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THE STRUCTURES OF SPIRADINES F AND G FROM SPIRAEA JAPONICA L. FIL

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Recently, we reported the structures of spiradines A, B, C and D isolated from *spiraea japonica* L. fil (1). In this communication, we wish to report the structures of spiradines F and G, main alkaloidal components.

Spiradine F (I), $C_{24}H_{33}O_4N$, m.p. 114-7°C (hydrochloride), $\nu_{max}^{CHCl_3}$ 1734 and 1240 cm^{-1}, is an acetate of spiradine G (II), $C_{22}H_{31}O_3N$, m.p. 168-170°C, pKa' 6.9 (50% aqueous methanol), $[\alpha]_D$ -137° (c, 1.16, MeOH).

The IR ($\nu_{max}^{CHCl_3}$ cm^{-1}) and NMR ($\delta_{TMS}^{CDCl_3}$ ppm) spectra of II indicated the presence of the following functional groups: $-\overset{|}{\underset{|}{C}}-CH_3$ (1.17 (3H, s)), $HO-CH<^{C}_{C}\}2H$ (3680; 4.60 (1H, t, J=5 cps)), $>C=CH_2$ (1650; 4.72 (1H, br. s) and 4.58 (1H, br. s)).

Since II contains three oxygen atoms, two remainings seem to constitute two ether groups and signals at 3.32 (1H, d, J=5 cps), 3.80 (1H, s) and 4.46 ppm (1H, s) may be due to protons on carbons attached to the ether oxygen atoms.

Mild reduction of II with sodium borohydride gave a triol (III), $\delta_{TMS}^{CDCl_3}$ 3.84 (1H, t, J=10 cps), 3.59 (2H, t, J=5.5 cps), 3.02 (1H, d, J=10 cps), the formation of which could be readily explained by the reductive cleavage of two ethereal linkages leading to the formation of two new hydroxyl groups. Therefore, these two ether groups can be accounted for as alkanolamine ethers. Two signals at 2.47 (2H, t, J=5.5 cps) and 3.59 ppm (2H, t, J=5.5 cps) coupled to each other can be assigned to the hydroxy-amino group ($>N-CH_2-CH_2-OH$).

Two one-proton singlets at 4.46 and 3.80 ppm in II can be assigned to protons on the carbon atom carrying both ethereal oxygen and nitrogen atoms ($>N-C\underline{H}-O-$).

Oxidation of II with chromium trioxide in pyridine afforded a monoketone (IV), m.p. 158-160°C, the IR spectrum of which had the absorption band at 1730 cm^{-1}, indicating the presence of a strained six-membered ring ketone. In fact, the

