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Photocyclization of Enamides. XXV.[1] Syntheses of Despyrrole Analogues of Ergot Alkaloids Including Elymoclavine, Lysergol, Isolysergol, Lysergine, Isolysergine, Fumigaclavine, Agroclavine, and Lysergene[2]

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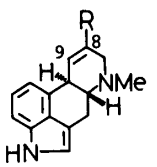
A general synthetic route was developed to the despyrrole analogues of a group of clavine alkaloids; virtually no previous synthetic work on these compounds has been reported.

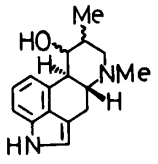
Keywords——reductive photocyclization; ergot alkaloid; enamide; clavine alkaloid; elymoclavine; lysergol; fumigaclavine; agroclavine; lysergene; despyrrole analogue

Most clavine alkaloids[3] can be structurally divided into three groups, one consisting of the alkaloids with an 8-ergolene skeleton such as agroclavine and elymoclavine, another consisting of those with a 9-ergolene skeleton such as lysergol and lysergine, and the third consisting of those with a hydroxyl group at the 9-position such as fumigaclavines[4] (Chart 1). Upon considering these structural features of clavine alkaloids, we assumed that *cis*- and *trans*-9-hydroxy-8-hydroxymethylergolines would play an important role as key intermediates for the synthesis of clavine alkaloids. As an extension of our work on the synthesis of ergoline alkaloids,[1,5,6] we now report the development of a general synthetic route toward most of the clavine alkaloids mentioned above by using the despyrrole analogues (**1** and **2**) of 9-hydroxy-8-hydroxymethylergolines as model compounds.



8-ergolene
elymoclavin: R=CH_2OH
agroclavin: R=Me

9-ergolene
lysergol: R=$\blacktriangleleft CH_2OH$
lysergine: R=$\blacktriangleleft$Me



9-hydroxyergoline

fumigaclavine B: 8α,9β

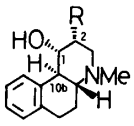
Chart 1

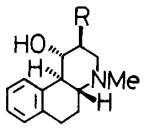
We have reported[5] the stereoselective synthesis of *cis*- (**1**) and *trans*-1,3-diols (**2**) by reductive photocyclization of enamides, and the use of these compounds for the synthesis of the despyrrole analogues of lysergic acid, the principal component of medicinal ergot.

Synthesis of the Despyrrole Analogues of Clavine Alkaloids

Acetylation of the *cis*- (**1**) and *trans*-1,3-diols (**2**) with acetic anhydride and pyridine under ice-cooling gave the respective monoacetates (**3** and **4**) in good yields. These compounds were later used for the synthesis of clavine analogues having a hydroxymethyl group at the 2-

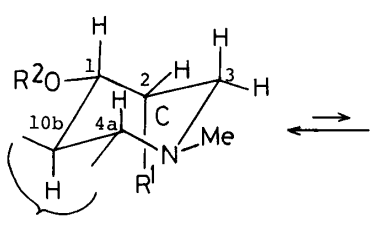
position, including elymoclavine and lysergols. Similarly, mesylation of the *cis*- (**1**) and *trans*-1,3-diols (**2**) in the presence of pyridine under ice-cooling gave the monomesylates (**5** and **6**, respectively) in good yields, and these products were converted into the corresponding *cis*- (**7**) and *trans*-2-methyl-1-ols (**8**) upon reduction with lithium aluminum hydride. Thus, we readily obtained the epimeric pairs of synthetic key intermediates (**3**—**8**), which contain a hydroxyl group at the 1-position in addition to either a hydroxymethyl or a methyl group at the 2-position. The stereochemistry of all these products (**3**—**8**) was established from their proton nuclear magnetic resonance (^{1}H-NMR) spectra (Table I), particularly the signal patterns due to the protons at the 1-position and the 2-substituents. The results were consistent with a stable chair conformation of ring C with the 1-hydroxyl group in an equatorial orientation, as shown by the structure (A) in Fig. 1, for all of these compounds.



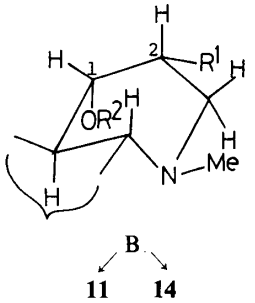


1: R=CH_2OH 2: R=CH_2OH
3: R=CH_2OAc 4: R=CH_2OAc
5: R=CH_2OMs 6: R=CH_2OMs
7: R=Me 8: R=Me

Chart 2



A



B

11 **14**

Fig. 1

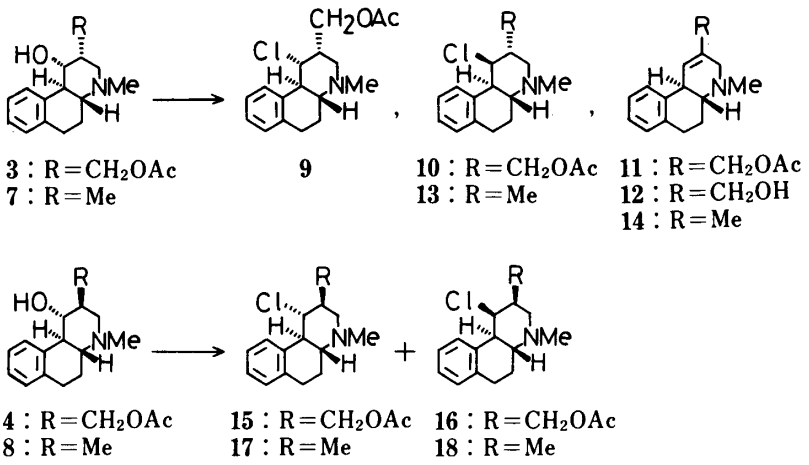
Based on the assumed stereostructures of the above key intermediates, we then investigated regioselective introduction of a double bond at either the 1–2 or the 1–10b position in order to establish a selective synthetic route to clavine alkaloids having 8- and 9-ergolene structures. However direct dehydration of the 1α-equatorially oriented hydroxyl group by a concerted *E*2-type elimination seems to be difficult because the hydroxyl group does not have any anti-periplanar β-hydrogen. Actually, attempted dehydration of the 2α-monoacetate (**3**) with thionyl chloride–pyridine mixture was unsuccessful. Further, the application of the known dehydration procedure[7] with a mixture of phosphoryl trichloride–phosphoric acid–pyridine to the 2α-monoacetate (**3**) at 80 °C afforded no dehydrated product but gave a mixture of the 1α- (**9**) and 1β-chlorides (**10**) in 31% and 16% yields, respectively. Stereochemical assignment of both chlorides (**9** and **10**) was firmly established by ^{1}H-NMR analysis, particularly nuclear Overhauser effect (NOE) measurement (Table I). Next, we investigated indirect introduction of a double bond *via* activation of the 1α-hydroxyl group by converting it into a removable form such as chloride and mesylate. Treatment of the monoacetate (**3**) with thionyl chloride in benzene under reflux for 1.5 h afforded the inverted 1β-chloride (**10**) in 69% yield together with the dehydrated product (**11**) in 21% yield. Under the same conditions, the 2β-monoacetate (**4**) was converted into a mixture of the conserved 1α-chloride (**15**) and inverted 1β-chloride (**16**) in 31% and 65% yields, respectively. Further, similar treatment of an epimeric pair of the 2-methyl derivatives (**7** and **8**) afforded almost the same results, giving a mixture of the 1β-chloride (**13**) and the dehydrated compound (**14**) in 31% and 32% yields from the 2α-methyl-1-ol (**7**) and a mixture of the 1α-chloride (**17**) and 1β-isomer (**18**) in 34% and 57% yields from the 2β-methyl-1-ol (**8**), respectively. The structures of the dehydrated unsaturated benzo[*f*]quinolines (**11** and **14**) were readily established from their ^{1}H-NMR spectra, particularly from their olefinic proton signals.

