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# Alkaloids of *Corydalis incisa* Pers. VI.[1] The Structures of Benzo[*c*]phenanthridine-type Alkaloids, 12-Hydroxycorynoline and 11-Epicorynoline

Genichiro Nonaka and Itsuo Nishioka

*Faculty of Pharmaceutical Sciences, Kyushu University*[2]

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New minor benzo[*c*]phenanthridine-type alkaloids, 12-hydroxycorynoline (I), $C_{21}H_{21}O_6N$, mp 245—246.5°, $[\alpha]_D$ 0°, and 11-epicorynoline (IX), $C_{21}H_{21}O_5N$, mp 195.5—196.5°, $[\alpha]_D$ 0°, along with 6-oxocorynoline (X), were isolated from *Corydalis incisa* Pers. (Papaveraceae). These structures were established by the spectroscopic studies and chemical correlations with the derivatives of corynoline.

We have previously[3] isolated from *Corydalis incisa* Pers. (Papaveraceae) four benzo[*c*]-phenanthridine-type alkaloids, acetylcorynoline, acetylisocorynoline, corynoline and isocorynoline, along with fourteen alkaloids of other types. Further investigations on the alkaloids of this plant have led to the isolation of new minor benzo[*c*]phenanthridine-type alkaloids, 12-hydroxycorynoline and 11-epicorynoline, together with 6-oxocorynoline. This paper concerns the structures of these alkaloids.

12-Hydroxycorynoline (I), colorless prisms, mp 245—246.5°, $[\alpha]_D$ 0° ($CHCl_3$), $C_{21}H_{21}O_6N$, gives almost the same ultraviolet (UV) spectrum ($\lambda_{max}^{MeOH}$ 240, 289 nm) as that of corynoline. Its nuclear magnetic resonance (NMR) spectrum shows the presence of a tertiary methyl group ($\delta$ 1.26), an N-methyl group ($\delta$ 2.17), two methylenedioxy groups ($\delta$ 5.96, 5.98) and four aromatic protons ($\delta$ 6.65—7.10). Compound I shows the hydroxyl absorption band (3300 $cm^{-1}$) on the infrared (IR) spectrum and affords a diacetate (II), mp 198—199°, $C_{25}H_{25}O_8N$, on acetylation with acetic anhydride and pyridine. These spectral and chemical data suggest that I has a benzo[*c*]phenanthridine skeleton in which two hydroxyl groups are present. The locations of the two hydroxyl groups are inferred by the comparative NMR spectral studies on I and corynoline. A signal due to $C_{11}$ proton is observed at $\delta$ 3.95 (I) and $\delta$ 3.92 (corynoline) as a broad multiplet, while a broad multiplet signal ($\delta$ 4.92) in I, assignable to $C_{12}$ proton, is shifted to downfield as compared to that of corynoline ($\delta$ 3.12), suggesting the two hydroxyl groups are located at $C_{11}$ and $C_{12}$. These findings are further confirmed by a direct conversion of corynoline to I.

The Oppenauer oxidation of corynoline with potassium *tert.* butoxide and 9-fluorenone gives a ketone (III), mp 249.5—250.5°, $C_{21}H_{19}O_5N$, which is further oxidized with $SeO_2$ in acetic anhydride to yield a diketone (IV), mp 244—247°, $C_{20}H_{17}O_6N \cdot 1/2H_2O$. On reduction with lithium aluminum hydride followed by chromatography over silica gel, IV yields a glycol which is identified with I by IR, NMR and mass spectral comparison ,and a stereoisomer (V), mp 246.5—247.5°, $C_{21}H_{21}O_6N$,[4] in the ratio of 1:8 (actually, the thin-layer chromatography (TLC) of the reaction product showed four spots, however, two others of them could not be

1) Part V: G. Nonaka and I. Nishioka, *Chem. Pharm. Bull.* (Tokyo), **23**, 294 (1975).
2) Location: *Maidashi, Higashi-ku, Fukuoka.*
3) G. Nonaka, H. Okabe, I. Nishioka, and N. Takao. *Yakugaku Zasshi*, **93**, 87 (1973).
4) The stereostructure of V is characterized by the following chemical and spectral evidences. V forms an acetonide, mp 238—239°, $C_{24}H_{25}O_6N$. On the NMR spectrum of V the signal assignable to $C_{12}$ proton is observed at a higher field ($\delta$ 4.61, $J$=4.5 Hz) than that of I. Since axial protons generally resonate at a higher field than their equatorial counterparts, the $C_{12}$ hydrogen is presumed to have a *quasi* axial configuration. Thus, the structure of V is established to be 12-(*quasi* equatorial)-hydroxycorynoline.

