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Terpenoids. VII.[1] The Structure and Absolute Configuration of Nodosin, a New Diterpenoid from *Isodon* Species

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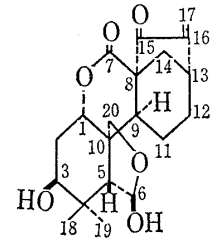
Nodosin, a new diterpenoid isolated from *Isodon trichocarpus* Kudo and *I. Japonicus* Hara, was converted to the keto lactone acetal X *via* several steps of reactions. The conversion made it possible to propose the structure II for nodosin. The remaining hydroxyl group proved to be located at C–11 and to have the β–configuration on the basis of a detailed NMR investigation. Thus, the structure and absolute configuration of nodosin were established as formula XIX.

Since the accomplishment of the chemical conversion of enmein into (—)–kaurane,[3] the authors have been studying the constituents in *Isodon trichocarpus* Kudo (Japanese name: "Kurobana–hikiokoshi") and *I. japonicus* Hara ("Hikiokoshi"), and have published the preliminary communications[4,5] on the isolation and structure of several new diterpenoids. The present paper deals with the details on the elucidation of the structure of a new enmein–type diterpenoid which was named nodosin. It was first isolated from the leaves of *Isodon trichocarpus* Kudo, and soon after, also from the leaves of *I. japonicus* Hara by the authors.

Nodosin was obtained as crystals having mp 275—280° (decomp.) and $[\alpha]_D^{17}$ −203°. The molecular formula, $C_{20}H_{26}O_6$, which is the same with that of enmein (I),[3,6] was established by the mass spectrum determination and analysis. The presence in the molecule of a five–membered hemiacetal, a δ–lactone and a five–membered ring ketone conjugating with an exocyclic methylene group was suggested by the following spectral data. Thus, the infrared (IR) spectrum (KBr) exhibited the absorption bands of the hydroxyl groups at 3500 and 3350 cm^{-1}, and the nuclear magnetic resonance (NMR) spectrum (pyridine) gave a singlet signal at δ 5.79 ppm, which is similar to the proton signal of the hydrogen at C–6 in enmein (I), and a AB type signal at δ 4.43 ppm (J=9.0 cps), which is similar to that of the methylene protons at C–20 in enmein. These data supported a hemiacetal environment which is quite similar to enmein. An absorption band at 1690 cm^{-1} in the IR spectrum gave a suggestion for the presence of a δ–lactone. The absorption maximum at 233 mμ (ε 8000) in the ultraviolet spectrum as well as the absorption bands at 1740 and 1640 cm^{-1} in the IR spectrum and the singlet signals at δ



Formula I

1) Part VI: E. Fujita, T. Fujita, and M. Shibuya, *Yakugaku Zasshi*, **87**, 1076 (1967).
2) Location: *Takatsuki, Osaka–fu.*
3) E. Fujita, T. Fujita, K. Fuji, and N. Ito, *Chem. Pharm. Bull.* (Tokyo), **13**, 1023 (1965); *Tetrahedron*, **22**, 3423 (1966).
4) E. Fujita, T. Fujita, and M. Shibuya, *Chem. Comm.*, **1966**, 297.
5) E. Fujita, T. Fujita, and M. Shibuya, *Tetrahedron Letters*, **1966**, 3153.
6) *a*) T. Ikeda and S. Kanatomo, *Yakugaku Zasshi*, **78**, 1128 (1958). *b*) T. Kubota, T. Matsuura, T. Tsutsui, S. Uyeo, M. Takahashi, H. Irie, A. Numata, T. Fujita, T. Okamoto, M. Natsume, Y. Kawazoe, K. Sudo, T. Ikeda, M. Tomoeda, S. Kanatomo, T. Kosuge, and K. Adachi, *Tetrahedron Letters*, **1964**, 1243; T. Kubota, T. Matsuura, T. Tsutsui, S. Uyeo, H. Irie, A. Numata, T. Fujita, and T. Suzuki, *Tetrahedron*, **22**, 1659 (1966). *c*) Y. Iitaka and M. Natsume, *Tetrahedron Letters*, **1964**, 1257. *d*) K. Shudo, M. Natsume, and T. Okamoto, *Chem. Pharm. Bull.* (Tokyo), **13**, 1019 (1965).

5.32 and 5.97 ppm assigned to the hydrogens of an end methylene in the NMR spectrum (pyridine) suggested the presence of a five-membered ring ketone conjugating with an exocyclic methylene group just as the D-ring of enmein.

Furthermore, the presence of an additional secondary hydroxyl group was supported on the basis of the IR absorption and a triplet signal at δ 5.16 ppm in the NMR (pyridine+D_2O) spectrum. It is clear that this secondary alcohol is located in an environment where the proton signal of the hydrogen attached to the hydroxylated carbon causes a considerable paramagnetic shift; this is a different point, when compared with the C-3 proton signal at δ 3.84 ppm (broad) in enmein.

