one of viroallosecurinine,[8] m.p. 135~136°, by the mixed melting point determination and by comparison of Rf values of TLC and retention times of GLC and IR spectra.

The authors are indebted to Dr. M. Makita for GLC analysis, Dr. T. Shingu, Kyoto University, for NMR spectra measurements and Mr. H. Sato, Hitachi Ltd., for mass spectra measurements. They also thank Dr. M. Suzuki, Tanabe Seiyaku Co., Ltd., for helpful discussion.

Summary

The leaves of *Securinega suffruticosa* REHD. furnished three new alkaloids, securinol A, B and C. The structures of securinol A and B were investigated.

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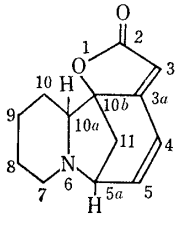
168. Zen-ichi Horii, Yasuhiko Yamawaki, Yasumitsu Tamura,*1 Seiichi Saito, Hiroshi Yoshikawa, and Keishi Kotera*2 : Degradations of Allosecurinine.

(*Faculty of Pharmaceutical Sciences, Osaka University,*[*1] *and Osaka Research Laboratory, Tanabe Seiyaku Co., Ltd.*[*2])

In 1962, Satoda, *et al.*[1] first isolated allosecurinine as a minor alkaloid of *Securinega suffruticosa* REHD. and showed that it is an epimer at C_{10a} of securinine[2~5,6a] (I), a major alkaloid of the same plant. At the almost same time, Parello, *et al.*[4] isolated phyllocrysine (=allosecurinine*[3,6b]) from *Rhyllanthus discoides* and reached independently to the same structural assignment as Satoda, *et al.* did. This structure was further supported by Chatterjee, *et al.*[7] Recent establishment of the absolute stereochemistry[8,9] (II) for



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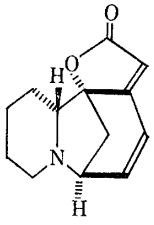

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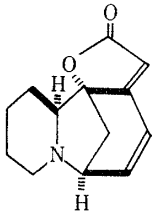

III

*1 Toneyama, Toyonaka, Osaka-fu (堀井善一, 山脇泰彦, 田村恭光).
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*3 Phyllocrysine was shown[10] to be identical with allosecurinine by mixed melting point determination, comparison of their infrared spectra and thin-layer chromatography.

1) I. Satoda, M. Murayama, J. Tsuji, E. Yoshii : Tetrahedron Letters, **1962**, 1199.
2) V. I. Murav'eva, A. I. Ban'kovskii : Doklady Akad. Nauk S. S. S. R., **110**, 998 (1956).
3) *a*) S. Saito, K. Kodera, N. Sugimoto, Z. Horii, Y. Tamura : Chem. & Ind. (London), **1962**, 1652. *b*) S. Saito, K. Kotera, N. Shigematsu, A. Ide, Z. Horii, Y. Tamura : Chem. & Ind. (London), **1963**, 689. *c*) S. Saito, K. Kotera, N. Shigematsu, A. Ide, N. Sugimoto, Z. Horii, M. Hanaoka, Y. Yamawaki, Y. Tamura : Tetrahedron, **19**, 2085 (1963).
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8) Z. Horii, M. Ikeda, Y. Yamawaki, Y. Tamura, S. Saito, K. Kodera : This Bulletin, **11**, 817 (1963); Tetrahedron, **19**, 2101 (1963).
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securinine has shown unambiguously that the absolute stereochemistry[10,11] of allosecurinine should be expressed as Ⅲ.

The present paper describes the degradations of allosecurinine (Ⅲ) leading to tetrahydroallosecurinine (XVⅢ), the N-acetyl amino-lactone (Ⅸ), lactam-carbinol C (XⅢ) and quinolizidine C (XVI), and the syntheses of the last three compounds, providing the definite proof for the relative configuration of allosecurinine (Ⅲ).