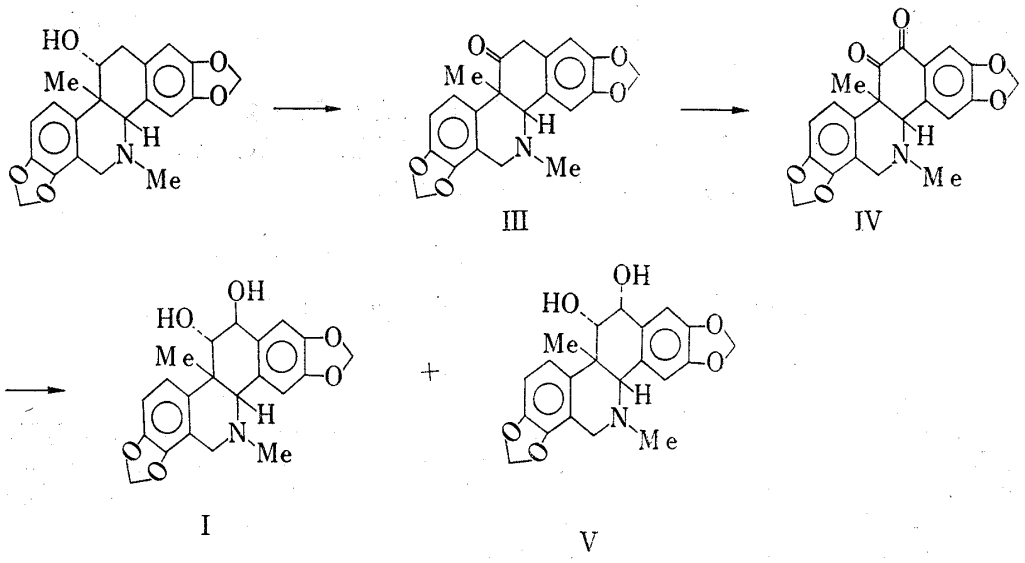



Chart 1

isolated on account of their low yields).

Accordingly, it is concluded that I has an additional hydroxyl group at $C_{12}$ in corynoline.

The relative configuration of a glycol in I is established as follows. On the NMR spectrum of I a small coupling constant ($W_{h/2}$=4 Hz) of $C_{12}$ proton indicates that $C_{11}$ and $C_{12}$ hydrogens have mutually (*quasi*) axial-(*quasi*) equatorial or equatorial-(*quasi*) equatorial configurations. The glycol in I resists to form an acetonide and an epoxide. Oxidation of I with mercuric acetate yields a tertiary base (VI), mp 211—213°, $C_{21}H_{19}O_6N$, leading to the conclusion that the configuration of $C_{11}$ hydroxyl group should be axial. Furthermore, when deoxycorynoline (VII) derived from the dehydration of corynoline with thionyl chloride, is subjected to performic acid oxidation, VII provides I in a good yield, while on the oxidation with osmium tetroxide, VII yields V and a small amount of VIII, mp 227—230°, $C_{21}H_{19}O_6N$, the latter of which is converted to V on lithium aluminum hydride reduction.