Preferential formation of the 1β-chlorides (**10**, **13**, **16**, and **18**) from the 1α-alcohols (**3**, **4**, **7**, and **8**) irrespective of the nature and stereochemistry of the neighboring group at the 2-position can be explained as follows; substitution reaction at the 1-hydroxyl group proceeds in the *SN*1 manner to form an intermediary carbonium ion at the 1-position, and this is

TABLE I. Selected ^{1}H-NMR Data (δ; J in Hz) in Relation to the Stereochemistry of 1α,2α-, 1α,2β-, 1β,2α-, and 1β,2β-Disubstituted Compounds in $CDCl_3$ (200 MHz)

Compd.	Stereochemistry	1-H[a]	2-H	3-H_{eq}[a]	3-H_{ax}	10b-H
3	1α,2α	4.23 (dd, J=11, 6)	2.28 (m)	2.98 (dd, J=12, 3)	2.23 (dd, J=12, 2.5)	2.64 (t, J=11)
7	1α,2α	4.15 (dd, J=10, 5)	2.20 (m)	2.84—2.70 (m)	2.29 (dd, J=12, 3)	2.70 (t, J=10)
9	1α,2α	4.52 (dd, J=11, 6)	2.52 (m)	3.06 (dd, J=12, 3)	2.19 (dd, J=12, 2)	2.82 (t, J=11)
4	1α,2β	3.76 (t, J=10)	2.16 (m)	2.94 (dd, J=11, 3)	2.16—2.00 (m)	2.64 (t, J=10)
15	1α,2β	4.20 (t, J=11)	2.50 (m)	3.02 (dd, J=12, 4)	2.07 (t, J=12)	2.95 (t, J=11)
17	1α,2β	3.89 (t, J=10)	2.27 (m)	2.80 (dd, J=12, 4)	1.90 (t, J=12)	2.82 (t, J=10)
10	1β,2α	4.98 (br s)	2.48 (m)	2.76 (br d, J=12)	2.92 (dd, J=12, 4)	3.24 (br d, J=10)
10[b]		(4%)	(11%)	(3%)	(0%)	(18%)
13	1β,2α	4.79 (br s)	2.46—2.26 (m)	2.64 (br d, J=12)	2.98—2.80 (m)	3.35 (br d, J=10)
30	1β,2α	4.32 (br s)	2.02 (m)	2.49 (br d, J=11)	2.63 (dd, J=11, 4)	2.97 (br d, J=11)
30[b]		(10%)	(13%)	(4%)	(0%)	(14%)
16	1β,2β	5.08 (br s)	2.66 (m)	2.82 (br dd, J=11, 3)	2.51 (t, J=11)	3.17 (br d, J=10)
18	1β,2β	4.91 (br s)	2.55—2.30 (m)	2.70 (m)	2.55—2.30 (m)	3.19 (br d, J=10)

a) In 1β,2α- (**10**, **13**, and **30**) and 1β,2β-disubstituted compounds (**16** and **18**), a long-range W-shaped coupling between 1-H and 3-H_{eq} was observed. *b*) The NOE values observed on saturation of the 2α-substituent group.



3 : R=CH_2OAc
7 : R=Me

9

10 : R=CH_2OAc
13 : R=Me

11 : R=CH_2OAc
12 : R=CH_2OH
14 : R=Me

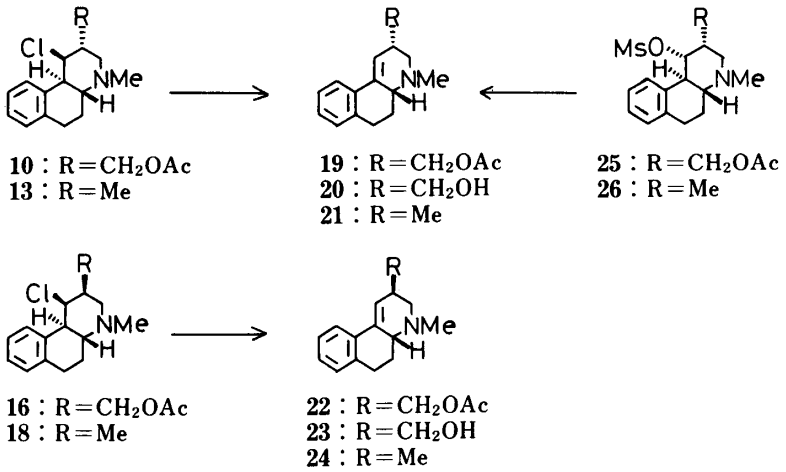
4 : R=CH_2OAc
8 : R=Me

15 : R=CH_2OAc
17 : R=Me

16 : R=CH_2OAc
18 : R=Me

Chart 3

susceptible to the attack of a chloride anion from the β-side to form the thermodynamically stable 1β-chlorides (**10**, **13**, **16**, and **18**, respectively) preferentially. On the other hand, attack from the α-side seems to be less favored due to the steric congestion between the 10-hydrogen and the 1α-chlorine group in the 1α-chlorides (**9**, **15**, and **17**) thus formed, so that the 1α-chlorides are obtained only as minor products. The formation of the dehydrated products (**11** and **14**) can be explained as follows; under the above reaction conditions, a reactive intermediate would exist mostly in the stable chair form (A) in equilibrium with the less favored and unstable boat form (B) as shown in Fig. 1. This less favored boat form (B) accounts for the formation of **11** and **14** in only poor yields as a result of *trans*-diaxial elimination of the 1-hydroxyl group and 2-hydrogen. As expected, base treatment of the 1β-chlorides (**10**, **13**, **16**, and **18**) with 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) gave the desired 1,10b-unsaturated derivatives (**19**, **21**, **22**, and **24**) in good yields as a result of *E*2-type elimination between 1β-axially oriented chloride and the more reactive benzylic 10b-hydrogen rather than hydrogen at the 2-position. Since these two acetates (**19** and **22**) were readily hydrolyzed to give the alcohols (**20** and **23**), which correspond to the despyrrole analogues of isolysergol and lysergol, a general synthetic route to the parent alkaloids is now established. On the other hand, the 1α-chlorides (**9**, **15**, and **17**) were too stable to DBU treatment to give any product, and were recovered unchanged.