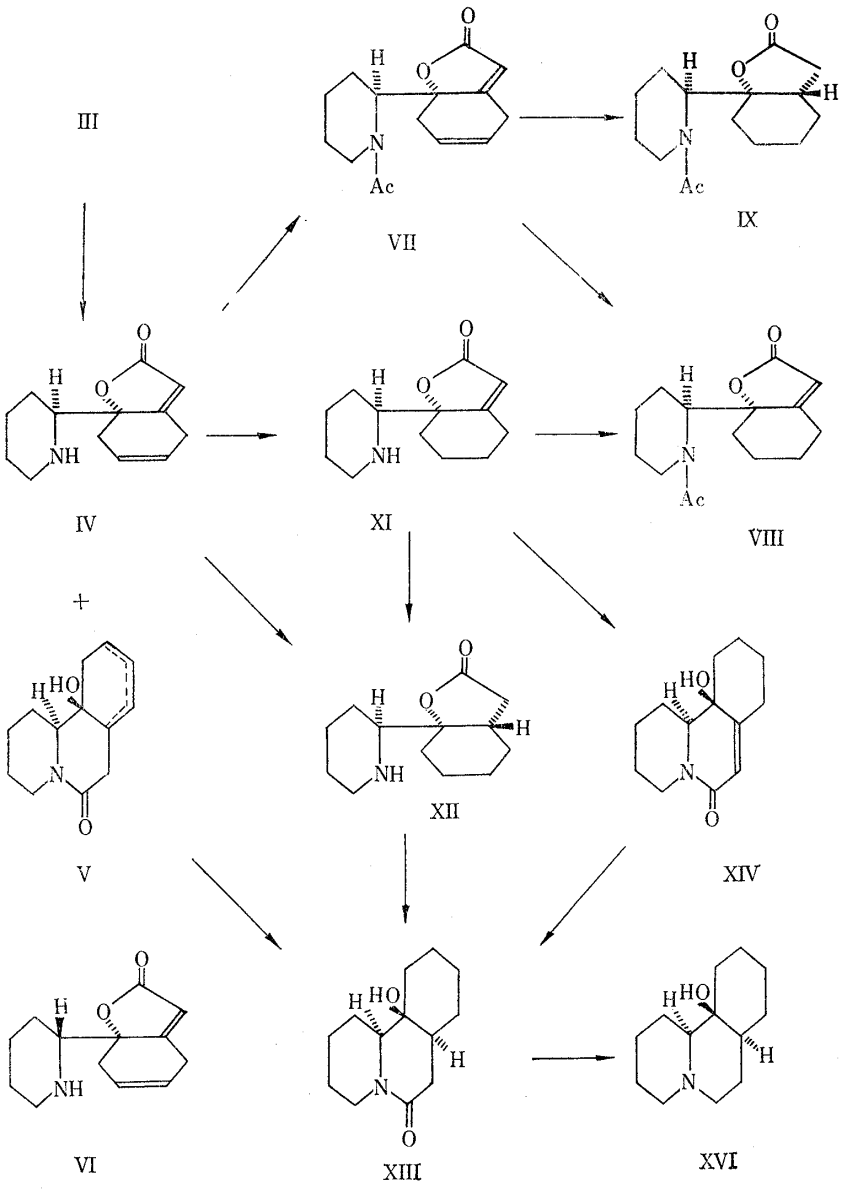


Chart 1.

Reduction of allosecurinine (Ⅲ) with aluminum amalgam in wet ether gave an amino-lactone (Ⅳ), characterized as crystalline salts, accompanied with a small amount of an unsaturated lactam (V), $C_{13}H_{19}O_2N$, m.p. 237~238.5°, unidentified with the unsaturated lactam (XIV) described later. The structure of Ⅳ was suggested from the fact[3c] that a similar reaction of securinine (Ⅱ) gave compound (Ⅵ) as a sole product

10) Z. Horii, M. Ikeda, Y. Tamura, S. Saito, M. Suzuki, K. Kotera: This Bulletin, **12**, 1118 (1964).
11) T. Nakano, T.H. Yang, S. Terao: Chem. & Ind. (London), **1963**, 1034; J. Org. Chem., **29**, 3441 (1964).

and actually confirmed by the ultraviolet and infrared spectra of the hydrochloride [UV : no absorption peak above 220 mμ; IR ν_{max}^{Nujol} cm^{-1} : 1815, 1765 (conj. γ-lactone), 1649, 1630 (double bonds)] and also by the nuclear magnetic resonance spectrum*4 of the acetate (Ⅶ) [NMR τ : 4.2~4.37 (3H, C=C-H), 4.88*5 (1H, N-CH-), 6.7, 6.87, 7.17 and 7.61 (4H, 2C=C-CH_2-), 6.5 (2H, N-CH_2-), 7.98 (3H, N-CO-CH_3)]. Catalytic hydrogenation of the unsaturated lactam (Ⅴ) consumed one molar equivalent of hydrogen to give lactam-carbinol C (XIII), which will be described later. Catalytic hydrogenation of the acetate (Ⅶ) gave a dihydro acetate (Ⅷ) [NMR τ : 4.37 (1H, C=C-H), 4.95*5 (1H, N-CH-), 6.55 (2H, N-CH_2-), 7.25 (2H, C=C-CH_2-), 8.00 (3H, N-CO-CH_3)] and a tetrahydro acetate (Ⅸ), m.p. 80~81.5°. The structure of the tetrahydro acetate (Ⅸ) was proved by the following synthesis of *rac*-Ⅸ (Chart 2).

cis-2-Hydroxy-2-(2-pyridyl)cyclohexaneacetic acid lactone[13] or ethyl *cis*-2-hydroxy-2-(2-pyridyl)cyclohexaneacetate[3c,13] was hydrogenated,[3c,12] acetylated and then chromatographed on alumina-chloroform. The eluate was shown to be a mixture of two components by gas-liquid chromatography, which was separated as described in the experi-