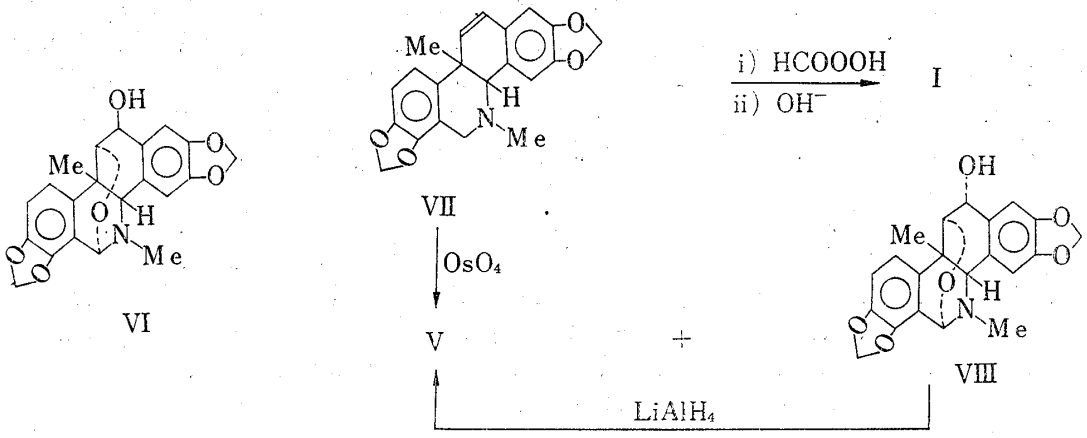



Chart 2

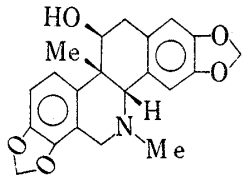
Based upon these chemical and spectral evidences it is demonstrated that I possesses a *trans*-diaxial glycol moiety, and I is characterized to be 12-(*quasi* axial)-hydroxycorynoline.

It is noticed that the chemical shift of $C_{11}$ acetyl protons in II is observed at a higher field ($\delta$ 1.70) as compared to that of a usual acetyl group on the NMR spectrum, being affected by the shielding effect of the benzene ring, and the signal due to a benzylic proton appears as a doublet having a large coupling constant ($\delta$ 5.14, $J$=7.5 Hz). These facts suggest that

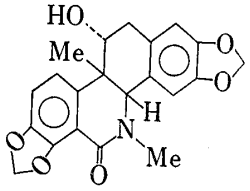
II is forced to change to the *cis*-B/C half chair-half boat conformation on account of the steric interaction between $C_{12}$ acetyl and $C_{13}$ methyl group.[5]

11-Epicorynoline (IX), colorless plates, mp 195.5—196.5°, $[\alpha]_D$ 0° ($CHCl_3$), $C_{21}H_{21}O_5N$, shows characteristic absorption bands due to a benzo[*c*]phenanthridine skeleton on the UV spectrum ($\lambda_{max}^{MeOH}$ 238 (sh.), 290 nm). The mass spectrum of IX exhibits the molecular ion peak at *m/e* 367, and the fragmentation pattern closely resembles to that of corynoline. The IR spectrum exhibits a hydroxyl absorption band (3600 $cm^{-1}$). The NMR spectrum reveals a tertiary methyl singlet ($\delta$ 1.10), an N-methyl singlet ($\delta$ 2.15), two methylenedioxy singlets ($\delta$ 5.92, 5.95), an aromatic singlet ($\delta$ 6.63) corresponding to two protons, and a two proton AB quartet ($\delta$ 6.68, 6.88, $J$=8.0 Hz). Furthermore, the well definite coupling due to ABX system on the NMR spectrum of IX confirms the mono-substituted pattern at $C_{11}$ or $C_{12}$ of the benzo-[*c*]phenanthridine skeleton. The proton corresponding to X portion appeared as a quartet at lower field ($\delta$ 4.52, $J_{BX}$=7.0 Hz, $J_{AB}$=9.5 Hz), is assignable to the hydroxyl bearing methine proton, and AB portions are observed as a pair of quartet ( $\delta$ 2.55, $J_{AX}$=9.5 Hz, $J_{AB}$=17.0 Hz; $\delta$ 3.28, $J_{BX}$=7.0 Hz, $J_{AB}$=17.0 Hz). The alcoholic hydroxyl group in IX resists oxidation with Sarett reagent (chromic anhydride-pyridine complex), Jones reagent (chromic anhydride-sulfuric acid) and active manganese dioxide. However, Oppenauer oxidation using potassium *tert.* butoxide and 9-fluorenone provides a corresponding ketone, mp 247—249°, which is identified as III by the direct comparison (TLC, IR (KBr) spectrum and a mixed melting point).

Consequently, the structure of IX is established to be 11-epicorynoline.




IX




X

6-Oxocorynoline (X), colorless needles, mp 295°<, exhibits absorption bands typical of an amide carbonyl (1640 $cm^{-1}$) and a hydroxyl group (3480 $cm^{-1}$) on the IR spectrum, and gives a closely related NMR spectrum to corynoline, except the extremely low field shift of the N-methyl singlet ($\delta$ 3.47) and the absence of the signal due to two $C_6$ protons. Furthermore, X is derived from acetylcorynoline upon a potassium permanganate oxidation. Thus, the structure of X is established to be 6-oxocorynoline.