10 : R=CH_2OAc
13 : R=Me

19 : R=CH_2OAc
20 : R=CH_2OH
21 : R=Me

25 : R=CH_2OAc
26 : R=Me

16 : R=CH_2OAc
18 : R=Me

22 : R=CH_2OAc
23 : R=CH_2OH
24 : R=Me

Chart 4

The 1,10b-unsaturated compounds (**20** and **21**) were more conveniently prepared from the 2α-substituted 1α-alcohols (**3** and **7**) *via* *E*1*cb*-type elimination of the corresponding mesylates (**25** and **26**). The monoacetate (**3**) and the methyl compound (**7**) were mesylated at room temperature to give the corresponding 2α-mesylates (**25** and **26**) in good yields, and these products were treated with potassium *tert*-butoxide in dimethyl sulfoxide (DMSO)[8] to afford the desired 1,10b-unsaturated compounds (**20** and **21**) in 59% and 51% yields, respectively, of which the former (**20**) was formed as a result of hydrolysis by the base employed. These products (**20** and **21**) were identical with the samples prepared by the aforementioned dehydrochlorination of the 1β-chlorides (**10** and **13**). Thus, the selective preparation of the 1,10b-unsaturated compounds by two methods, one *iva* the 1β-chlorides and the other more conveniently *via* the 1α-mesylates, is now established.

Among clavine alkaloids, lysergene has a unique diene structure. As shown above, the susceptibility of the mesyloxy group to elimination on base treatment raises the possibility of synthesizing this diene structure from the dimesylate (**27**), which was prepared by mesylation of the 1,3-*cis*-diol (**1**) at room temperature. As expected, treatment of the dimesylate (**27**) with potassium *tert*-butoxide in DMSO at room temperature gave the diene (**28**) in 55% yield. The ^{1}H-NMR spectrum showed three broad singlets due to olefinic protons at δ 6.84, 5.04, and 4.94 (each 1H), of which the latter two represent hydrogens of the exomethylene group, thus establishing the structure (**28**) as the despyrrole analogue of lysergene. The Birch reduction of the diene (**28**) with sodium in liquid ammonia for 10 min afforded a mixture of two 1,4-adducts (**29** and **14**) in 57% and 16% yields, respectively. The minor product (**14**) was identical with the authentic sample of despyrroloagroclavine prepared as above, while the major product (**29**) was found to correspond to the despyrrole analogue of agroclavine-I[9] from its ^{1}H-NMR spectrum, which shows signals due to one olefinic proton at δ 5.52 and a methyl group on a double bond at δ 1.66 and the presence of a coupling (J=5.5 Hz) between the 4a- and 10b-hydrogens.

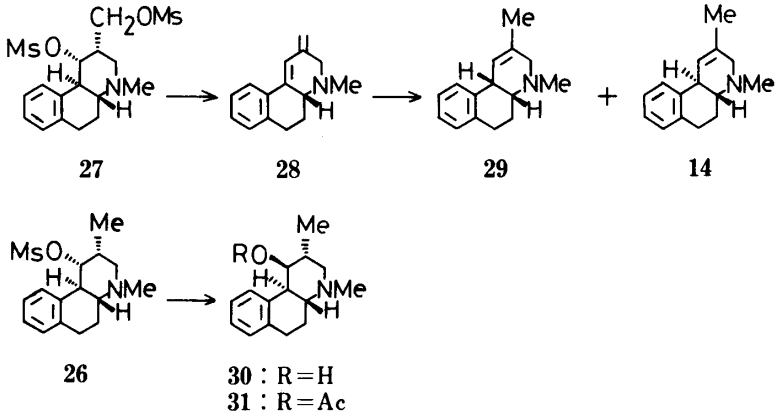


Chart 5

Finally, we have developed a synthetic route for fumigaclavines, which have a 9β-hydroxyl group, *via* a route involving steric inversion of the 1α-hydroxyl group in **7**. Among many methods available in the literature for steric inversion of the hydroxyl group as exemplified by those of Mitsunobu and Eguchi,[10] Mukaiyama and Hojo,[11] and Hanessian and Vatele,[12] as well as methods involving quarternary salts,[13] solvolysis,[14] and potassium superoxide,[15] we picked the method with superoxide, which was recommended for the inversion of sterically hindered hydroxyl groups. Treatment of the 1α-mesylate (**26**) in DMSO with potassium superoxide in the presence of 18-crown-6-ether resulted in smooth inversion of the 1α-mesyloxy group to give the inverted 1β-alcohol (**30**) in 50% yield. The structure of the

TABLE II. ^{1}H-NMR Data (δ; J in Hz) for 1,10b-Unsaturated Compounds (**19**—**24**) in $CDCl_3$ (200 MHz)

	19	**20**	**21**	**22**	**23**	**24**
1-H	6.19 (br d, J=5.5)	6.29 (br d, J=5.5)	6.25, (br d, J=5)	6.13 (br s)	6.24 (br s)	6.16 (br s)
2-H	2.56 (m)	2.60—2.46 (m)	2.52—2.34 (m)	3.06—2.85 (m)	2.90—2.76 (m)	2.74 (m)
3-H_{eq}	2.96—2.82 (m)	3.04—2.88 (m)	2.70—2.53 (m)		3.07 (br dd, J=11, 5)	2.96 (br dd, J=11, 5)
3-H_{ax}	2.46 (dd, J=11, 4)	2.71 (ddd, J=12, 4, 2)		2.14 (t, J=12)	2.21 (dd, J=11, 10)	2.04 (t, J=11)
4a-H	2.74 (br d, J=12)	2.80 (br d, J=13)	2.80 (br d, J=11)	2.75 (br d, J=12)	2.90—2.76 (m)	2.75 (br d, J=11)
5-H_{eq}	2.40 (m)	2.60—2.46 (m)	2.52—2.34 (m)	2.41 (m)	2.42 (m)	2.43 (m)
5-H_{ax}	1.52 (m)	1.60 (m)	1.60 (m)	1.55 (m)	1.60 (m)	1.59 (m)
6-H_2	2.96—2.82 (m)	3.04—2.88 (m)	2.93 (m)	3.06—2.85 (m)	2.93 (m)	2.93 (m)
10-H	7.54 (m)	7.57 (m)	7.56 (m)	7.54 (m)	7.61 (m)	7.60 (m)
Other Ar-H	7.22—7.06 (m)	7.26—7.06 (m)	7.22—7.06 (m)	7.22—7.06 (m)	7.22—7.09 (m)	7.22—7.06 (m)
NMe	2.44 (s)	2.49 (s)	2.49 (s)	2.48 (s)	2.54 (s)	2.50 (s)
2-CH_2R	4.25 (dd, J=11, 5.5)	3.99 (dd, J=10, 3)	1.21 (d, J=7)	4.08 (dd, J=11, 6)	3.69 (dd, J=10, 5.5)	1.04 (d, J=7)
(R=OAc, OH, or H)	4.12 (dd, J=11, 9)	3.82 (dt, J=10, 2)		4.02 (dd, J=11, 6.5)	3.60 (dd, J=10, 6.5)	
OAc	2.07 (s)			2.08 (s)		

1β-alcohol (**30**) was confirmed from the ^{1}H-NMR spectrum, which showed 1-H at δ 4.32 as a broad singlet, as in the case of the 1β-chlorides (**10** and **13**) (Table I).

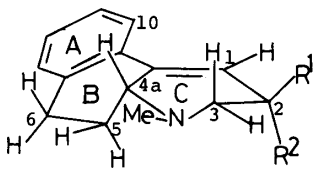
Thus, the synthetic route to the despyrrole analogues (**30** and **31**) of fumigaclavines B and A, the latter of which corresponds to the acetate of fumigaclavine B, was established. It was also found that the previous assignment[16] of the ^{1}H-NMR signals of fumigaclavine B required revision.