Nodosin on hydrogenation in the presence of Adams' catalyst gave two crystalline products, dihydronodosin, $C_{20}H_{28}O_6$, and tetrahydronodosin, $C_{20}H_{30}O_6$. Dihydronodosin was treated with acetic anhydride and pyridine at room temperature for two hours to afford a crystalline monoacetate, $C_{22}H_{30}O_7$. It was characteristic that the singlet signal at δ 5.79 ppm

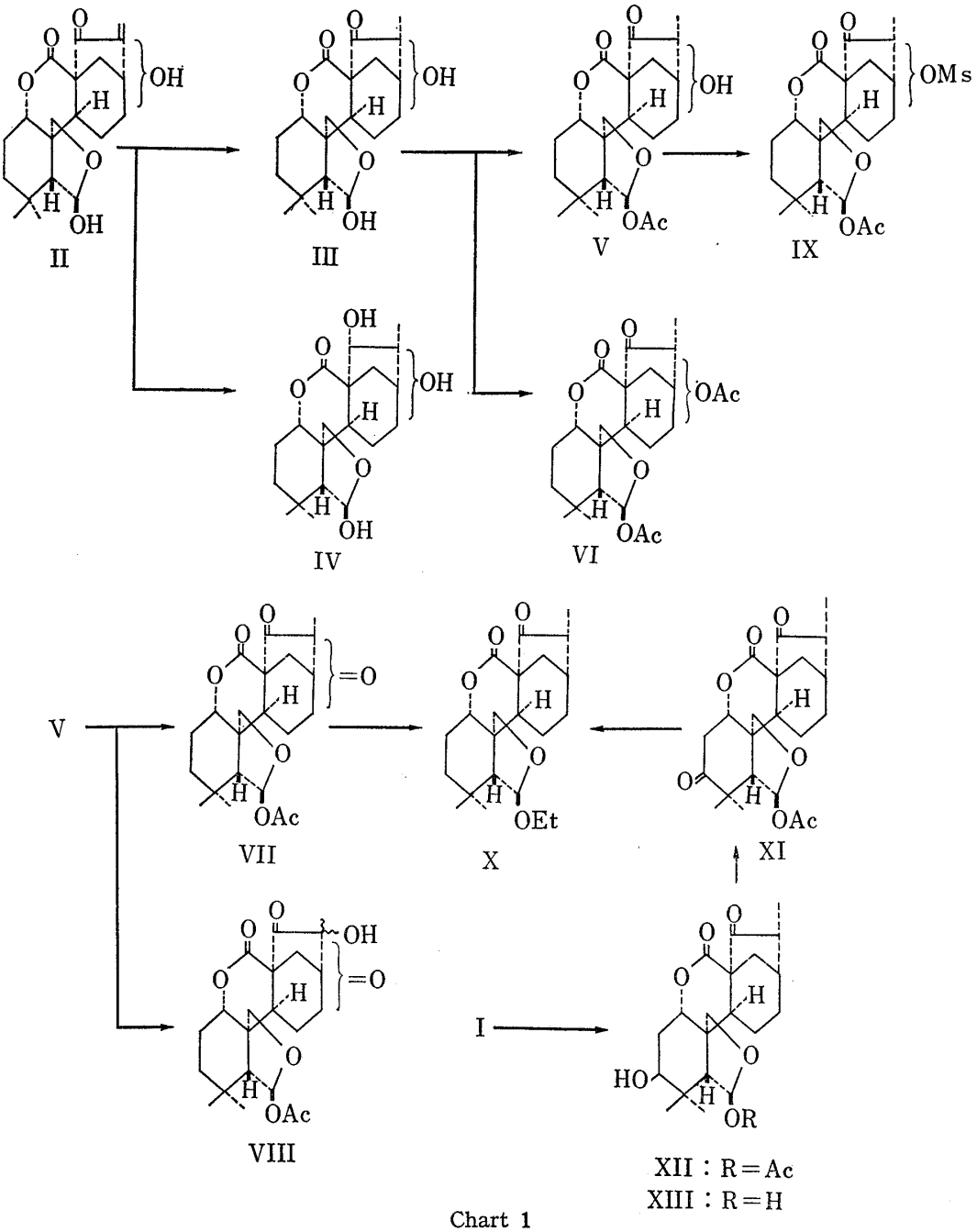
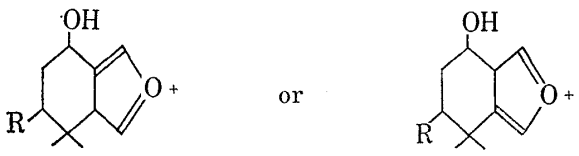