The most likely biogenetic relationships among the alkaloids isolated from *Corydalis incisa* Pers., are summerized in Chart 3. Biogenetic studies are currently underway to investigate these.

## Experimental[6]

**12-Hydroxy Corynoline (I)**——Repeated silica gel or alumina chromatography of fraction 4 as described in part I[3] resulted in the isolation (16.5 mg from 49.6 kg of dried herb in the vegetative stage). Colorless prisms ($CHCl_3$–MeOH), mp 245—246.5°, $[\alpha]_D^{17}$ 0° ($c$=0.14, $CHCl_3$). Mass Spectrum: Calcd. for [$M^+$], $C_{21}H_{21}O_6N$: 383.140. Found: 383.137. UV $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$): 240 (3.84), 289 (3.75). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3300 (OH). NMR ($CDCl_3$): 1.26 (3H, s, ≡C–$CH_3$), 2.17 (3H, s, >N–$CH_3$), 2.10—2.60 (1H, broad s, OH), 3.34 (1H, s, Ar–CH–N<), 3.44, 4.07 (2H, ABq, $J$=15.0 Hz, Ar–$CH_2$–N<), 3.92 (1H, broad s, $C_{11}$–H), 4.94 (1H, broad s, $C_{12}$–H), 5.96, 5.98 (each 2H, s, 2 –$OCH_2O$–), 6.65, 7.02 (each 1H, s, aromatic proton), 6.77, 6.98 (each 1H, d, $J$= 8.5 Hz, aromatic proton).

5) S. Naruto, S. Arakawa, H. Kaneko, *Tetrahedron Letters*, **1968**, 1705.
6) Refer to part II (this Bulletin, **21**, 1020 (1973).) for general methods.