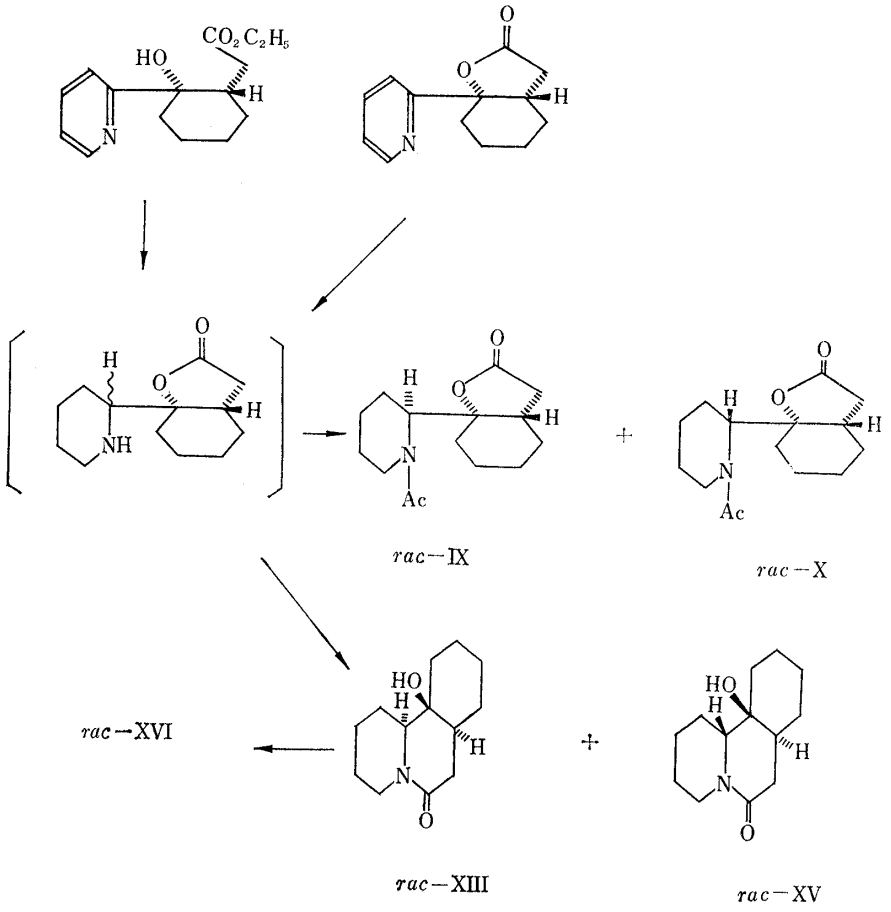
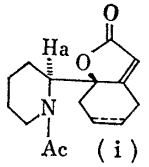


Chart 2.

*4 NMR spectra were measured in deuteriochloroform with tetramethylsilane as an internal reference.

*5 This low-field proton signal was also observed in the NMR spectrum of the corresponding compound (i) in virosecurinine series, and shown to be ascribed most likely to Ha by decoupling method [T. Nakano, T. H. Yang, S. Terao : J. Org. Chem., 28, 2619 (1963)].



(i)

12) Z. Horii, M. Hanaoka, M. Ikeda, Y. Yamawaki, Y. Tamura, S. Saito, N. Shigematsu, K. Kotera : This Bulletin, 13, 27 (1965).

13) Z. Horii, Y. Yamawaki, M. Hanaoka, Y. Tamura, S. Saito, H. Yoshikawa : *Ibid.*, 13, 22 (1965).

mental part to give *rac*-IX, m.p. 90~92°, and the known *rac*-X,[3c] m.p. 143~145°. The former shows an identical infrared spectrum in solution with that of IX derived from allosecurinine.

Catalytic hydrogenation of IV over palladium on carbon took up one molar equivalent of hydrogen to give an amino-lactone (XI), characterized as crystalline salts, which afforded the acetate (VIII), identified with the hydrogenation product from VII. Catalytic hydrogenations of IV and XI gave an amino-lactone (XII), characterized as crystalline salts. Compound (XII), when an ethanolic solution of its salt was passed through an alumina column or an ethereal solution of the free base was allowed to stand for several hours, gave a lactam-carbinol (XIII), $C_{13}H_{21}O_2N$, m.p. 258~260°, designated lactam carbinol C.*6 Stirring a solution of XI in 10% aq. sodium hydroxide at room temperature gave an unsaturated lactam (XIV), m.p. 170~172°. A sharp signal at 4.5 τ for one olefinic proton in its nuclear magnetic resonance spectrum shows that the double bond is located at the position as shown in structure (XIV). Catalytic hydrogenation of XIV over platinum oxide, or hydrolysis of XI with potassium hydroxide solution, followed by catalytic hydrogenation over Raney nickel afforded also lactam-carbinol C (XIII). Lactam-carbinol C (XIII) shows an identical infrared spectrum in solution with that of *rac*-XIII,*7 synthesized as follows (Chart 2).

Catalytic hydrogenation of ethyl *cis*-2-hydroxy-2-(2-pyridyl)cyclohexaneacetate[3c, 13] followed by chromatographical separation on silica gel-chloroform, gave two fractions. The first fraction gave *rac*-lactam-carbinol C (*rac*-XIII), m.p. 227~229°, and the second fraction the known *rac*-lactam-carbinol B*6,[3c] (*rac*-XV), m.p. 211~212.5°. The both products, *rac*-XIII and *rac*-XV, showed the same molecular formula but their melting points and their infrared spectra in finger print regions are different, indicating that both are stereoisomers.

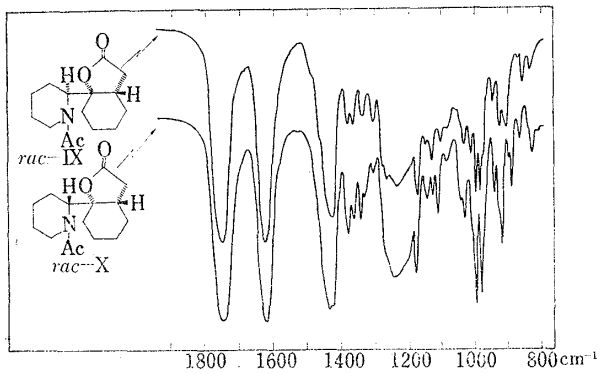


Fig. 1. Infrared Spectra of the N-Acetyl Amino-lactones (*rac*-IX and *rac*-X) in Chloroform