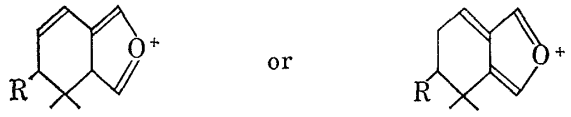
Chart 1

in the NMR spectrum of nodosin caused a paramagnetic shift to δ 6.46 ppm in the monoacetate. Hence, it was reasonably assumed that the hydroxyl group of hemiacetal was acetylated. Another secondary hydroxyl group was hardly acetylated under this condition, and even a reaction for sixteen days did not accomplish diacetylation, but a little monoacetate was still recovered. This is a big contrast to the easy acetylation of the secondary hydroxyl group at C–3 in enmein on standing overnight under the same condition.

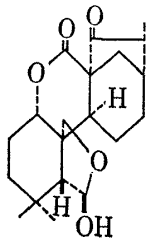
Oxidation of dihydronodosin monoacetate with the chromic acid–pyridine compelx afforded a crystalline keto derivative, $C_{22}H_{28}O_7$, in which the secondary alcohol was oxidized, as a major product, and a crystalline keto tertiary alcohol, $C_{22}H_{28}O_8$, as a minor product. The latter has a hydroxyl absorption at 3350 cm^{-1} in the IR spectrum (KBr), and the analysis of its NMR spectrum led to a conclusion that the substance is an alcohol formed by oxidation of the active methine to which a secondary methyl group was attached (see experimental). The former on thioketalization and subsequent desulfurization with Raney nickel in ethanol yielded an acetal, $C_{22}H_{32}O_5$, mp 169—170° (decomp.). It proved to be identical with the keto lactone acetal X[5] which was prepared from dihydroenmeinone acetate (XI), an oxidation product of dihydroenmein 6–acetate (XII),[6b] by thioketalization and subsequent desulfurization with Raney nickel in ethanol. This interconversion confirmed that nodosin is an isomer of enmein differing in the location of a secondary hydroxyl group. Thus, the foregoing conversion can be represented as Chart 1.



XIV : R=OH (m/e 183)
XVII : R=H (m/e 167)



XV : R=OH (m/e 165)
XVIII : R=H (m/e 149)



XVI

Chart 2

Accordingly, structures II, III, IV, V, VI, VII and VIII can be reasonably assigned to nodosin, dihydronodosin, tetrahydronodosin, dihydronodosin monoacetate, dihydronodosin diacetate, the keto derivative and the keto tertiary alcohol, respectively.

Since the unidentified secondary hydroxyl group in nodosin is much more hardly acetylated than the β–axial hydroxyl group at C–3 in enmein (I), it must be located at a more hindered position than the β–axial C–3 position. An investigation of such a position using a stereo–model resulted in the selection of α–axial at C–2, β–*quasi* axial at C–11, α–*quasi* axial at C–12 or β–*quasi* axial conformation at C–14.[7] In the NMR spectrum of compound VII, a quartet signal at δ 4.54 ppm appeared, which was assigned to the proton at C–1. The fact denied the presence of the hydroxyl group at C–2. The mass spectral data[8] also excluded the possibility of the presence of a hydroxyl group on the A–ring; the mass spectrum of dihydroenmein (XIII), which has a hydroxyl group at C–3, exhibited the fragment ions of m/e 183 and 165, to which structures XIV and XV were assigned, whereas that of dihydroisodocarpin (XVI),[5] which has no hydroxyl group on the A–ring, exhibited the corresponding fragment ions of m/e 167 and 149, to which structures XVII and XVIII were assigned, and the mass spectrum of dihydronodosin gave the fragment ions of m/e 167 and 149 just as dihydroisodocarpin.

7) The C–ring should be present as a boat form just as in enmein: see ref. 4c).
8) The detailed mass spectra on a series of enmein derivatives will be published elsewhere.

In the NMR spectrum ($CDCl_3$) of keto acetate VII, the sharp singlet signals (each 1H) were observed at δ 3.13 and 3.02 ppm. One of them was assigned to a proton attached to a carbon which is adjacent to a newly formed carbonyl group, and the other to a proton at C–5. (See later.) These observations excluded the possibility of the presence of the carbonyl group at C–12 or C–14, that is, the location of the original hydroxyl group at C–12 or C–14. Moreover, considering from the fact that the proton signal of the hydrogen attached to the carbon at which the hydroxyl group is located appeared as triplet in nodosin and as quartet in dihydronodosin, the location of the hydroxyl group at C–14 was denied.