In conclusion, synthetic methodology for most of the hitherto unobtainable four types of clavine alkaloids which have 8- and 9-ergolene, diene, and 9β-hydroxyergoline structures, has now been established by using the *cis*- (**1**) and *trans*-1,3-diols (**2**) as common key intermediates.

Stereochemical Study of 1,10b-Unsaturated Benzo[*f*]quinolines

The successful syntheses of a group of benzo[*f*]quinolines as model compounds of ergot alkaloids have led us to carry out a systematic study on the stereochemistry of despyrrole analogues of clavine alkaloids, particularly the 1,10b-unsaturated benzo[*f*]quinolines related to the 9-ergolene type of alkaloids, whose ^{1}H-NMR spectra have not been thoroughly studied,[1,17,18] except for the 9-ergolenes bearing a carbonyl group at the 8-position.

The ^{1}H-NMR spectral data for the 1,10b-unsaturated benzo[*f*]quinolines (**19**—**24**) are summarized in Table II. As a result of the decoupling experiments, W-shaped long-range coupling between hydrogen at the 1-position and an equatorial hydrogen at the 3-position was found, in addition to an allylic coupling between the hydrogens at the 1- and 4a-positions, in all compound (**19**—**24**). These ^{1}H-NMR data, particularly the chemical shifts of hydrogens at the 4a-position which have almost identical values in all the compounds (**19**—**24**), also suggest that these compounds exist in the same half-chair conformation.



19: R^1=H, R^2=CH_2OAc
20: R^1=H, R^2=CH_2OH
21: R^1=H, R^2=Me
22: R^1=CH_2OAc, R^2=H
23: R^1=CH_2OH, R^2=H
24: R^1=Me, R^2=H

Fig. 2

In compounds (**19**—**21**) which have a substituent in a 2α-configuration, the signal of the olefinic proton at the 1-position was found to be coupled with hydrogen at the 2-position with a J value of 5—5.5 Hz, and there was coupling between the hydrogens at the 3_{ax}- and 2-positions (J=4 Hz), suggesting that the substituent at the 2-position is in a *quasi*-axial orientation. On the other hand, compounds (**22**—**24**) which have a 2β-substituent exhibited the olefinic proton signal as a broad singlet and there was coupling of 10—12 Hz between the hydrogens at the 3_{ax}- and 2-positions, suggesting that the 2-substituent is in a *quasi*-equatorial configuration. The above spectral evidence shows conclusively that all the compounds (**19**—**24**) take the same conformation except for the configuration of the 2-substituent, as shown in Fig. 2. This is consistent with the results observed on the previously reported[18] 9-ergolene derivatives with a carbonyl group at the 8-position, thus providing important information for determining the conformation of benzo[*f*]quinolines and clavine alkaloids.

Experimental

The ^{1}H-NMR spectra were measured with JEOL PMX-60 and Varian XL-200 instruments for solutions in deuteriochloroform (tetramethylsilane as internal reference). The NOE values were calculated from the NOE differential spectra in which the control spectrum with the decoupler off-resonance was subtracted from the spectrum after signal saturation. The decoupler was cycled through a series of 4 frequencies at a given signal during the saturation period. Infrared (IR) spectra were measured with a Hitachi 215 spectrophotometer for solutions in

chloroform and mass spectra (MS) with a Hitachi M-80 machine. All melting points were determined with a Kofler-type hot-stage apparatus. Extracts from the reaction mixtures were dried over anhydrous sodium sulfate.

Only the ^{1}H-NMR data not listed in Tables I and II are described below.

***rel*-(1*S*,2*S*,4a*R*,10b*R*)-2-Acetoxymethyl-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinolin-1-ol (3)**——Acetic anhydride (0.4 ml) was added dropwise to a stirred solution of the *cis*-1,3-diol (**1**)[5] (300 mg) in pyridine (4 ml) under ice-cooling, and the mixture was stirred at 0 °C for a further 4 h. Then 10% aqueous sodium carbonate was added and the mixture was extracted with methylene dichloride. The extract was washed with water, dried, and evaporated to give a residue, which was chromatographed on silica gel. Elution with chloroform gave *rel*-(1*S*,2*S*,4a*R*,10b*R*)-1-acetoxy-2-acetoxymethyl-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinoline (8 mg, 7%), mp 109—110 °C [colorless needles from ether–light petroleum (bp 30—60 °C)]. IR: 1730 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.24—6.98 (4H, m, Ar-H), 5.34 (1H, dd, J=10, 6 Hz, 1-H), 4.52 (1H, dd, J=12, 8 Hz, CH_2OAc), 4.45 (1H, dd, J=12, 6 Hz, CH_2OAc), 2.97 (1H, dd, J=12, 3 Hz, 3-H_{eq}), 2.83 (1H, t, J=10 Hz, 10b-H), 2.78 (2H, m, 6-H_2), 2.60 (1H, m, 2-H), 2.26 (1H, dd, J=12, 3 Hz, 3-H_{ax}), 2.22 (3H, s, NMe), 2.13 and 2.08 (each 3H, s, OAc × 2), 2.02 (1H, m, 5-H_{eq}), 1.88—1.66 (2H, m, 4a-H and 5-H_{ax}). *Anal.* Calcd for $C_{19}H_{25}NO_4$: C, 68.86; H, 7.60; N, 4.23. Found: C, 68.78; H, 7.60; N, 4.32. Elution with chloroform–methanol (98 : 2, v/v) gave the monoacetate (**3**) (268 mg, 77%), mp 96—97 °C (colorless crystals from ether). IR: 3450 (OH), 1730 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.71 (1H, br d, J=8 Hz, 10-H), 7.30—7.10 (3H, m, 7—9-H), 4.70 (1H, dd, J=11, 5 Hz, CH_2OAc), 4.50 (1H, dd, J=11, 7.5 Hz, CH_2OAc), 2.78 (2H, m, 6-H_2), 2.20 (3H, s, NMe), 2.10 (3H, s, OAc), 2.04 (1H, m, 5-H_{eq}), 1.86—1.60 (2H, m, 4a-H and 5-H_{ax}). *Anal.* Calcd for $C_{17}H_{23}NO_3$: C, 70.56; H, 8.01; N, 4.84. Found: C, 70.36; H, 8.02; N, 4.79. Elution with chloroform–methanol (95 : 5, v/v) afforded the recovered starting material (**1**) (45 mg, 15%).

***rel*-(1*S*,2*R*,4a*R*,10b*R*)-2-Acetoxymethyl-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinolin-1-ol (4)**——A solution of the *trans*-1,3-diol (**2**)[5] (200 mg) and acetic anhydride (0.5 ml) in pyridine (8 ml) was worked up in the same manner as described for the acetylation of **1** to afford the monoacetate (**4**) (212 mg, 91%), mp 141—142 °C (colorless crystals from benzene). IR: 3400 (OH), 1730 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.78 (1H, br d, J=8 Hz, 10-H), 7.26—7.10 (3H, m, 7—9-H), 4.46 (1H, dd, J=11, 5 Hz, CH_2OAc), 4.25 (1H, dd, J=11, 3 Hz, CH_2OAc), 2.90—2.78 (2H, m, 6-H_2), 2.31 (3H, s, NMe), 2.12 (3H, s, OAc), 2.20—2.16 (1H, m, 5-H_{eq}), 1.88—1.66 (2H, m, 4a-H and 5-H_{ax}). *Anal.* Calcd for $C_{17}H_{23}NO_3$: C, 70.56; H, 8.01; N, 4.84. Found: C, 70.51; H, 8.04; N, 4.93.