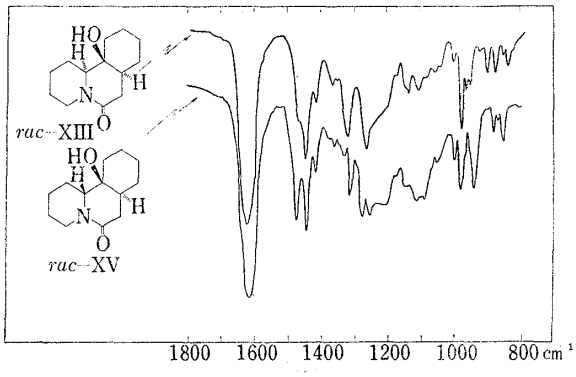


Fig. 2. Infrared Spectra of Lactam-carbinols C and B (*rac*-XIII and *rac*-XV) in Chloroform

Lithium aluminum hydride reduction of lactam-carbinol C (XIII) gave a quinolizidine (XVI), $C_{13}H_{23}ON$, m.p. 53~55°, designated quinolizidine C,*6 which shows an identical infrared spectrum in solution with that of *rac*-XVI prepared previously.[3c]

Thus, the identifications of the degradation products (IX), (XIII) and (XVI) with the corresponding synthetic samples establish the relative configuration of the three asymmetric carbon atoms, C_{5a}, C_{10a} and C_{10b}, in allosecurinine (III).

*6 Lactam-carbinol C is a stereoisomer of lactam-carbinols A and B, degradation products of securinine. Lithium aluminum hydride reductions of these A, B, and C gave quinolizidines A, B, and C, respectively [cf. 3c)].

*7 In the previous paper,[3c] *rac*-lactam-carbinol C (*rac*-XIII) has been synthesized as a mixture with *rac*-lactam-carbinol B but not isolated in a pure state.

It has been reported[1,4,7] that allosecurinine (III) afforded dihydroallosecurinine (XVII) on sodium borohydride reduction, and dihydro- and hexahydro-derivatives on catalytic hydrogenation over platinum oxide. However, no report has so far been appeared on tetrahydro-derivative of allosecurinine. Catalytic hydrogenation of dihydroallosecurinine (XVII) over platinum oxide in glacial acetic acid gave an oily tetrahydroallosecurinine (XVIII), characterized as a picrate, m.p. 210° (decomp.), and a methiodide, m.p. 242~243° (decomp.).

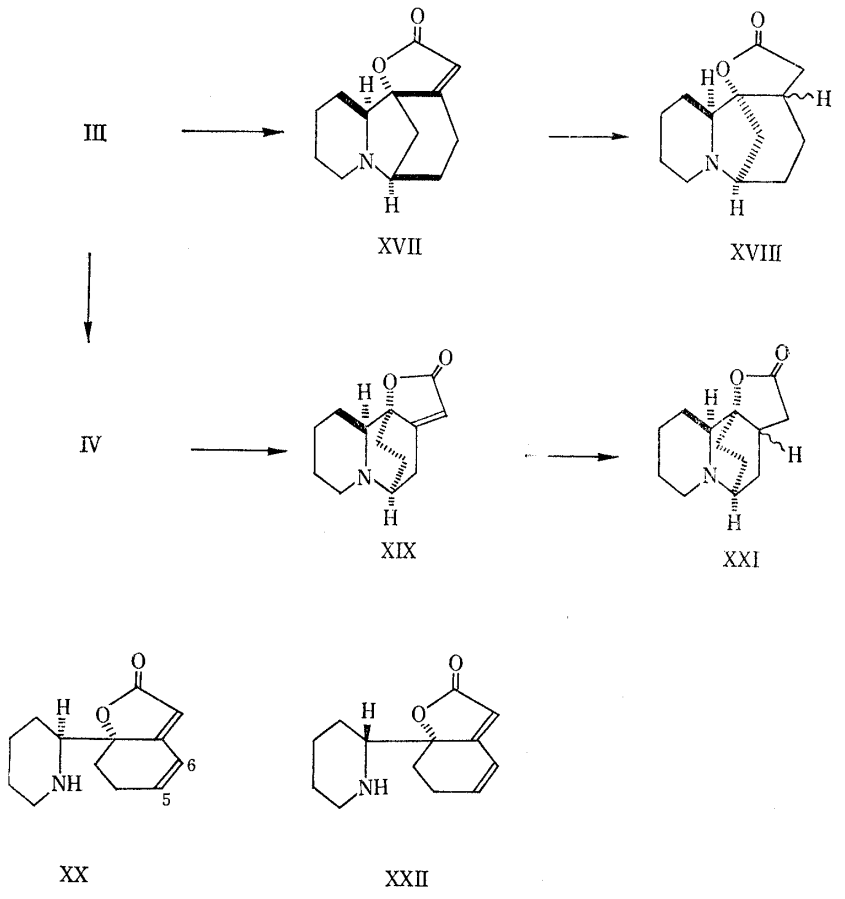


Chart 3.

Distillation of the unsaturated amino-lactone (IV) *in vacuo* or standing it at room temperature for several days gave a crystalline product (XIX), $C_{13}H_{17}O_2N$, m.p. 116~117.5°. The molecular formula of this compound corresponds to that of dihydroallosecurinine (XVII) or compound (XX). Formation of the latter is the most expectative from the fact[3c] that compound (VI), degradation product of securinine, has been converted by distillation into compound (XXII) [the hydrochloride, UV λ_{max}^{EtOH} mμ (log ε) : 258 (4.15)]. However, both possibilities were excluded by comparison of the ultraviolet spectra of XIX and XXII, and by direct comparison of XVII and XIX. Finally, the structure (XIX) with six-membered B ring was assigned for this compound from the following considerations.