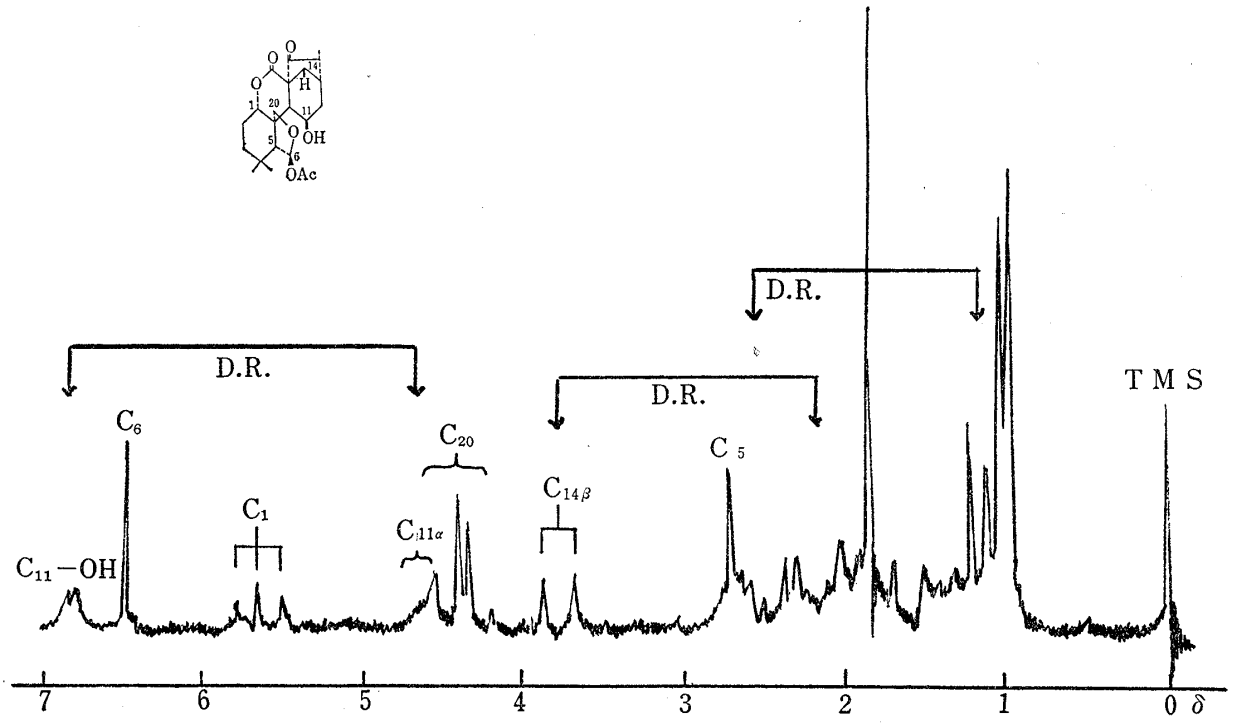


Fig. 1. Nuclear Magnetic Resonance Spectrum of V in C_5D_5N

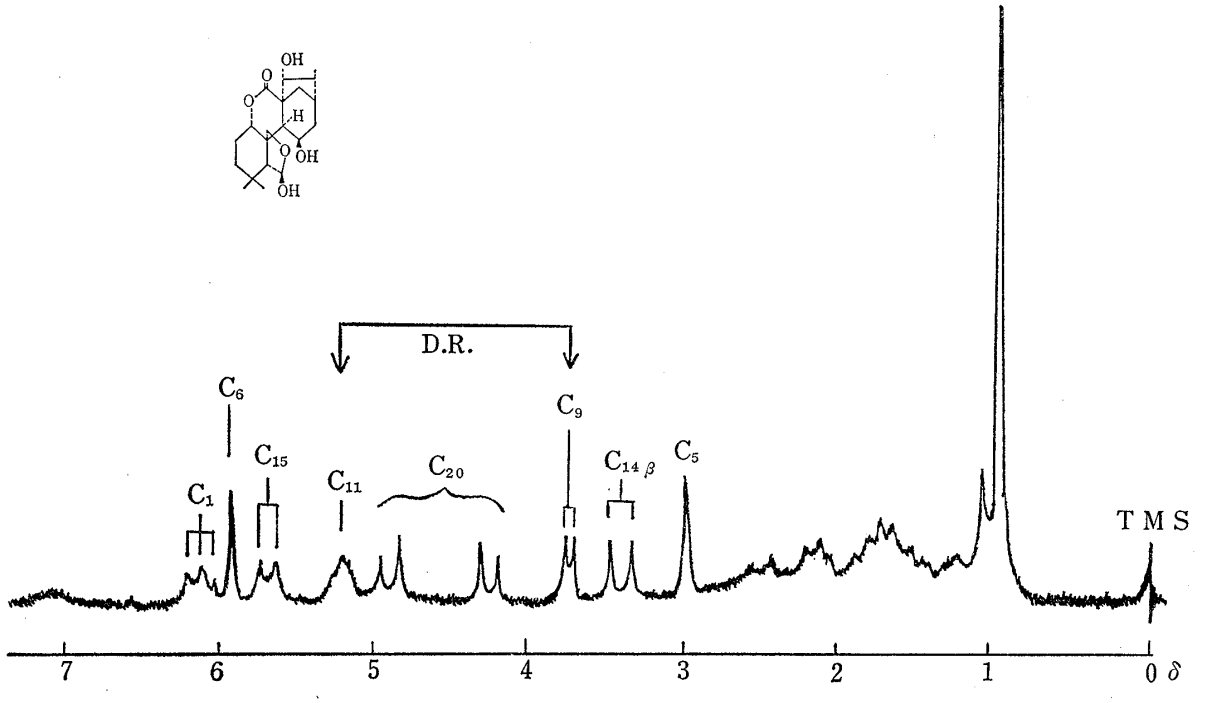
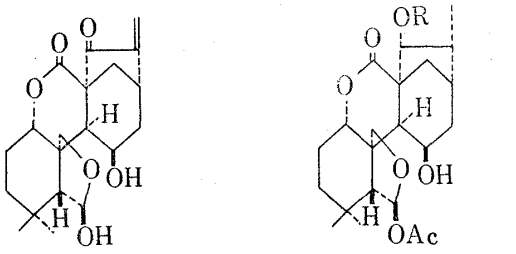