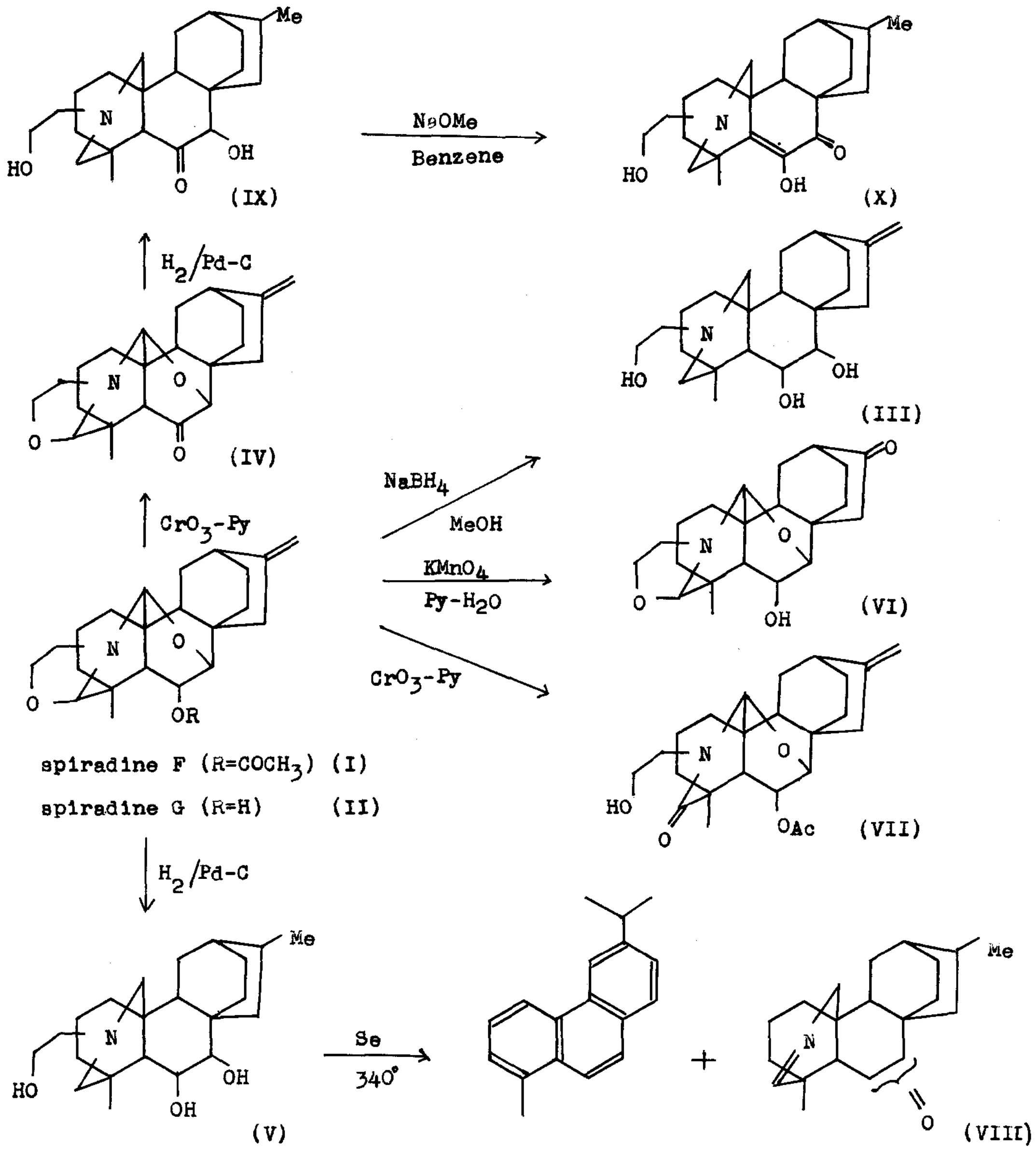


Fig. 1 Reactions of Spiradines F and G

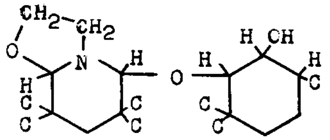
absorption band at 1730 cm^{-1}, was shifted to 1705 cm^{-1} by hydrogenolysis of two ethereal bonds. The doublet at 3.32 ppm coupled to the signal at 4.60 ppm (1H, t, J=5 cps) in II became a singlet at 3.30 ppm in IV.

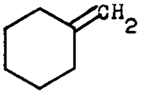
Oxidation of spiradine F (I) with chromium trioxide in pyridine gave a hydroxy-lactam (VII), $\nu_{max}^{CHCl_3}$ 3400 (-OH) and 1640 cm^{-1}(six-membered ring lactam): one alkanolamine ether in I was oxidatively cleaved, and both hydroxyl and lactam groups were newly formed.

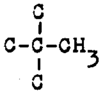
The presence of an exocyclic methylene group in the six-membered ring was confirmed by catalytic reduction of spiradine G (II) to V [$>CH-CH_3$: 0.95 ppm (d, J=8 cps)], and oxidation of II with potassium permanganate to VI ($>C=O$: 1705 cm^{-1}).

Selenium dehydrogenation reaction of V gave 6-isopropyl-1-methylphenanthrene and an imino-ketone (VIII).

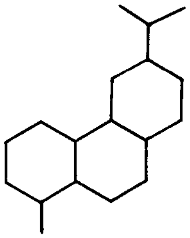
On the basis of the above mentioned facts, the following partial structures can be proposed for spiradine G (II).



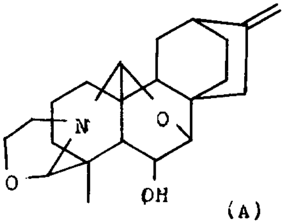




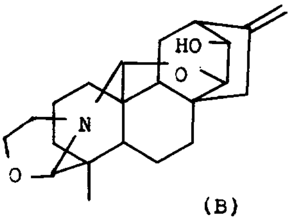
$\mathrm{C{-}\overset{\displaystyle C}{\underset{\displaystyle C}{C}}{-}CH_3}$



Accordingly, these partial structures allow two tentative structures A and B for spiradine G (II) on steric ground.



(A)

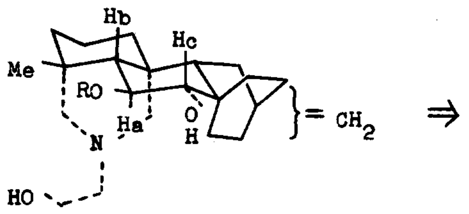


(B)

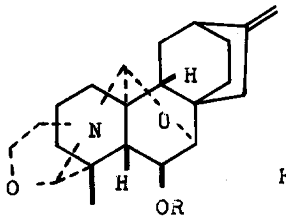
However, the formation of an enolated α-diketone (X) excluded the latter.

Since the α-ketol (IX) has an ORD curve with the molecular amplitude (+4700°) of opposite sign and similar intensity to that of 5α-cholestane-6-one (-7300°), IX has the absolute configuration antipodal to the latter. The values of coupling constant (Jab=Jac=10 cps) in the triol (III) indicate that Ha, Hb and Hc are axial protons, as shown below.

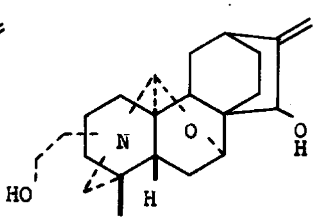
Therefore, spiradines F ($R=COCH_3$) and G (R=H) have the following stereostructure (C).



(III)



(C)



(D)

Spiradine G has a large rotation (M_D -479°) comparable with that of ajaconine (D; M_D -439°). In addition, the spatial interaction effect of the hydroxyl group to the methyl signal is observed in the NMR spectrum of III, as shown below (2).

$$\begin{cases} R=H & 1.07 \text{ ppm } (3H, s) \\ R=COCH_3 & 0.80 \text{ ppm } (3H, s) \end{cases}$$

These spectral findings support the proposed structure (C) and its stereochemistry.

All m.ps are uncorrected. Satisfactory analyses were obtained for all new compounds described herein.

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REFERENCES

(1) G. Goto, K. Sasaki, N. Sakabe and Y. Hirata, Tetrahedron Letters, 1369 (1968).
G. Goto and Y. Hirata, Tetrahedron Letters, 2989 (1968).

(2) Y. Kawasoe, Y. Sato, M. Natsume, H. Hasegawa, T. Okamoto and K. Tsuda, Chem. Pharm. Bull. (Tokyo), 338 (1962).