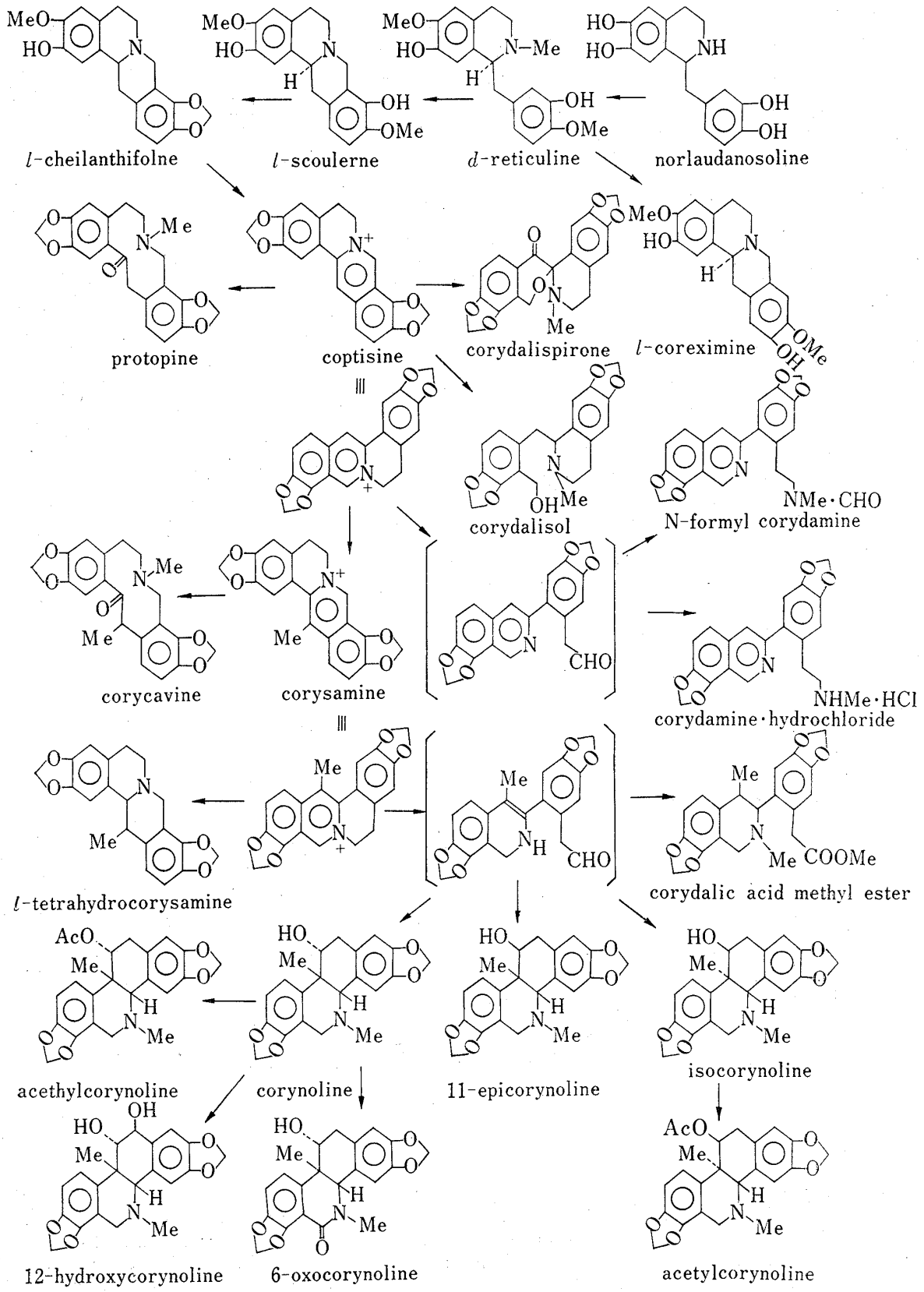



Chart 3. Biogenesis of Alkaloids in *Corydalis incisa* Pers.

**Formation of III from Corynoline**——A mixture of corynoline (1.0 g), potassium *tert.* butoxide (prepared from 0.4 g of potassium and 4.0 g of *tert.* butanol) and 9-fluorenone (3.5 g) in benzene was allowed to stand at room temperature for 1 hr in a $N_2$ atmosphere, and then refluxed for 1 hr. The reaction mixture was extracted with 2% HCl. The acidic layer was neutralized with 28% $NH_4OH$ and extracted with $CHCl_3$. The $CHCl_3$ solution was washed with $H_2O$, dried ($Na_2SO_4$) and evaporated. The residue was recrystallized

from $CHCl_3$–MeOH to give III (0.9 g), colorless needles, mp 249.5—250.5°. *Anal.* Calcd. for $C_{21}H_{19}O_5N$: C, 69.03; H, 5.24; N, 3.73. Found: C, 68.68; H, 5.32; N, 3.63. UV $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$): 289 (3.97). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 1710 (>C=O). NMR ($CDCl_3$): 1.21 (3H, s, ≡C–$CH_3$), 2.10 (3H, s, >N–$CH_3$), 3.28, 4.10 (2H, ABq, $J$=18.0 Hz, Ar–$CH_2$–CO–), 3.25 ,4.03 (2H, ABq, $J$=16.5 Hz, Ar–$CH_2$–N<), 3.26 (1H, s, Ar–CH–N<), 5.95 (2H, q, $J$=1.0 Hz, –$OCH_2O$–), 5.97 (2H, s, –$OCH_2O$–), 6.64, 6.76 (each 1H, s, aromatic proton), 6.79, 7.04 (each 1H, d, $J$=8.0 Hz, aromatic proton).

**Formation of IV from III**——To a solution of III (1.40 g) in acetic anhydride (20 ml) was added $SeO_2$ (0.64 g), and the mixture was heated at 90—100° for 1 hr. Acetic anhydride was decomposed by adding $H_2O$, and the solution was filtered, neutralized with $NH_4OH$ and extracted with ether. The ether layer was washed with $H_2O$, dried ($Na_2SO_4$) and evaporated. The reddish oily residue (0.99 g) was chromatographed over silica gel (50 g, 2.8×17.5 cm). The benzene–AcOEt (9: 1) eluate was recrystallized from $CHCl_3$–MeOH to afford yellow leaflets (IV) (0.37 g); mp 244—247°. *Anal.* Calcd. for $C_{21}H_{17}O_6N \cdot 1/2H_2O$: C, 64.94; H, 4.68; N, 3.68. Found: C, 65.26, 65.37; H, 4.68, 4.52; N, 3.34, 3.36. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 1732, 1680 (C=O). NMR ($CDCl_3$): 1.43 (3H, s, ≡C–$CH_3$), 2.02 (3H, s, >N–$CH_3$), 3.48 (1H, s, Ar–CH–N<), 3.48, 4.06 (2H, ABq, $J$=16.5 Hz, Ar–$CH_2$–N<, 5.96 (2H, q, $J$=1.5 Hz, –$OCH_2O$–), 6.13 (2H, s, –$OCH_2O$–), 6.77, 6.94 (each 1H, *d*, $J$=8.5 Hz, aromatic proton), 6.88, 7.49 (each 1H, s, aromatic proton).