The presence of the α,β-unsaturated γ-lactone with a hydrogen at α-position and no more olefinic linkage in compound (XIX) was indicated by the spectral and chemical evidences : peaks at 1815, 1733 and 1642 cm^{-1} in the infrared spectrum (KBr); a maximum at 215 mμ (log ε 4.29) in the ultraviolet spectrum; a signal at 4.4 τ for one olefinic proton in the nuclear magnetic resonance spectrum; catalytic hydrogenation of XIX over platinum oxide in ethanol took up one molar equivalent of hydrogen to give a dihydro derivative (XXI) [the perchlorate, IR ν_{max}^{KBr} cm^{-1} : 1779 (γ-lactone)]. The nitrogen

atom in XIX is tertiary and forms a bridgehead from the following data : the presence of *trans*-quinolizidine bands at 2770, 2703 and 2632 cm^{-1} and the lack of N-H band in the infrared spectrum (CCl_4); treatment of XIX with acetic anhydride resulted in the recovery of the starting material unchanged. The ring closure of IV into XIX could be interpreted well as proceeding according to an intramolecular addition of the piperidine moiety onto 5,6-double bond of XX, after the transformation of IV into XX.

Experimental*8

Reduction of Allosecurinine (III) with Aluminum Amalgam——A mixture of allosecurinine (III, 5 g.), ether (300 ml.), aluminum amalgam (prepared by amalgamation of aluminum turnings (8 g.) with 0.5% aq. $HgCl_2$ solution) and H_2O (5 ml.) was stirred at room temperature until a yellow color of the solution disappeared. Filtration and evaporation of the solution gave an oil (4.7 g.) containing a small amount of crystalline material which was collected by filtration and recrystallized from EtOH to give the unsaturated lactam (V, 50 mg.) as colorless plates, m.p. 237~238.5°. IR $\nu_{max}^{CHCl_3}$ cm^{-1} : 3546, 3390 (OH), 1623 (lactam). *Anal.* Calcd. for $C_{13}H_{19}O_2N$: C, 70.55; H, 8.65; N, 6.33. Found : C, 70.84; H, 8.58; N, 6.18.

The oily part separated by filtration was converted to the hydrochloride by the usual method. Recrystallization from EtOH–ether gave 2-hydroxy-2-(2-piperidyl)-4-cyclohexene-$\Delta^{1,\alpha}$-acetic acid lactone (IV). $HCl \cdot H_2O$ (4.5 g.) as colorless crystals, m.p. 197° (decomp.). IR ν_{max}^{Nujol} cm^{-1} : 1815, 1765 (conj. γ-lactone), 1649, 1630 (double bonds). An analytical sample was dried over P_2O_5 overnight at room temperature and atmospheric pressure. *Anal.* Calcd. for $C_{13}H_{18}O_2NCl \cdot H_2O$: N, 5.12. Found : N, 4.70. The perchlorate was prepared from the free base recovered from the hydrochloride and recrystallized from EtOH–ether as colorless needles, m.p. 204°(decomp.). IR ν_{max}^{KBr} cm^{-1} : 1754 (conj. γ-lactone), 1642, 1613 (double bonds). $[\alpha]_D^{21}$ +65.2°(c=0.1). *Anal.* Calcd. for $C_{13}H_{18}O_6NCl$: C, 48.83; H, 5.67; N, 4.38. Found : C, 49.08; H, 5.75; N, 4.31. The picrate, yellow prisms from EtOH, m.p. 178°. *Anal.* Calcd. for $C_{19}H_{20}O_9N_4$: C, 50.89; H, 4.50; N, 12.50. Found : C, 51.14; H, 4.39; N, 12.20.

2-Hydroxy-2-(N-acetyl-2-piperidyl)-4-cyclohexene-$\Delta^{1,\alpha}$-acetic Acid Lactone (VII)——A solution of IV (170 mg.) in Ac_2O (10 ml.) was allowed to stand overnight and heated in a steam bath for 30 min. The excess of Ac_2O was distilled off under reduced pressure and the residue was dissolved in H_2O (10 ml.), made alkaline with K_2CO_3 and extracted with ether. The ether extract was washed with saturated NaCl solution, dried and evaporated. The residual product (220 mg.) was recrystallized from *n*-hexane to give the acetate (VII) as colorless needles, m.p. 116~117°. IR ν_{max}^{KBr} cm^{-1} : 1739 (conj. γ-lactone), 1639 (amide). UV : no characteristic band above 220 mμ. $[\alpha]_D^{18}$ −121°(c=0.018). *Anal.* Calcd. for $C_{15}H_{19}O_3N$: C, 68.94; H, 7.33; N, 5.36. Found : C, 69.04; H, 7.17; N, 5.14.

2-Hydroxy-2-(N-acetyl-2-piperidyl)-$\Delta^{1,\alpha}$-cyclohexaneacetic Acid Lactone (VIII)——a) From 2-hydroxy-2-(N-acetyl-2-piperidyl)-4-cyclohexene-$\Delta^{1,\alpha}$-acetic acid lactone (VII) : A solution of VII (50 mg.) in EtOH (20 ml.) was hydrogenated over 5% Pd-C (20 mg.) at atmospheric pressure and room temperature. After one molar equivalent of hydrogen was taken up, the catalyst was filtered off and the filtrate was evaporated to give an oil (50 mg.) which solidified on cooling. Recrystallization of the product from *n*-hexane gave the acetate (VIII, 40 mg.) as colorless plates, m.p. 107~109°. IR ν_{max}^{KBr} cm^{-1} : 1733(conj. γ-lactone), 1637 (amide). *Anal.* Calcd. for $C_{15}H_{21}O_3N$: C, 68.41; H, 8.04; N, 5.32. Found : C, 68.38; H, 7.99; N, 5.71.

b) From 2-hydroxy-2-(2-piperidyl)-$\Delta^{1,\alpha}$-cyclohexaneacetic acid lactone (XI) : A solution of XI (100 mg.) in Ac_2O (3 ml.) was allowed to stand overnight at room temperature and heated in a steam bath for 30 min. The excess of Ac_2O was distilled off under reduced pressure and the residue was dissolved in H_2O (10 ml.), made alkaline with K_2CO_3 and extracted with ether. Evaporation of the ether extract and recrystallization of the residue from *n*-hexane gave the acetate (VIII, 95 mg.) as colorless plates, m.p. 107~109°, which was identical with VIII obtained in a).