General Procedure for Mesylation of Alcohols (1, 2, 3, and 7) with Mesyl Chloride; *rel*-(1*S*,2*S*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-2-mesyloxymethyl-4-methylbenzo[*f*]quinolin-1-ol (5)——Mesyl chloride (0.2 ml) was added dropwise to a stirred solution of the *cis*-1,3-diol (**1**) (100 mg) in pyridine (2 ml) under ice cooling, and the mixture was stirred for a further 1 h. Then 10% aqueous ammonium hydroxide was added, and the mixture was extracted with methylene dichloride. The extract was washed with water, dried, and evaporated to give a solid, which was recrystallized from ethyl acetate to afford the monomesylate (**5**) (125 mg, 95%) as colorless crystals, mp 116.5—119 °C. IR: 3350 (OH), 1365 (OMs), 1330, 1170 cm^{-1}. ^{1}H-NMR δ: 7.52 (1H, m, 10-H), 7.30—7.00 (3H, m, 7—9-H), 4.72 (2H, m, CH_2OMs), 4.23 (1H, dd, J=10, 5 Hz, 1-H), 3.02 (3H, s, OMs), 2.20 (3H, s, NMe). *Anal.* Calcd for $C_{16}H_{23}NO_4S$: C, 59.06; H, 7.12; N, 4.30. Found: C, 59.18; H, 7.18; N, 4.21.

The mesylates (**6** and **25**—**27**) were prepared under similar conditions.

rel-(1*S*,2*R*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-2-mesyloxymethyl-4-methylbenzo[*f*]quinolin-1-ol (**6**): Stirred under ice cooling (87% from **2**), mp 161—163 °C (colorless crystals from methylene dichloride–ether). IR: 3350 (OH), 1360 (OMs), 1352, 1170 cm^{-1}. ^{1}H-NMR δ: 7.63 (1H, m, 10-H), 7.27—7.00 (3H, m, 7—9-H), 4.42 (2H, m, CH_2OMs), 3.83 (1H, t, J=10 Hz, 1-H), 3.02 (3H, s, OMs), 2.28 (3H, s, NMe). *Anal.* Calcd for $C_{16}H_{23}NO_4S \cdot 1/3H_2O$: C, 57.98; H, 7.20; N, 4.23. Found: C, 57.99; H, 7.02; N, 4.19.

rel-(1*S*,2*S*,4a*R*,10b*R*)-2-Acetoxymethyl-1,2,3,4,4a,5,6,10b-octahydro-1-mesyloxy-4-methylbenzo[*f*]quinoline (**25**): Stirred at room temperature (77% from **3**), mp 108.5—111 °C (colorless crystals from ethyl acetate). IR: 1735 (OAc), 1365 (OMs), 1340, 1170 cm^{-1}. ^{1}H-NMR δ: 7.50—6.95 (4H, m, Ar-H), 5.23 (1H, dd, J=11, 6 Hz, 1-H), 4.53 (2H, m, CH_2OAc), 3.05 (3H, s, OMs), 2.20 (3H, s, NMe), 2.07 (3H, s, OAc). *Anal.* Calcd for $C_{18}H_{25}NO_5S$: C, 58.54; H, 6.86; N, 3.81. Found: C, 58.54; H, 6.87; N, 3.75.

rel-(1*R*,2*R*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-1-mesyloxy-2,4-dimethylbenzo[*f*]quinoline (**26**): Stirred at room temperature (80% from **7**), mp 97—98 °C (colorless needless from ether). IR: 1340 (OMs), 1330, 1170 cm^{-1}. ^{1}H-NMR δ: 7.35—7.07 (4H, m, Ar-H), 5.18 (1H, dd, J=10, 5 Hz, 1-H), 2.95 (3H, s, OMs), 2.13 (3H, s, NMe), 1.33 (3H, d, J=7 Hz, CMe). *Anal.* Calcd for $C_{16}H_{23}NO_3S$: C, 62.11; H, 7.49; N, 4.53. Found: C, 62.03; H, 7.50; N, 4.70.

rel-(1*S*,2*S*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-1-mesyloxy-2-mesyloxymethyl-4-methylbenzo[*f*]quinoline (**27**): Stirred at room temperature (95% from **1**), mp 120—122 °C (colorless crystals from ethyl acetate). IR: 1360 (OMs), 1340, 1170 cm^{-1}. ^{1}H-NMR δ: 7.30—7.00 (4H, m, Ar-H), 5.28 (1H, dd, J=10, 5 Hz, 1-H), 4.70 (2H, m, CH_2OMs), 3.03 (6H, s, OMs × 2), 2.20 (3H, s, NMe). *Anal.* Calcd for $C_{17}H_{25}NO_6S_2$: C, 50.60; H, 6.24; N, 3.47. Found: C, 50.51; H, 6.14; N, 3.32.

***rel*-(1*R*,2*R*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-2,4-dimethylbenzo[*f*]quinolin-1-ol (7)**——Lithium aluminum hydride (500 mg) was added in small portions to an ice-cooled solution of the monomesylate (**5**) (531 mg) in anhydrous tetrahydrofuran (THF) (200 ml). The mixture was refluxed for 1 h. Usual work-up afforded the crude product, which was chromatographed on silica gel. Elution with chloroform–methanol (98 : 2, v/v) gave the 2-methyl-

1-ol (**7**) (259 mg, 69%), mp 97.5—98.5 °C [colorless needles from ether–light petroleum (bp 30—60 °C)]. IR: 3400 (OH) cm^{-1}. ^{1}H-NMR δ: 7.76 (1H, br d, J=8 Hz, 10-H), 7.28—7.10 (3H, m, 7—9-H), 2.84—2.70 (2H, m, 6-H_2), 2.22 (3H, s, NMe), 2.04 (1H, m, 5-H_{eq}), 1.90—1.58 (2H, m, 4a-H and 5-H_{ax}), 1.27 (3H, d, J=7 Hz, CMe). *Anal.* Calcd for $C_{15}H_{21}NO$: C, 77.88; H, 9.15; N, 6.05. Found: C, 77.75; H, 9.28; N, 5.98. Elution with chloroform–methanol (97 : 3, v/v) gave the *cis*-1,3-diol (**1**) (81 mg, 20%).