Fig. 2. Nuclear Magnetic Resonance Spectrum of IV in C_5D_5N

Thus, these facts led to a conclusion that the secondary hydroxyl group is located at C–11. The coupling constants reasonably explain the assignment of a *β–quasi* axial conformation to this hydroxyl group. The abnormal paramagnetic shift of the proton signal at C–5 in the foregoing acetate VII is due to the anisotropic effect of the carbonyl group at C–11. In the NMR spectra of nodosin (II), dihydronodosin (III), monoacetate (V), diacetate (VI), and mesylate (IX) which was obtained by the reaction of the compound V with methane sulfonyl chloride and pyridine, a one proton doublet appeared at δ 3.72 (pyridine), 3.87, 3.78, 3.14 (C_5D_5N) and 2.97 ppm ($CDCl_3$), respectively. The coupling constants were in the range of 11.0—12.0 cps. In the NMR spectrum of the compound VII no proton signal was observed in the range of δ 2.9—3.9 ppm except the sharp singlets at δ 3.02 and 3.13 ppm described above. On the basis of the spin decoupling experiments on the proton signal at δ 3.78 ppm (see Fig. 1.), this signal could be assigned to a β–hydrogen at C–14. This hydrogen is deshielded by the anisotropic effect of the β–hydroxyl group at C–11. The NMR spectrum of dihydronodosin monoacetate (V) is shown in Fig. 1.



XIX XX : R=H XXI : R=Ac

Chart 3

Thus, the structure and aboslute configuration of nodosin were elucidated as shown in the formula XIX. Hence, the hydroxyl group of each foregoing structural formula in Chart 1 should be put at C–11 and should be given the β–configuration.

The assignment of the α–orientation to the new hydroxyl group at C–15 of tetrahydronodosin (IV) was based on the coupling constant value (J=10.0 cps)[3] of the doublet signal of C–15 proton in the NMR spectra of IV, its monoacetate XX, and diacetate XXI. The fact that dihydronodosin (III) on reduction with lithium tri–*t*–butoxy aluminum hydride gave IV also supported the assignment. In the NMR spectrum (Fig. 2) of IV, a doublet signal at 3.71 ppm was found to be due to the proton at C–9 through the spin decoupling experiments with the proton at C–11. The unusual paramagnetic shift of the doublet can be well explained by the anisotropic effect of the α–hydroxyl group at C–15.

Experimental[9]