2-Hydroxy-2-(N-acetyl-2-piperidyl)cyclohexaneacetic Acid Lactone (IX)——A solution of VII (120 mg.) in EtOH (30 ml.) was hydrogenated over PtO_2 (30 mg.) at atmospheric pressure and room temperature. After two molar equivalents of hydrogen was taken up, the catalyst was filtered off and the filtrate was evaporated to dryness to give a crystalline product (130 mg.). Recrystallization of the product from *n*-hexane gave the acetate (IX) as colorless cubes, m.p. 80~80.5°. IR $\nu_{max}^{CHCl_3}$ cm^{-1} : 1754 (γ-lactone), 1626 (amide). $[\alpha]_D^{21}$ −92.9° (c=0.07). *Anal.* Calcd. for $C_{15}H_{23}O_3N$: C, 67.89; H, 8.74; N, 5.28. Found : C, 67.82; H, 8.62; N, 5.57.

*8 Melting points and boiling points are uncorrected. Extracts were dried over anhyd. Na_2SO_4. Specific optical rotations were measured with a Yanagimoto photomagnetic direct reading polarimeter model OR-20, using 10 cm. cell and EtOH as solvent. Thin-layer chromatography (TLC) was carried out with $CHCl_3$ as solvent on Aluminum oxide G (Merck Co., Ltd.). Analyses of gas-liquid chromatography (GLC) were conducted with a Shimadzu gas chromatography GC-1B equipped with a hydrogen flame ionization detector, employing SE-30 column (column temperature 175°).

This compound (IX) shows an identical IR spectrum in $CHCl_3$ with that of *rac*-IX described later.

2-Hydroxy-2-(2-piperidyl)-$\Delta^{1,\alpha}$-cyclohexaneacetic Acid Lactone (XI)——A solution of IV·HCl·H_2O (1 g.) in EtOH (60 ml.) was hydrogenated over 5% Pd-C (300 mg.), until one molar equivalent of hydrogen was taken up, at atmospheric pressure and room temperature. The catalyst was filtered off and evaporation of the filtrate gave a crystalline product (1 g.) which was dissolved in H_2O (40 ml.), made alkaline with K_2CO_3 and extracted with $CHCl_3$. The dried $CHCl_3$ extract was evaporated to give a viscous oil (XI, 0.8 g.). The perchlorate, colorless needles from EtOH–ether, m.p. 224° (decomp.). IR ν_{max}^{KBr} cm^{-1}: 1754 (conj. γ-lactone), 1645 (double bond). *Anal.* Calcd. for $C_{13}H_{20}O_6NCl$: C, 48.52; H, 6.23; N, 4.35. Found: C, 48.67; H, 6.04; N, 4.27. The hydrochloride (monohydrate), colorless pillars from EtOH, m.p. 226°. IR ν_{max}^{Nujol} cm^{-1}: 1755 (conj. γ-lactone), 1635 (double bond). An analytical sample was dried over P_2O_5 overnight at room temperature and atmospheric pressure. *Anal.* Calcd. for $C_{13}H_{20}O_2NCl\cdot H_2O$: N, 5.08. Found: N, 5.29.

2-Hydroxy-2-(2-piperidyl) cyclohexaneacetic Acid Lactone (XII)——a) From 2-hydroxy-2-(2-piperidyl)-$\Delta^{1,\alpha}$-cyclohexaneacetic acid lactone (XI): A solution of XI·$HClO_4$ (170 mg.) in EtOH (40 ml.) was hydrogenated over 5% Pd-C (5 mg.). After one molar equivalent of hydrogen was taken up, the catalyst was filtered off and the filtrate was evaporated to give a crystalline product (170 mg.). Recrystallization of the product from acetone–ether gave XII·$HClO_4$ as colorless needles, m.p. 210~212° (decomp.). IR ν_{max}^{KBr} cm^{-1}: 1754 (conj. γ-lactone). $[\alpha]_D^{21}$ +27.1° (c=0.07). *Anal.* Calcd. for $C_{13}H_{22}O_6NCl$: C, 48.19; H, 6.85; N, 4.33. Found: C. 48.53; H, 6.73; N, 4.45. The hydrochloride of XII was prepared from the hydrochloride of XI by hydrogenation over 5% Pd-C and recrystallized from EtOH–ether as colorless needles, m.p. 215° (decomp.).

b) From 2-hydroxy-2-(2-piperidyl)-4-cyclohexene-$\Delta^{1,\alpha}$-acetic acid lactone (IV): A solution of IV·HCl·H_2O was hydrogenated over 5% Pd-C until two molar equivalents of hydrogen was taken up. The resulted mixture was treated as described in a). The hydrochloride of XII, m.p. 215° (decomp.), thus prepared, was identical with the sample obtaied in a).

Lactam-carbinol C (XIII)——a) From 2-hydroxy-2-(2-piperidyl)cyclohexaneacetic acid lactone (XII): A solution of XII·HCl in EtOH was passed through an alumina column. Evaporation of the EtOH eluate, followed by recrystallization from EtOH, gave quantitatively lactam-carbinol C (XIII) as colorless plates, m.p. 258~260°.

