-9β-methyl-*trans*-decalin-3β-carboxylic Acid (*XV*)

Carboxylation of 9-methyl-*trans*-2-decalone[14] using triphenylmethyl potassium was carried out as usual giving the crude keto-acid *XIV*, m.p. 109—110°C (dec.) in 81% yield. The acid (12·0 g) was taken up in 0·2M-NaOH (300 ml) and treated with sodium borohydride (4·0 g). After standing overnight the mixture was worked up in the usual manner. The acidic products weighed 10·8 g and contained 90% of *cis*- and 10% of another hydroxy-acid, according to vapour phase chromatography. Three crystallisations from ethyl acetate gave the pure *cis*-hydroxy-acid (7·6 g) melting at 154—155·5°C. For $C_{12}H_{20}O_3$ (212·3) calculated: 67·89% C, 9·50% H; found: 67·95% C, 9·45% H.

Methyl ester, m.p. 51—52°C (pentane). Prepared from the acid by treatment with diazomethane. For $C_{13}H_{22}O_3$ (226·3) calculated: 66·99% C, 9·80% H; found: 68·73% C, 9·70% H. IR spectrum ($5 \cdot 10^{-3}$M, tetrachloromethane): 3540 cm^{-1} (s), 3625 cm^{-1} (i). Heating of the ester with methanolic sodium methoxide resulted in substantial dehydration.

Hydrazide, m.p. 120—122°C (benzene). Prepared from the ester in 79% yield. For $C_{12}H_{22}N_2O_2$ (226·3) calculated: 63·68% C, 9·80% H, 12·38% N; found: 63·65% C, 9·64% H, 12·25% N.

3β-Amino-2β-hydroxy-9β-methyl-*trans*-decalin (*VIIIa*)

The hydrazide from the above preparation (1·6 g) was converted in the usual way to the urethane, m.p. 153—153·5°C (benzene) which upon alkaline hydrolysis afforded the amino alcohol *VIIIa*, melting at 123—123·5°C (0·7 g, 54%), For $C_{11}H_{21}NO$ (183·3) calculated: 72·08% C, 11·55% H, 7·64% N; found: 72·23% C, 11·43% H, 7·52% N.

3α-Amino-2β-hydroxy-9β-methyl-*trans*-decalin (*XVII*)

2,3β-Epoxy-9β-methyl-*trans*-decalin (1·5 g; prepared from 2α-bromo-3β-hydroxy-9β-methyl-*trans*-decalin m.p. 68—69°C according to Marshall and coworkers[12]) and ammonium chloride (0·1 g) in 96% ethanol (70 ml) saturated at −10°C with ammonia were heated in an autoclave

TABLE III

N,N-Dimethylamino Alcohols *IVb*—*IXb*

Compound[a]	M.p., °C	Formula (mol. weight)	Calculated/Found		
			% C	% H	% N
IVb	44—44·5	$C_{13}H_{25}NO$ (211·3)	73·88 73·93	11·92 11·87	6·63 6·74
Vb	76—78	$C_{12}H_{25}NO$ (199·3)	72·30 71·85	12·64 12·55	7·03 6·96
VIb	59—59·5	$C_{10}H_{21}NO$ (171·3)	70·12 70·47	12·36 12·45	8·18 8·26
VIIb	70—71	$C_{11}H_{23}NO$ (185·3)	71·30 71·54	12·51 12·56	7·56 7·53
VIIIb	115—116	$C_{13}H_{25}NO$ (211·3)	73·88 73·89	11·92 11·57	6·63 6·95
IXb	120/0·2[b]	$C_{13}H_{25}NO$ (211·3)	73·88 73·93	11·92 11·86	[c]

[a] All compounds were prepared by the Clarke-Eschweiler procedure, sublimed *in vacuo*, crystallised from pentane and sublimed immediately before spectral measurement. All were shown to be homogeneous by vapour phase chromatography, using a 3 m column packed with polyethylene glycol on a support pre-treated with ethanolic potassium hydroxide; [b] bath temperature/Torr; [c] owing to the small quantity of compound available, the nitrogen analysis was omitted.

at 160°C for 6 hours. The amino alcohol *XVII* (1·2 g; 72%) was isolated as usual; after sublimation and crystallisation from ligroin it melted at 119—121·5°C. For $C_{11}H_{21}NO$ (183·3) calculated: 72·08% C, 11·55% H, 7·64% N; found: 71·95% C, 11·66% H, 7·68% N.

Benzoyl derivative, m.p. 177—179°C (methanol). For $C_{18}H_{25}NO_2$ (287·4) calculated: 75·22% C, 8·77% H, 4·87% N; found: 75·38% C, 8·86% H, 5·00% N.

3α-Amino-2α-hydroxy-9β-methyl-*trans*-decalin (*IXa*)

3α-Benzamido-2β-hydroxy-9β-methyl-*trans*-decalin (150 mg) was dissolved in thionyl chloride (1 ml) and allowed to stand for 2 hours. The oxazoline *XVIII* was isolated as the picrate (175 mg, 67%), m.p. 173—174°C. For $C_{24}H_{26}N_4O_8$ (498·5) calculated: 57·83% C, 5·26% H, 11·24% N; found: 57·60% C, 5·19% H, 11·36% N.

After liberation from the picrate (135 mg) with lithium hydroxide solution, the oxazoline *XVIII* was hydrolysed by boiling with hydrochloric acid (10 ml) and ethanol (5 ml) for 20 hours. The usual work-up procedure gave 43 mg (87%) of *IXa*, m.p. 115—116°C (ligroin), depressed on admixture of the *cis*-isomer *VIIIa*.

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Translated by the author (M. T.).

ERRATUM

STEREOCHEMICAL STUDIES. LIX.

"FLATTENED" CHAIR AND TWIST-BOAT CONFORMATIONS IN *cis*-2-DIMETHYLAMINOCYCLOHEXANOLS

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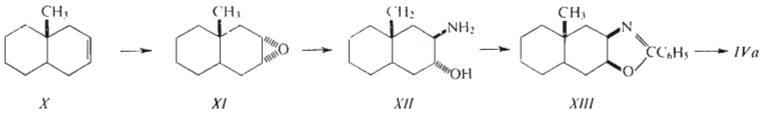
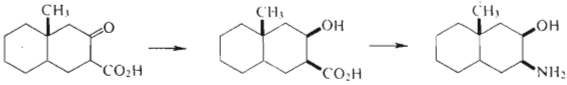
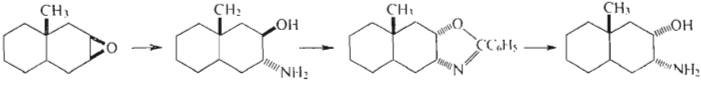
This Journal *36* (1971), p. 1440, Scheme 3 is to be replaced by the following scheme:



X *XI* *XII* *XIII*



XIV *XV* *VIIIa*



XVI *XVII* *XVIII* *IXa*

SCHEME 3