**Formation of I and V from IV**——To a stirred solution of IV (370 mg) in dry tetrahydrofuran (THF) was added $LiAlH_4$ (0.29 g) in dry THF, and the mixture was refluxed for 1 hr. Usual working up gave a mixture which was chromatographed over silica gel (120 g, 3.8×22 cm). The benzene–AcOEt (3: 1) eluate was recrystallized from $CHCl_3$–MeOH to give colorless prisms (V) (325 mg); mp 246.5—247.5°. *Anal.* Calcd. for $C_{21}H_{21}O_6N$: C, 65.78; H, 5.52; N, 3.65. Found: C, 66.06; H, 5.52; N, 3.52. UV $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$): 241 (3.77), 290 (3.68). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3490 (OH). NMR ($CDCl_3$): 1.19 (3H, s, ≡C–$CH_3$), 2.19 (3H, s, >N–$CH_3$), 3.31 (1H, s, Ar–CH–N<), 3.34, 4.09 (2H, ABq, $J$=15.5 Hz, Ar–$CH_2$–N<), 3.92 (1H, *d*, $J$=4.5 Hz, $C_{11}$–H), 4.61 (1H, d, $J$=4.5 Hz, $C_{12}$-H), 5.98 (2H, q, $J$=1.5 Hz, –$OCH_2O$–), 6.00 (2H, s, –$OCH_2O$–), 6.63, 7.23 (each 1H, s, aromatic proton), 6.78, 6.94 (each 1H, d, $J$=8.0 Hz, aromatic proton). Subsequent eluate with benzene–AcOEt (3: 1) was recrystallized from $CHCl_3$–MeOH to afford colorless prisms (39 mg); mp 244—246°. *Anal.* Calcd. for $C_{21}H_{21}O_6N$: C, 65.78; H, 5.52; N, 3.65. Found: C, 65.82; H, 5.24; N, 3.66. This base was identified with 12-hydroxycorynoline by IR (KBr), NMR and mass spectral comparison.

**Acetylation of I**——A mixture of I (100 mg), acetic anhydride (2 ml) and pyridine (2 ml) was allowed to stand overnight at room temperature. The reaction mixture was treated in the usual manner. Recrystallization from $CHCl_3$–MeOH afforded a diacetate (II) (112 mg); colorless prisms, mp 198—199°. *Anal.* Calcd. for $C_{25}H_{25}O_8N$: C, 64.23; H, 5.39; N, 3.00. Found: C, 64.14; H, 5.39; N, 2.99. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 1740, 1728 (OAc). NMR ($CDCl_3$): 1.20 (3H, s, ≡C–$CH_3$), 1.70, 2.14 (each 3H, s, 2×$OCOCH_3$), 2.28 (3H, s, >N–$CH_3$), 3.28 (1H, s, Ar–CH–N<), 3.38, 4.04 (2H, ABq, $J$=16.0 Hz, Ar–$CH_2$–N<), 5.14 (1H, d, $J$=7.5 Hz, $C_{11}$-H), 5.95, 5.97 (each 2H, s, 2×–$OCH_2O$–), 6.41 (1H, d, $J$=7.5 Hz, $C_{12}$-H), 6.64, 6.80 (each 1H, s, aromatic proton), 6.65, 6.86 (each 1H, d, $J$=8.0 Hz, aromatic proton). Mass Spectrum *m/e*: 467 ($M^+$).

**Acetylation of V**——**V** (100 mg) was acetylated with acetic anhydride (2 ml) and pyridine (2 ml) overnight at room temperature. Usual working up gave a diacetate (110 mg); colorless prisms ($CHCl_3$–MeOH), mp 204—205°. *Anal.* Calcd. for $C_{25}H_{25}O_8N$: C, 64.23; H, 5.39; N, 3.00. Found: C, 63.84; H, 5.40; N, 2.97. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 1732 (OAc). NMR ($CDCl_3$): 1.41 (3H, s, ≡C–$CH_3$), 1.81, 2.00 (each 3H, s, 2×–$OCOCH_3$), 2.35 (3H, s, >N–$CH_3$), 3.88 (2H, s, Ar–$CH_2$–N<), 3.90 (1H, s, Ar–CH–N<), 5.62 (1H, d, $J$=3.8 Hz, $C_{11}$-H), 5.94, 5.97 (each 2H, s, 2×–$OCH_2O$–), 6.08 (1H, d, $J$=3.8 Hz, $C_{12}$-H), 6.68, 7.23 (each 1H, s, aromatic proton), 6.66, 6.96 (each 1H, d, $J$=7.5 Hz, aromatic proton). Mass Spectrum *m/e*: 467 ($M^+$).