An aq. solution of either XII·$HClO_4$ or XII·HCl was made alkaline with K_2CO_3, extracted with ether and standing the ether extract for several hours gave XIII, m.p. 258~260°. IR γ_{max}^{KBr} cm^{-1}: 3289 (OH), 1634 (lactam). $[\alpha]_D^{21}$ +45.3°(c=0.1). *Anal.* Calcd. for $C_{13}H_{21}O_2N$: C, 69.92; H, 9.48: N, 6.27. Found: C, 69.88; H, 9.44; N, 6.02.

This compound was shown to be homogeneous by GLC and TLC, and showed an identical IR spectrum in $CHCl_3$ with that of *rac*-XIII described later.

b) From unsaturated lactam (V): A solution of V (30 mg.) in EtOH (15 ml.) was hydrogenated over PtO_2 (10 mg.) at atmospheric pressure and room temperature. After one molar equivalent of hydrogen was taken up, the catalyst was filtered off and the filtrate was evaporated to give XIII as colorless crystals quantitatively.

This compound was shown to be homogeneous by TLC and identical with lactam-carbinol C obtained in a).

c) From 2-hydroxy-2-(2-piperidyl)-$\Delta^{1,\alpha}$-cyclohexaneacetic acid lactone (XI): After refluxing for 2.5 hr., a mixture of XI·HCl·H_2O (215 mg.), KOH (200 mg.), H_2O (2 ml.) and tetrahydrofuran (1 ml.) was hydrogenated over Raney nickel (1 spoon), resulting in the uptake of one molar equivalent of hydrogen. The filtrate was acidified with 10% HCl, refluxed for 2.5 hr., concentrated and extracted with $CHCl_3$. Evaporation of the $CHCl_3$ extract gave XIII, which was identified in IR spectrum with lactam-carbinol C obtained in a).

d) From unsaturated lactam (XIV): A solution of XIV described later in EtOH was hydrogenated over PtO_2 and treated as described in a) to give XIII, quantitatively, which was shown to be hemogeneous by TLC and identical in IR spectrum with lactam-carbinol C obtained in a).

Unsaturated Lactam (XIV)——To a stirred solution XI·HCl·H_2O (500 mg.) in H_2O (2 ml.), 10% aq. NaOH solution (5 ml.) was added dropwise at room temperature and stirring was continued for an additional 2 hr. A crystalline material precipitated was extracted with benzene. Evaporation of the benzene extract and recrystallization of the residue from AcOEt gave the lactam (XIV, 300 mg.) as colorless needles, m.p. 170~172°. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3540, 3270 (OH), 1668 (double bond), 1614 (lactam). $[\alpha]_D^{18}$ +197° (c=0.07). *Anal.* Calcd. for $C_{13}H_{19}O_2N$: C, 70.55; H, 8.65; N, 6.33. Found: C, 70.63; H, 8.39; N. 6.44.

Quinolizidine C (XVI)——A solution of lactam-carbinol C (XIII, 1 g.) in anhyd. tetrahydrofuran (150 ml.) was added dropwise at 15~17° to a stirred suspension of $LiAlH_4$ (2 g.) in anhyd. tetrahydrofuran (40 ml.) and anhyd. ether (20 ml.) during a period of 30 min. After the addition was complete, the reaction mixture was refluxed with stirring for 15 hr. Water was added dropwise carefully to the ice-cooled reaction mixture to decompose the excess of $LiAlH_4$ and stirring was continued for an additional 10 min. An inorganic material was filtered off. Evaporation of the dried filtrate and subsequent distillation at 95~100° (bath temperature)/0.05 mm. Hg gave a colorless viscous oil (640 mg.) which crystallized imme-

diately. Recrystallization from petr. ether gave quinolizidine C (XVI) as colorless pillars, m.p. 53~55°. IR ν_{max}^{KBr} cm^{-1} : 3436 (OH), 2786, 2740, 2660 (*trans*-quinolizidine). $[\alpha]_D^{22}$ −13.5°(c=0.2). *Anal.* Calcd. for $C_{13}H_{23}ON$: C, 74.59; H, 11.08; N, 6.69. Found : C, 74.57; H, 11.05; N, 6.45.

This compound shows an identical IR spectrum in $CHCl_3$ with that of *rac*-XVI (prepared previously.[3c])

The picrate, yellow crystals from EtOH, m.p. 196~197.5°. *Anal.* Calcd. for $C_{19}H_{26}O_8N_4$: C, 52.05; H, 5.98; N, 12.78. Found : C, 52.11; H, 5.99; N, 12.74.

Tetrahydroallosecurinine (XVIII)——A solution of dihydroallosecurinine (XVII, 700 mg.) in glacial AcOH (30 ml.) was hydrogenated over PtO_2 (150 mg.) at atmospheric pressure and room temperature, until one molar equivalent of hydrogen was taken up. The catalyst was filtered off. The filtrate was evaporated to dryness under reduced pressure and the residue was dissolved in H_2O (20 ml.), made alkaline with K_2CO_3 and extracted with ether. The ether extract was washed with saturated NaCl solution, dried and evaporated to give an oil (XVIII, 670 mg.) which was characterized as the picrate, yellow needles from aq. EtOH, m.p. 210°(decomp.). *Anal.* Calcd. for $C_{19}H_{22}O_9N_4$: C, 50.66; H, 4.92; N, 12.44. Found: C, 50.94; H, 4.88; N, 12.14. The methiodide was prepared by refluxing the oily base with CH_3I in acetone, white crystals from MeOH-ether, m.p. 242~243°(decomp.). IR ν_{max}^{Nujol} cm^{-1} : 1786 (γ-lactone). *Anal.* Calcd. for $C_{14}H_{22}O_2NI$: C, 46.29; H, 6.10; N, 3.86. Found : C, 46.49; H, 5.91; N, 4.08.