***rel*-(1*R*,2*S*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-2,4-dimethylbenzo[*f*]quinolin-1-ol (Despyrroloisofumigaclavine B) (8)**——Reduction of the monomesylate (**6**) (150 mg) with lithium aluminum hydride (90 mg) in anhydrous THF (80 ml) in the same manner as described the reduction of **5** afforded a solid, which was separated by preparative thin layer chromatography (p-TLC) on silica gel [methylene dichloride–methanol (83 : 17, v/v) as an eluant] to give a mixture of the 2β-methyl-1α-ol (**8**) (91 mg, 85%), and the *trans*-1,3-diol (**2**) (8 mg, 7%), which were isolated and shown to be identical with corresponding authentic samples.[5]

Treatment of the Alcohol (3) with $POCl_3$–H_3PO_4 in Pyridine——A solution of the alcohol (**3**) (30 mg), 85% phosphoric acid (0.01 ml), and phosphoryl trichloride (0.15 ml) in anhydrous pyridine (1 ml) was warmed at 80 °C under a nitrogen stream for 1 h. The reaction mixture was poured into ice–water, acidified with 10% hydrochloric acid, and washed with ether. The aqueous layer was made alkaline with sodium carbonate and extracted with benzene. The extract was washed with water, dried, and evaporated to give a residue. Separation of the crude product by p-TLC on silica gel [chloroform–methanol (94 : 6, v/v) as an eluant] afforded *rel*-(1*S*,2*S*,4a*R*,10b*R*)-2-acetoxymethyl-1-chloro-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinoline (**9**) (10 mg, 31%) and *rel*-(1*R*,2*S*,4a*R*,10b*R*)-2-acetoxymethyl-1-chloro-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinoline (**10**) (5 mg, 16%). **9**: mp 140—143 °C (colorless crystals from ether). IR: 1735 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.54 (1H, br d, J=8 Hz, 10-H), 7.30—7.10 (3H, m, 7—9-H), 4.70—4.64 (2H, m, CH_2OAc), 2.90—2.72 (2H, m, 6-H_2), 2.18 (3H, s, NMe), 2.10 (3H, s, OAc), 2.04—1.74 (2H, m, 4a-H and 5-H_{eq}), 1.72—1.56 (1H, m, 5-H_{ax}). *Anal.* Calcd for $C_{17}H_{22}ClNO_2 \cdot 3/7H_2O$: C, 64.71; H, 7.30; N, 4.44. Found: C, 64.77; H, 7.20; N, 4.45. **10**: mp 88—89 °C (colorless crystals from methanol). IR: 1740 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.30—7.04 (4H, m, Ar-H), 4.46—4.40 (2H, m, CH_2OAc), 2.87 (2H, m, 6-H_2), 2.50 (1H, br t, J=10 Hz, 4a-H), 2.36 (3H, s, NMe), 2.34 (1H, m, 5-H_{eq}), 2.12 (3H, s, OAc), 1.55 (1H, m, 5-H_{ax}). *Anal.* Calcd for $C_{17}H_{22}ClNO_2$: C, 66.33; H, 7.20; N, 4.55. Found: C, 66.34; H, 7.41; N, 4.47.

General Procedure for Chlorination of the Alcohols (3, 4, 7, and 8) with Thionyl Chloride; Chlorination of the Alcohol (3)——Thionyl chloride (4 ml) was added dropwise to a stirred, ice-cooled solution of the alcohol (**3**) (100 mg) in benzene (20 ml), and the mixture was then refluxed for 1.5 h. The excess of thionyl chloride and the solvent were removed under reduced pressure. Then 10% aqueous sodium carbonate was added to the residue, and the solution was extracted with methylene dichloride. The organic layer was washed with water, dried, and evaporated to give the crude product, which was separated by p-TLC on silica gel [methylene dichloride–methanol (95 : 5, v/v) as an eluant] to afford the 1β-chloride (**10**) (74 mg, 69%), which was identical with the product obtained above, and *rel*-(4a*R*,10b*R*)-2-acetoxymethyl-3,4,4a,5,6,10b-hexahydro-4-methylbenzo[*f*]quinoline (**11**) (20 mg, 21%) as an unstable oil. IR: 1730 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.36 (1H, br d, J=8 Hz, 10-H), 7.28—7.10 (3H, m, 7—9-H), 6.42 (1H, br s, 1-H), 4.63 and 4.56 (2H, ABq, J=12 Hz, CH_2OAc), 3.48 (1H, m, 10b-H), 3.39 (1H, br d, J=14 Hz, 3-H_{eq}), 3.04—2.90 (3H, m, 3-H_{ax} and 6-H_2), 2.44 (3H, s, NMe), 2.40—2.16 (2H, m, 4a-H and 5-H_{eq}), 2.09 (3H, s, OAc), 1.74 (1H, m, 5-H_{ax}). High-resolution MS m/z: 271.1571 Calcd for $C_{17}H_{21}NO_2$ (M^+). Found: 271.1580. The alcohols (**4**, **7**, and **8**) were similarly treated under identical conditions.

rel-(1*S*,2*R*,4a*R*,10b*R*)-1-Chloro-1,2,3,4,4a,5,6,10b-octahydro-2,4-dimethylbenzo[*f*]quinoline (**13**): (31% from **7**), mp 97—98 °C (colorless crystals from *n*-hexane). ^{1}H-NMR δ: 7.30—7.06 (4H, m, Ar-H), 2.98—2.80 (2H, m, 6-H_2), 2.50 (1H, td, J=10, 3 Hz, 4a-H), 2.40 (3H, s, NMe), 2.46—2.26 (1H, m, 5-H_{eq}), 1.60 (1H, m, 5-H_{ax}), 1.39 (3H, d, J=7 Hz, CMe). *Anal.* Calcd for $C_{15}H_{20}ClN$: C, 72.13; H, 8.07; N, 5.61. Found: C, 72.02; H, 7.98; N, 5.69.

rel-(4a*R*,10b*R*)-3,4,4a,5,6,10b-Hexahydro-2,4-dimethylbenzo[*f*]quinoline (**14**): (32% from **7**), as an unstable oil. ^{1}H-NMR δ: 7.40 (1H, m, 10-H), 7.18 (3H, m, 7—9-H), 6.06 (1H, br s, 1-H), 3.39 (1H, br d, J=11 Hz, 10b-H), 3.23 (1H, br d, J=16 Hz, 3-H_{eq}), 2.97 (2H, m, 6-H_2), 2.83 (1H, br d, J=16 Hz, 3-H_{ax}), 2.40 (3H, s, NMe), 2.26 (1H, m, 5-H_{eq}), 2.13 (1H, td, J=11, 4 Hz, 4a-H), 1.76 (3H, br s, CMe), 1.72 (1H, m, 5-H_{ax}). This compound was identical with an authentic sample.[19]

rel-(1*S*,2*R*,4a*R*,10b*R*)-2-Acetoxymethyl-1-chloro-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinoline (**15**): (31% from **4**), mp 86—87 °C (colorless crystals from ether). IR: 1735 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.56 (1H, br d, J=8 Hz, 10-H), 7.34—7.14 (3H, m, 7—9-H), 4.52 (1H, dd, J=11, 3 Hz, CH_2OAc), 4.32 (1H, dd, J=11, 6 Hz, CH_2OAc), 3.00—2.88 (1H, m, 6-H_{eq}), 2.77 (1H, ddd, J=15, 8, 2.5 Hz, 6-H_{ax}), 2.29 (3H, s, NMe), 2.12 (3H, s, OAc), 2.10—1.68 (3H, m, 4a-H and 5-H_2). *Anal.* Calcd for $C_{17}H_{22}ClNO_2$: C, 66.33; H, 7.20; N, 4.55. Found: C, 66.37; H, 7.21; N, 4.75.