**Formation of VI**——To a solution of V (110 mg) in 6% acetic acid (5 ml) was added $Hg(OAc)_2$ (200 mg) and the mixture was warmed on a water bath for 2.5 hr. Precipitates were filtered off after cooling, and the filtrate was made alkaline with 28% $NH_4OH$. The alkaline solution was extracted with ether. The ether layer was washed with $H_2O$, dried ($Na_2SO_4$) and evaporated. The residue was crystallized from with MeOH–ether to give colorless prisms (VI) (62 mg); mp 211—213° ($CHCl_3$–MeOH). *Anal.* Calcd. for $C_{21}H_{19}O_6N$: C, 66.13; H, 5.02; N, 3.67. Found: C, 65.90; H, 4.98; N, 3.67. IR $\nu_{max}^{KBr}$ 3440 (OH).

**Formation of I from VII**——To a solution of VII (1.00 g) in 85% formic acid was added performic acid (prepared from 10 ml of 85% formic acid and 1.2 ml of 30% $H_2O_2$), and the mixture was allowed to stand at room temperature for 1 hr. An excess of performic acid was decomposed with $Na_2S_2O_3$, and the solvent was evaporated *in vacuo*. The residue was dissolved in MeOH (14 ml). To this solution was added 20% aq. NaOH solution, and refluxed for 30 min. The precipitates were filtered after cooling, and the filtrate was extracted with $CHCl_3$. The $CHCl_3$ layer was washed with $H_2O$, dried ($Na_2SO_4$) and evaporated. The precipitates and $CHCl_3$ extract were combined, and recrystallized from $CHCl_3$–MeOH to give colorless prisms (820 mg), which was identified with I by the IR (KBr) spectral comparison and mixed melting point determination.

**Formation of V and VIII from VII**——A mixture of VII (349 mg), $OsO_4$ (288 mg) and pyridine (0.5 ml) in dry benzene (6 ml) was allowed to stand in a refrigerator for 5.5 hr. To this reaction mixture was added $Na_2SO_3$ (1.26 g), $H_2O$ (6 ml) and EtOH (6 ml), and heated under reflux for 50 min. The black precipitates were filtered off, washed with EtOH. The filtrate was concentrated *in vacuo*, and extracted with $CHCl_3$. The $CHCl_3$ layer was washed with $H_2O$, dried ($Na_2SO_4$) and evaporated to give an oily residue (376 mg),

which was chromatographed over silica gel (40 g, 15×2.8 cm). The hexane–AcOEt (3:1 to 2:1) eluate gave colorless prisms (215 mg), mp 243—245° ($CHCl_3$–MeOH), which was identical with V by IR (KBr) spectral comparison. The eluate with hexane–AcOEt (1:1 to 0:1) was recrystallized from $CHCl_3$–MeOH to afford colorless prisms (VIII) (39 mg), mp 227—230°. *Anal.* Calcd. for $C_{21}H_{19}O_6N$: N, 3.67. Found: N, 3.59. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3165 (OH). NMR ($CDCl_3$): 1.33 (3H, s, ≡C–$CH_3$), 2.12 (3H, s, >N–$CH_3$), 2.84 (1H, s, $C_{14}$-H), 3.68 (1H, m, $W_{h/2}$=8.0 Hz, $C_{11}$-H), 4.57 (1H, m, $W_{h/2}$=8.0 Hz, $C_{12}$-H), 5.38 (1H, s, Ar–CH–N<), 5.97, 6.02 (each 1H, s, $-OCH_2O-$), 6.61—7.26 (4H, aromatic proton).

**Formation of Acetonide of V**——To a solution of V (158 mg) in acetone (10 ml) was added 70% perchloric acid (5 drops), and the mixture was allowed to stand at room temperature for 8 days. The reaction mixture was diluted with $H_2O$, and made alkaline with 4% aqueous $Na_2CO_3$ solution. The alkaline solution was extracted with $CHCl_3$. The $CHCl_3$ solution was washed, dried ($Na_2SO_4$) and evaporated. The residue was recrystallized from $CHCl_3$–MeOH to give colorless prisms (acetonide of V) (80 mg); mp 238—239°. *Anal.* Calcd. for $C_{24}H_{25}O_6N$: C, 68.07; H, 5.95; N, 3.31. Found: C, 68.08; H, 5.99; N, 3.31.