Isolation of Nodosin (XIX)——The dried leaves (100 kg) of *Isodon trichocarpus* Kudo which was collected at Kanazawa district in August of 1964 was extracted with MeOH (3000 liter) under refluxing for 54 hr. The extract was evaporated to 100 liter *in vacuo* and left standing for 2 weeks at room temperature to give the crude crystals of enmein (600 g). To the filtrate (500 ml) was added MeOH (500 ml) and refluxed for 1 hr with addition of charcoal (20 g), then filtered. The green color got yellow, when this treatment was repeated for 3 times. Methanol was distilled off to give a residue (200 g), which was dissolved in AcOEt. The solution was washed first with 0.5% Na_2CO_3 and secondly with 0.1 N HCl. After washing with H_2O and drying over anhydrous Na_2SO_4, the solvent was distilled off to give a syrupy residue (100 g). The syrup (20 g) was chromatographed on a silica gel (800 g) column. The eluate with the mixture of $CHCl_3$ and acetone (8:2) yielded nodosin which has the *Rf* value of 0.5 on the thin-layer chromatogram (TLC).[10] Recrystallization from MeOH afforded the pure plates. The yield was 30 mg from 1 kg of the dried leaves. The quite similar treatment with 1 kg of the dried leaves of *I. japonicus* gave 150 mg of nodosin, mp 275—280° (decomp.), $[\alpha]_D^{17}$ −203° (c=1, pyridine). IR cm^{-1} (KBr): 3500, 3350, 1740, 1690, 1640. UV λ_{max}^{EtOH} 233 mμ (ε 8000). NMR (δ) (in pyridine): 5.97, 5.32 (each 1H, singlet, $>C=C<\underline{H}$), 5.79 (1H, singlet, C–6–$\underline{H}$), 5.16

9) All melting points were uncorrected. The NMR spectra were measured with Varian A–60 spectrometer using tetramethylsilane as internal standard.

10) Nakarai silica layer G was used as the adsorption layer and developed with a mixture of acetone and $CHCl_3$ (3:7). Colored with iodine.

(1H, broad, C-11-H), 4.43 (2H, AB type, $J=9.0$ cps, H_2 at C-20), 3.72 (1H, doublet, $J=11.5$ cps, β-H at C-14), 1.01 (6H, singlet). NMR (δ) (pyridine+D_2O): 5.16 (1H, triplet, $J=4.0$ cps, C-11-H). *Anal.* Calcd. for $C_{20}H_{26}O_6$: C, 66.28; H, 7.23. Found: C, 66.46; H, 7.37. M^+ 362.

Hydrogenation of Nodosin——Nodosin (II, XIX) (400 mg) was dissolved in MeOH (10 ml), and PtO_2 (5 mg) was added to the solution, then hydrogenation was carried out for 1 hr. After filtration, the solution was concentrated to give a crystalline residue (398 mg), which was recrystallized from MeOH to yield dihydronodosin (III) (300 mg) as crystals, mp 245—248° (decomp.). IR cm^{-1} (KBr): 3550, 3460, 1750, 1710. NMR (δ) (in C_5D_5N): 6.22 (1H, doublet, C-11-OH), 5.73 (1H, triplet, $J=8.0$ cps, C-1-H), 3.87 (1H, doublet, $J=11.0$ cps, β-H at C-14), 1.05 (3H, doublet, $J=6.0$ cps). *Anal.* Calcd. for $C_{20}H_{28}O_6$: C, 65.91; H, 7.74. Found: C, 66.09; H, 7.89. The mother liquior of the recrystallization of dihydronodosin gave two spots (*Rf* 0.5 and 0.2) on TLC.[10] Column chromatography on silica gel was effected to separate a substance (47 mg) having *Rf* 0.2 on TLC from another one having *Rf* 0.5 which proved to be dihydronodosin (III). The former was recrystallized from AcOEt to give a pure sample of tetrahydronodosin (IV), mp 225—228°. IR cm^{-1} (KBr): 3350, 1695. NMR (δ)(in pyridine): 3.33 (1H, doublet, $J=10.5$ cps, β-H at C-14), 3.71 (1H, doublet, $J=3.5$ cps, C-9-H), 5.18 (1H, multiplet, C-11-H), 5.59 (1H, doublet, $J=10.0$ cps, C-15-H). *Anal.* Calcd. for $C_{20}H_{30}O_6$: C, 65.55; H, 8.25. Found: C, 65.31; H, 8.31.

Dihydronodosin 6-Acetate (V)——Dihydronodosin (III) (50 mg) was dissolved in pyridine (1 ml) and Ac_2O (1 ml) was added to the solution. The mixture was allowed to stand for 2 hr, then evaporated *in vacuo* to dryness to give crude monoacetate V as crystals (52 mg). Recrystallization from MeOH yielded the pure sample, mp 290—300°. IR cm^{-1} (KBr): 3460, 1740, 1695. NMR (δ) (in C_5D_5N): 6.46 (1H, singlet, C-6-H), 3.78 (1H, doublet, $J=11.5$ cps, β-H at C-14), 1.83 (3H, singlet). *Anal.* Calcd. for $C_{22}H_{30}O_7$: C, 65.01; H, 7.44. Found: C, 65.30; H, 7.54.