Compound (XIX)——Compound (IV, 2 g.) was distilled at 160~170° (bath temperature)/0.5 mm. Hg to give a yellowish viscous oil (1.74 g.) which was chromatographed on Al_2O_3 (35 g.). Recrystallization of the benzene eluate from *n*-hexane gave XIX (1.2 g.) as colorless plates, m.p. 116~117.5°. IR ν_{max}^{KBr} cm^{-1}; 1815, 1733 (conj. γ-lactone), 1642 (double bond); $\nu_{max}^{CCl_4}$ cm^{-1} : 2770, 2703, 2632 (*trans*-quinolizidine), 1786, 1761 (conj. γ-lactone), 1650 (double bond). $[\alpha]_D^{21}$ −32.5°(c=0.1). *Anal.* Calcd. for $C_{13}H_{17}O_2N$: C, 71.20; H, 7.82; N, 6.39. Found : C, 71.60; H, 7.77; N, 6.26. The perchlorate, colorless needles from aq. EtOH, m.p. 206°(decomp.). IR ν_{max}^{KBr} cm^{-1} : 1786, 1754 (conj. γ-lactone), 1658 (double bond). UV λ_{max}^{EtOH} : 215 mμ (log ε 4.29). *Anal.* Calcd. for $C_{13}H_{18}O_6NCl$: C, 48.83; H, 5.67; N, 4.38. Found : C, 49.21; H, 5.67; N, 4.23. The picrate, yellow needles from aq. EtOH, m.p. 216°(decomp.). *Anal.* Calcd. for $C_{19}H_{20}O_9N_4$: C, 50.89; H, 4.50; N, 12.50. Found : C, 51.26; H, 4.73; N, 12.58.

Compound (XXII)——A solution of XIX (30 mg.) in EtOH (10 ml.) was hydrogenated over PtO_2 (20 mg.) at atmospheric pressure and room temperature. After one molar equivalent of hydrogen was taken up, the catalyst was filtered off and the filtrate was evaporated to give a viscous oil (30 mg.) which was converted to the perchlorate, colorless needles from EtOH, m.p. 240°(decomp.). IR ν_{max}^{KBr} cm^{-1} : 1779 (γ-lactone). *Anal.* Calcd. for $C_{13}H_{20}O_6NCl$: C, 48.52; H, 6.26; N, 4.35. Found: C, 48.51; H, 6.23; N, 4.36.

***rac*-2-Hydroxy-2-(N-acetyl-2-piperidyl)cyclohexaneacetic Acid Lactone (*rac*-IX)**——A crude acetylation product[3c] (8 g.) of ethyl *cis*-2-hydroxy-2-(2-piperidyl)cyclohexaneacetate or *cis*-2-hydroxy-2-(2-piperidyl)cyclohexaneacetic acid lactone was chromatographed on Al_2O_3 (100 g.). The $CHCl_3$ eluate gave a mixture of crystalline and oily materials. To this mixture a small amount of ether was added, and an ether insoluble crystalline portion was collected by filtration. Evaporation of the filtrate gave a viscous oil which was triturated with ligroin to give a crystalline product (2.7 g.). Several recrystallizations from ligroin gave *rac*-IX as white crystals, m.p. 90~92°. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1754 (γ-lactone), 1626 (amide). *Anal.* Calcd. for $C_{15}H_{23}O_3N$: C, 67.89; H, 8.74; N, 5.28. Found : C, 67.72; H, 8.60; N, 5.38.

This compound was shown to be homogeneous by GLC and TLC, and identical with IX derived from allosecurinine in IR spectrum in $CHCl_3$.

On the other hand, a crystalline portion collected on the filter gave *rac*-X, white crystals from ligroin, m.p. 143~145°, which was shown[3c] to be identical in IR spectrum in $CHCl_3$ with natural X derived from securinine.

***rac*-Lactam-carbinol C (*rac*-XIII)**——A crude hydrogenation product[3c] of ethyl *cis*-2-hydroxy-2-(2-pyridyl)cyclohexaneacetate was chromatographed on silica gel. Recrystallization of the first eluate ($CHCl_3$) gave *rac*-XIII as colorless plates from acetone, m.p. 227~229°. IR $\nu_{max}^{CHCl_3}$ cm^{-1} : 3559, 3390 (OH), 1621(lactam). *Anal.* Calcd. for $C_{13}H_{21}O_2N$: C, 69.92; H, 9.48; N, 6.27. Found: C, 70.21; H, 9.40; N, 6.04.

This compound was shown to be homogeneous by TLC and identical in IR spectrum in $CHCl_3$ with lactam-carbinol C derived from allosecurinine.

The second eluate (AcOEt) gave colorless crystals (*rac*-XV),[3c] m.p. 211~212°, which was shown to be identical in IR spectrum in $CHCl_3$ with lactam-carbinol B derived from securinine.

Summary

Degradations of allosecurinine (III) gave the N-acetyl amino-lactone (IX), lactam-carbinol C (XIII), quinolizidine C (XVI), tetrahydroallosecurinine (XVIII) and compound (XIX). Identifications of the former three compounds (IX), (XIII) and (XVI) with the corresponding synthetic specimens provided a definite proof for the relative configuration of allosecurinine (III).

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