rel-(1*R*,2*R*,4a*R*,10b*R*)-2-Acetoxymethyl-1-chloro-1,2,3,4,4a,5,6,10b-octahydro-4-methylbenzo[*f*]quinoline (**16**): (61% from **4**), mp 104—105 °C (colorless crystals from ether). IR: 1740 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.36—7.10 (4H, m, Ar-H), 4.25 (1H, dd, J=11, 7 Hz, CH_2OAc), 4.10 (1H, dd, J=11, 6 Hz, CH_2OAc), 2.90 (2H, m, 6-H_2), 2.56 (1H, m, 4a-H), 2.46 (3H, s, NMe), 2.38 (1H, m, 5-H_{eq}), 2.13 (3H, s, OAc), 1.57 (1H, m, 5-H_{ax}). *Anal.* Calcd for $C_{17}H_{22}ClNO_2$: C, 66.33; H, 7.20; N, 4.55. Found: C, 66.62; H, 7.36; N, 4.62.

rel-(1*R*,2*S*,4a*R*,10b*R*)-1-Chloro-1,2,3,4,4a,5,6,10b-octahydro-2,4-dimethylbenzo[*f*]quinoline (**17**): (34% from **8**), as an oil. ^{1}H-NMR δ: 7.53 (1H, br d, J=8 Hz, 10-H), 7.32—7.10 (3H, m, 7—9-H), 2.84—2.79 (1H, m, 6-H_{eq}), 2.72 (1H, ddd, J=15, 8, 2.5 Hz, 6-H_{ax}), 2.24 (3H, s, NMe), 2.12—1.66 (2H, m, 4a-H and 5-H), 1.21 (3H, d, J=7 Hz, CMe). High-resolution MS *m/z*: 249.1282 Calcd for $C_{15}H_{23}NCl$ (M^+). Found: 249.1278.

rel-(1*S*,2*S*,4a*R*,10b*R*)-1-Chloro-1,2,3,4,4a,5,6,10b-octahydro-2,4-dimethylbenzo[*f*]quinoline (**18**): (57% from **8**), mp 90—91 °C (colorless crystals from ether). ^{1}H-NMR; 7.34—7.08 (4H, m, Ar-H), 2.89 (2H, m, 6-H_2), 2.56 (1H, ddd, J=12, 10, 3 Hz, 4a-H), 2.55—2.30 (1H, m, 5-H_{eq}), 2.44 (3H, s, NMe), 1.58 (1H, m, 5-H_{ax}), 1.12 (3H, d, J=7 Hz, CMe). *Anal.* Calcd for $C_{15}H_{20}NCl$: C, 72.13; H, 8.07; N, 5.61. Found: C, 71.85; H, 8.09; N, 5.58.

***rel*-(4a*R*,10b*R*)-3,4,4a,5,6,10b-Hexahydro-4-methyl-2-benzo[*f*]quinolinemethanol (Despyrroloelymoclavine) (12)**——A solution of the acetate (**11**) (18 mg) in methanol (2 ml) containing conc. HCl (0.2 ml) was refluxed under a nitrogen stream for 1 h. The reaction mixture was concentrated to a small volume and then diluted with water, and washed with benzene. The aqueous layer was made alkaline with 10% aqueous sodium carbonate and extracted with methylene dichloride. The extract was washed with water, dried, and evaporated to give a solid, which was recrystallized from ethyl acetate to afford the alcohol (**12**) (13 mg, 86%) as colorless crystals mp 128—130 °C. IR: 3375 (OH) cm^{-1}. ^{1}H-NMR δ: 7.38 (1H, m, 10-H), 7.28—7.12 (3H, m, 7—9-H), 6.34 (1H, br s, 1-H), 4.16 and 4.10 (2H, ABq, J=13 Hz, CH_2OH), 3.56—3.40 (2H, m, 10b-H and 3-H_{eq}), 3.04—2.82 (3H, m, 3-H_{ax} and 6-H_2), 2.42 (3H, s, NMe), 2.30 (1H, m, 5-H_{eq}), 2.18 (1H, m, 4a-H), 1.73 (1H, m, 5-H_{ax}). *Anal.* Calcd for $C_{15}H_{19}NO$: C, 78.56; H, 8.35; N, 6.11. Found: C, 78.36; H, 8.24; N, 6.18.

General Procedure for Dehydrochlorination of the Chlorides (10, 13, 16, and 18) with DBU; *rel*-(2*S*,4a*R*)-2-Acetoxymethyl-2,3,4,4a,5,6-hexahydro-4-methylbenzo[*f*]quinoline (19)——A solution of the 1β-chloride (**10**) (59 mg) and DBU (1.1 ml) in benzene (37 ml) was refluxed under a nitrogen stream for 17 h. The reaction mixture was washed with water, dried, and evaporated to give a residue, which was separated by p-TLC on silica gel [methylene dichloride–methanol (92 : 8, v/v) as an eluant] to afford the acetate (**19**) (45 mg, 87%), mp 71—72 °C (colorless crystals from *n*-hexane). IR: 1730 (OAc) cm^{-1}. *Anal.* Calcd for $C_{17}H_{21}NO_2$: C, 75.24: H, 7.80; N, 5.16. Found: C, 74.95; H, 7.82; N, 5.13. Compounds **21**, **22**, and **24** were obtained under similar conditions.

rel-(2*S*,4a*R*)-2,3,4,4a,5,6,-Hexahydro-2,4-dimethylbenzo[*f*]quinoline (despyrroloisolysergine) (**21**): Refluxed for 25 h (54% from **13**), as an oil. High-resolution MS *m/z*: 213.1513 Calcd for $C_{15}H_{19}N$ (M^+). Found: 213.1516. [oxalate: mp 188—190 °C (colorless crystals from ethanol). *Anal.* Calcd for $C_{17}H_{21}NO_4$: C, 67.31; H, 6.98; N, 4.62. Found: C, 67.06; H, 7.00; N, 4.82].

rel-(2*R*,4a*R*)-1-Acetoxymethyl-2,3,4,4a,5,6,-hexahydro-4-methylbenzo[*f*]quinoline (**22**): Refluxed for 8 h (95% from **16**), mp 66—67.5 °C (colorless needles from *n*-hexane). IR: 1740 (OAc) cm^{-1}. *Anal.* Calcd for $C_{17}H_{21}NO$: C, 75.24; H, 7.80; N, 5.16. Found: C, 74.97; H, 7.97; N, 5.31.

rel-(2*R*,4a*R*)-2,3,4,4a,5,6-Hexahydro-2,4-dimethylbenzo[*f*]quinoline (Despyrrololysergine) (**24**): Refluxed for 11.5 h (96% from **18**), mp 51—54 °C (colorless needles from *n*-hexane). *Anal.* Calcd for $C_{15}H_{19}N \cdot 3/5\ H_2O$: C, 80.38; H, 9.08; N, 6.25. Found: C, 80.53; H, 8.95; N, 6.34.

***rel*-(2*S*,4a*R*)-2,3,4,4a,5,6-Hexahydro-4-methyl-2-benzo[*f*]quinolinemethanol (Despyrroloisolysergol) (20)**——A solution of the acetate (**19**) (20 mg) in methanol (2 ml) containing conc. HCl (0.2 ml) was worked up in the same manner as described for **12** to afford the alcohol (**20**) (16 mg, 94%), mp 110—111 °C (colorless crystals from ether). IR: 3275 (OH) cm^{-1}. *Anal.* Calcd for $C_{15}H_{19}NO$: C, 78.56; H, 8.35; N, 6.11. Found: C, 78.30; H, 8.44; N, 6.18.