**11-Epicorynoline (IX)**——This base was separated from the mother liquor produced during the purification of corynoline (73 mg from 35.0 kg of dried herb collected in the reproductive stage). Colorless plates ($CHCl_3$–MeOH), mp 195.5—196.5°, $[\alpha]_D^{17}$ 0° ($c$=0.5, $CHCl_3$). Mass Spectrum: Calcd. for ($M^+$), $C_{21}H_{21}O_5N$: 367.142. Found: 367.142. UV $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$): 238sh. (4.03), 290 (3.95). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3600 (OH). NMR ($CDCl_3$): 1.10 (3H, s, ≡C–$CH_3$), 2.15 (3H, s, >N–$CH_3$), 2.55 (1H, q, $J_{AX}$=9.5 Hz, $J_{AB}$=17.0 Hz, $C_{12}$-H), 3.28 (1H, q, $J_{BX}$=7.0 Hz, $J_{AB}$=17.0 Hz, $C_{12}$-H), 4.52 (1H, q, $J_{BX}$=7.0 Hz, $J_{AX}$=9.5 Hz, $C_{11}$-H), 3.15 (1H, s, Ar–CH–N<), 3.40, 4.02 (2H, ABq, $J$=16.0 Hz, Ar–$CH_2$–N<), 5.92, 5.95 (each 2H, s, 2×$-OCH_2O-$), 6.63 (2H, s, aromatic proton), 6.68, 6.88 (each 1H, d, $J$=8.0 Hz, aromatic proton).

**Formation of III from IX**——A mixture of IX (35 mg), potassium *tert.* butoxide (prepared from 50 mg of potassium and 500 mg of *tert.* butanol) and 9-fluorenone (0.3 g) in benzene was heated under reflux for 1 hr in a $N_2$ atmosphere. The reaction mixture was washed with $H_2O$, and extracted with 2% HCl solution. The acidic solution was neutralized with 10% $NH_4OH$ and extracted with ether. The ether layer was washed, dried ($Na_2SO_4$) and evaporated. A colorless oil (32 mg) was purified by silica gel chromatography (3.0 g, 1×9 cm). The hexane–AcOEt (5:1) eluate afforded colorless prisms ($CHCl_3$–MeOH) (15 mg), mp 247—248°, which was identified with III by IR (KBr) spectral comparison, and shown no depression on mixed melting point determination.

**6-Oxocorynoline (X)**——Fraction 4 obtained from the chromatography of the crude alkaloids mixture as described in part I was repeatedly chromatographed over silica gel using benzene–acetone, AcOEt–acetone and $CHCl_3$–MeOH to yield colorless needles (X) (144 mg) from 49.6 kg of the dried herb in the vegetative period), mp 295°<, IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3490 (OH), 1640 (–CON<). NMR ($CDCl_3$): 1.41 (3H, s, ≡C–$CH_3$), 3.02 (2H, d.d, $J$=9.0 Hz, 1.0 Hz, $C_{12}$-H), 3.47 (3H, s, >N–$CH_3$), 4.16 (1H, t, $J$=9.0 Hz, $C_{11}$-H), 4.05 (1H, s, Ar–CH–N<), 5.85—6.09 (4H, m, 2×$-OCH_2O-$), 6.43, 6.63 (each 1H, s, aromatic proton), 6.76, 7.55 (each 1H, d, $J$=7.0 Hz, aromatic proton).

**Formation of X from Acetylcorynoline**——To a stirred solution of acetylcorynoline (248 mg) in pyridine (30 ml) was gradually added an aqueous 0.5% $KMnO_4$ solution, and the mixture was kept overnight at room temperature. An excess of $KMnO_4$ was decomposed by adding MeOH, and $MnO_2$ was filtered off. The solvent was evaporated *in vacuo* and the residue was extracted with $CHCl_3$. The $CHCl_3$ extract was triturated with MeOH to afford colorless needles, mp 300°<. *Anal.* Calcd. for $C_{21}H_{19}O_6N$: N, 3.67. Found: N, 3.66. The IR (KBr) spectrum and *Rf* value on TLC were identical with X.

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