Dihydronodosin Diacetate (VI)——Dihydronodosin (III) (50 mg) was dissolved in pyridine (1ml), and Ac_2O (1 ml) was added to the solution, then the mixture was allowed to stand for 16 days. The reaction mixture was evaporated *in vacuo* to dryness to give a residue (50 mg), which was chromatographed on silica gel column. Thus, monoacetate V (19 mg) and oily diacetate VI ((24 mg) were separated. Diacetate: IR cm^{-1} ($CHCl_3$): 1760 (shoulder), 1740. NMR (δ) (in $CDCl_3$): 6.23 (1H, singlet, C-6-H), 3.03 (1H, doublet, $J=12.0$ cps, β-H at C-14), 2.19, 2.04 (each 3H, singlet).

Oxidation of Dihydronodosin 6-Acetate (V)——Monoacetate V (65 mg) was dissolved in pyridine (3 ml), and a complex prepraed from CrO_3 (200 mg) and pyridine (2 ml) was added to the solution, then the mixture was allowed to stand overnight. The reaction mixture was diluted with 3 times of H_2O in volume, and extracted with $CHCl_3$. Washing with H_2O, drying over anhydrous Na_2SO_4 and evaporation of the solvent left an oily residue (50 mg), which gave two spots on TLC.[11] Column chromatography of the mixture on silica gel was effected to separate a crystalline compound (27 mg) possessing the *Rf* of 0.5 on TLC[11] and another crystal (9 mg) possesing the *Rf* of 0.3.

i) The compound possessing the *Rf* 0.5: Dehydrodihydronodosin monoacetate (VII). mp 200—202° (from MeOH). IR cm^{-1} (KBr): 1755, 1745, 1720. NMR (δ) (in $CDCl_3$): 3.13, 3.02 (each 1H, singlet, C-5-H and C-9-H), 4.54 (1H, quartet, $J=6.5$ cps, C-1-H). *Anal.* Calcd. for $C_{22}H_{28}O_7$: C, 65.33; H, 6.98. Found: C, 66.05; H, 7.39. Mass Sp. *m/e* 362 ($M-CH_2CO$), *m/e* 344 ($M-CH_3COOH$).

ii) The compound possessing the *Rf* 0.3: tertiary alcohol VIII. mp 217—221° (from MeOH). IR cm^{-1} (KBr): 3350, 1780, 1745, 1720. NMR (δ) (in $CDCl_3$): 3.56, 3.01 (each 1H, singlet, C-5-H and C-9-H), 3.45 (1H, singlet, C-16-OH), 1.51 (3H, singlet, C-16-CH_3).

Thioketalization of VII followed by Desulfurization——Dehydrodihydronodosin monoacetate (VII) (80 mg) was treated with ethanedithiol (0.5 ml) and BF_3 etherate (0.3 ml). After standing for 2 hr, the reaction mixture was thrown into a saturated Na_2CO_3 solution and extracted with $CHCl_3$. The extract was washed with H_2O and dried over anhydrous Na_2SO_4, then the solvent was distilled off to give a residue. The latter was dissolved in EtOH (10 ml) and refluxed for 7 hr with Raney Ni (4 g). After filtration, EtOH was evaporated to give a residue which was purified with column chromatography and recrystallization from MeOH. mp 169—170° (20 mg), $[\alpha]_D^{17}$ −163° ($c=1$, $CHCl_3$). The compound was identified with a sample of keto lactone acetal X by mixture melting point determination and spectral comparisons.

Dihydroenmeinone 6-Acetate (XI)——A solution of dihydroenmein 6-acetate (XII) (1 g) in pyridine (10 ml) was added under stirring to a complex prepared from CrO_3 (3 g) and pyridine (30 ml). After standing overnight, H_2O (120 ml) was added. The mixture was extracted with $CHCl_3$ and the extract was washed with H_2O. After drying over Na_2SO_4, the solvent was distilled off to give a crystalline residue (750 mg). It was chromatographed on silica gel, and the eluate with $CHCl_3$ yielded the needles, mp 191—193° (decomp.), after recrystallization from MeOH. IR cm^{-1} (KBr): 1755, 1720. *Anal.* Calcd. for $C_{22}H_{28}O_7$: C, 65.33; H, 6.98. Found: C, 65.04; H, 7.19.

3-Desoxydihydroenmein 6-Acetal (X)——A mixture of dihydroenmeinone 6-acetate (XI) (240 mg), ethanedithiol (1 ml) and BF_3-etherate (0.5 ml) was allowed to stand for 1 hr at room temperature, and then poured into a saturated Na_2CO_3 aq. (20 ml). The mixture was extracted with $CHCl_3$. The extract, after

11) Developed with a mixture of acetone and $CHCl_3$ (5:95).