***rel*-(2*R*,4a*R*)-2,3,4,4a,5,6-Hexahydro-4-methyl-2-benzo[*f*]quinolinemethanol (Despyrrololysergol) (23)**——A solution of the acetate (**22**) (58 mg) in methanol (7 ml) containing conc. HCl (0.7 ml) was worked up in the same manner as described for **12** to afford the alcohol (**23**) (43 mg, 88%), mp 123—125 °C (colorless crystals from methylene dichloride–ether). IR: 3350 (OH) cm^{-1}. *Anal.* Calcd for $C_{15}H_{19}NO$: C, 78.56; H, 8.35; N, 6.11. Found: C, 78.38; H, 8.39; N, 6.20.

General Procedure for the Reaction of the Mesylates (25, 26, and 27) with Potassium *tert*-Butoxide; Despyrroloisolysergol (20)——Potassium *tert*-butoxide (45 mg) was added to a stirred solution of the mesylate (**25**) (30 mg) in DMSO (1 ml) under ice cooling, and the mixture was stirred at room temperature under a nitrogen stream for 2 h. Then water was added, and the mixture was extracted repeatedly with ether. The combined ethereal extracts were washed with brine, dried, and evaporated to give a residue, which was purified by p-TLC on silica gel [methylene dichloride–methanol (94 : 6, v/v) as an eluant] to afford the eliminated product (**20**) (11 mg, 59%), which was identical with the product obtained above. Compounds **21** and **28** were similarly obtained from their respective mesylates (**26** and **27**).

Despyrroloisolysergine (**21**): (51% from **26**). This compound was identical with the product obtained by the treatment of the 1β-chloride (**13**) with DBU.

2,3,4,4a,5,6-Hexahydro-4-methyl-2-methylenebenzo[*f*]quinoline (Despyrrololysergene) (**28**): (55% from **27**), as an oil. ^{1}H-NMR δ: 7.69 (1H, m, 10-H), 7.24—7.12 (3H, m, 7—9-H), 6.84 (1H, br s, 1-H), 5.04 and 4.94 (each 1H, br s, C=CH_2), 3.44 (1H, d, J=13.5 Hz, 3-H_{eq}), 3.14 (1H, br d, J=13.5 Hz, 3-H_{ax}), 2.97 (1H, br d, J=11 Hz, 4a-H), 2.94 (2H, m, 6-H_2), 2.49 (3H, s, NMe), 2.42 (1H, dq, J=12, 4 Hz, 5-H_{eq}), 1.51 (1H, m, 5-H_{ax}). High-resolution MS *m/z*: 211.1359 Calcd for $C_{15}H_{17}N$ (M^+). Found: 211.1351.

Birch Reduction of the Diene (28)——The diene (**28**) (35 mg) in THF (1 ml) was added to liquid ammonia (*ca.*

30 ml), and then sodium (30 mg) was added. The reaction mixture was stirred for 10 min, then excess ammonium chloride was added to stop the reaction. Ammonia was evaporated off and the residue was treated with water. The aqueous layer was extracted with methylene dichloride. The extract was washed with water, dried, and evaporated to give an oil. Separation of the crude product by p-TLC on silica gel [chloroform–methanol (94 : 6, v/v) as an eluant] gave *rel*-(4a*R*,10b*S*)-3,4,4a,5,6,10b-hexahydro-2,4-dimethylbenzo[*f*]quinoline (despyrroloagroclavine-I) (**29**) (20 mg, 57%) as an unstable oil. ^{1}H-NMR δ: 7.30—7.14 (4H, m, Ar-H), 5.52 (1H, br s, 1-H), 3.68 (1H, br, $W_{1/2}$ = 12 Hz, 10b-H), 3.04 (1H, ddd, J = 10.5, 5.5, 3 Hz, 4a-H), 2.96 (2H, br s, 3-H_2), 2.90—2.65 (2H, m, 6-H_2), 2.53 (3H, s, NMe), 1.96—1.64 (2H, m, 5-H_2), 1.66 (3H, br s, CMe). High-resolution MS *m/z*: 213.1534 Calcd for $C_{15}H_{19}N$ (M^+). Found: 213.1536 and despyrroloagroclavine (**14**) (6 mg, 16%), which was identical with the product obtained by the treatment of the alcohol (**7**) with thionyl chloride.

***rel*-(1*S*,2*R*,4a*R*,10b*R*)-1,2,3,4,4a,5,6,10b-Octahydro-2,4-dimethylbenzo[*f*]quinolin-1-ol (Despyrrolofumigaclavine B) (30)**——A solution of the mesylate (**26**) (178 mg) in DMSO (2 ml) was added to a solution of potassium superoxide (150 mg) and 18-crown-6-ether (600 mg) in DMSO (4 ml), and the mixture was stirred vigorously at room temperature for 1 h. Then water was added, and the mixture was extracted repeatedly with ether. The combined extracts were washed with brine, dried, and evaporated to give a residue, which was purified by p-TLC on silica gel [methylene dichloride–methanol (90 : 10, v/v) as an eluant] to afford the alcohol (**30**) (63 mg, 50%), mp 164—165 °C (colorless crystals from ethyl acetate). IR: 3300 (OH) cm^{-1}. ^{1}H-NMR δ: 7.30 (1H, br d, J = 8 Hz, 10-H), 7.20—7.02 (3H, m, 7—9-H), 2.81 (2H, m, 6-H_2), 2.26 (3H, s, NMe), 2.30—2.18 (2H, m, 4a-H and 5-H_{eq}), 1.45 (1H, m, 5-H_{ax}), 1.17 (3H, d, J = 7 Hz, CMe). *Anal.* Calcd for $C_{15}H_{21}NO$: C, 77.88: H, 9.15; N, 6.05. Found: C, 77.89; H, 9.16; N, 6.18.

***rel*-(1*S*,2*R*,4a*R*,10b*R*)-1-Acetoxy-1,2,3,4,4a,5,6,10b-octahydro-2,4-dimethylbenzo[*f*]-quinoline (Despyrrolofumigaclavine A) (31)**——A solution of the alcohol (**30**) (16 mg) and acetic anhydride (0.05 ml) in pyridine (0.3 ml) was kept at room temperature overnight. The resulting solution was worked up in the manner described for **3** to give a residue, which was purified by p-TLC on silica gel [methylene dichloride–methanol (94 : 6, v/v) as an eluant] to afford the acetate (**31**) (18 mg, 95%), mp 81—82 °C (colorless crystals from ether *n*-hexane). IR: 1725 (OAc) cm^{-1}. ^{1}H-NMR δ: 7.22—7.08 (4H, m, Ar-H), 5.54 (1H, t, J = 2 Hz, 1-H), 3.11 (1H, br d, J = 11 Hz, 10b-H), 2.90 (2H, m, 6-H_2), 2.60 (2H, d-like, 3-H_2), 2.38 (3H, s, NMe), 2.44—2.24 (2H, m, 4a-H and 5-H_{eq}), 2.07 (1H, m, 2-H), 1.88 (3H, s, OAc), 1.56 (1H, m, 5-H_{ax}), 1.29 (3H, d, J = 7 Hz, CMe). *Anal.* Calcd for $C_{17}H_{23}NO_2$: C, 74.69; H, 8.48; N, 5.12. Found: C, 74.83; H, 8.69; N, 5.08.

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