washing with H_2O and drying, was evaporated to dryness under reduced pressure. The redisue was refluxed in EtOH (30 ml) with Raney Ni W-2 (6 g) for 10 hr and the reaction mixture was filtrated while hot. The solvent was evaporated to give the residue (200 mg) which was chromatographed on silica gel column. An eluate with $CHCl_3$ gave 3-desoxydihydroenmein 6-acetal (X) (76 mg) as crystals. mp 169—170°, $[\alpha]_D^{17}$ −159° (c=1, $CHCl_3$). IR cm^{-1} (KBr): 1760, 1720. NMR (δ) ($CDCl_3$): 0.97, 1.00 (each 3H, singlet), 1.08 (3H, triplet, $-OCH_2C\underline{H}_3$), 1.14 (3H, doublet, C-16-C$\underline{H}_3$), 3.50 (2H, multiplet, $-OC\underline{H}_2CH_3$), 3.97 (2H, AB type, J=9.0 cps, $\underline{H}_2$ at C-20), 4.38 (1H, triplet, C-1-$\underline{H}$), 4.88 (1H, singlet, C-6-$\underline{H}$). *Anal.* Calcd. for $C_{22}H_{32}O_5$: C, 70.18; H, 8.57. Found: C, 70.21; H, 8.87.

Mesylation of Dihydronodosin 6-Acetate (V): Dihydronodosin 6-Acetate 11-Mesylate (IX)——Dihydronodosin 6-acetate (V) (30 mg) was dissolved in pyridine (1 ml) and two drops of MsCl was added to this solution under ice-cooling, then the mixture was allowed to stand overnight at room temperature. Extraction of the reaction mixture with $CHCl_3$, washing of the extract with H_2O, drying over anhydrous Na_2SO_4 and evaporation of the solvent gave a residue (31 mg), which was chromatographed on silica gel to yield dihydronodosin 6-acetate 11-mesylate (IX) as an oily product (17 mg). IR cm^{-1} ($CHCl_3$): 1760, 1720. NMR (δ) (in $CDCl_3$): 5.39 (1H, triplet, J=4.0 cps, C-11-$\underline{H}$), 3.19 (3H, singlet), 2.97 (1H, doublet, J=12.0 cps, β-$\underline{H}$ at C-14).

Reduction of Dihydronodosin (III) with LiAl (t-BuO)$_3$H——Dihydronodosin (III) (20 mg) was dissolved in tetrahydrofuran (2 ml), to which a solution of LiAl (t-BuO)$_3$H (40 mg) in tetrahydrofuran (1 ml) was added. The mixture was allowed to stand for 2 days under stirring at room temperature. The reaction mixture was thrown into ice-water and extracted with AcOEt. Washing with H_2O, drying over anhydrous Na_2SO_4 and evaporation of the solvent left a residue (20 mg). It was chromatographed on a silica gel column to separate a more polar substance (10 mg) from the unreacted material III (5 mg). The former was crystallized from AcOEt to give a sample, mp 228—230°, which was shown to be identical with tetrahydronodosin (IV) by a mixture melting point test and the spectral comparisons.

Acetylation of Tetrahydronodosin (IV)——Tetrahydronodosin (IV) (50 mg) was dissolved in a mixture of Ac_2O (1 ml) and pyridine (1 ml), and the solution was allowed to stand overnight at room temperature. Evaporation of the solvent and excess reagent *in vacuo* gave a residue (55 mg), which was chromatographed on a silica gel column to yield a fraction (diacetate) (17 mg) possessing *Rf* value of 0.6 on TLC and another fraction (monoacetate) (25 mg) possessing *Rf* value of 0.5 on TLC.

Diacetate was recrystallized from MeOH to afford crystals, mp 218—222°. IR cm^{-1} (KBr): 3500, 1745, 1705. NMR (δ) (in $CDCl_3$): 2.02, 2.05 (3H, singlet), 4.41 (1H, multiplet, C-11-$\underline{H}$), 5.50 (1H, quartet, J=6.0, 10.0 cps, C-1-$\underline{H}$), 5.88 (1H, doublet, J=10.0 cps, C-15-$\underline{H}$), 6.20 (1H, singlet, C-6-$\underline{H}$). *Anal.* Calcd. for $C_{24}H_{34}O_8$: C, 63.98; H, 7.61. Found: C, 64.25; H, 7.91.

Monoacetate was recrystallized from MeOH repeatedly to yield crystals, mp 203—205°. IR cm^{-1} (KBr): 3300—3550, 1740, 1730, 1700. NMR (δ) (in $CDCl_3$): 2.03 (3H, singlet), 4.36 (1H, multiplet, C-11-$\underline{H}$), 4.97 (1H, doublet of doublets, J=5.0, 10.0 cps, C-15-$\underline{H}$), 5.47 (1H, quartet, J=6.0, 10.0 cps, C-1-$\underline{H}$), 6.20 (1H, singlet, C-6-$\underline{H}$). *Anal.* Calcd. for $C_{22}H_{32}O_7$: C, 64.68; H, 7.90. Found: C, 64.81; H, 8.07.

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