

THE CONSTITUTION OF NEOTENONE AND DOLICHONE  
BIOGENETIC CONNEXIONS IN THE SUB-FAMILY PAPILIONATAE

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(Received 15 June 1962)

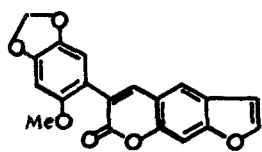
THE roots of Neoratanenia (Dolichos) pseudopachyrrhiza (Leguminosae) are known to be toxic to insects<sup>1</sup> and circumstantial evidence suggested that this might be due to the presence of rotenoids. In the present investigation three crystalline compounds have been isolated. One, pachyrrhizin (I), has earlier been encountered in Pachyrrhizus erosus<sup>2,3</sup> but the other two, (±)-neotenone formulated as the furanoisoflavone (II) and (±)-dolichone formulated as the furanorotenoid (III), are new compounds.

(±)-Neotenone, C<sub>19</sub>H<sub>14</sub>O<sub>6</sub>, m.p. 180.5<sup>o</sup>,  $\nu_{\max}$  1684 cm<sup>-1</sup>, had infra-red and ultra-violet spectral characteristics reminiscent of elliptone, but it was not a rotenoid for dehydrogenation with manganese dioxide gave a furanoisoflavone which could be hydrolysed to the deoxybenzoin (IV, R = Me) or oxidized by alkaline hydrogen peroxide to the acids (V) and (VI). The identities of the latter were established by comparison with synthetic specimens. (±)-Neotenone could be reconstructed by treating the deoxybenzoin (IV, R = Me) with ethyl orthoformate-pyridine-piperidine, which gave the isoflavone. Reduction with sodium borohydride and oxidation with chromic acid then gave (±)-neotenone. The nuclear magnetic resonance

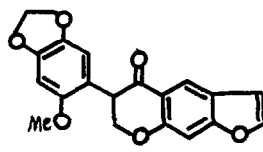
<sup>1</sup> M.J. Holman, A Survey of Insecticide Materials of Vegetable Origin. The Imperial Institute, London (1940).

<sup>2</sup> L.B. Norton and R. Hansberry, J. Amer. Chem. Soc. **67**, 1609 (1945).

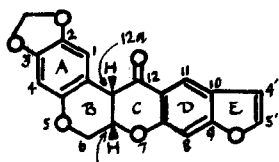
<sup>3</sup> E. Simonitsch, H. Frei and H. Schmid, Monatsh. **88**, 541 (1957).



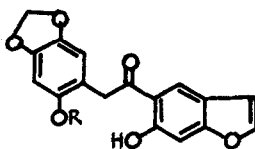
I



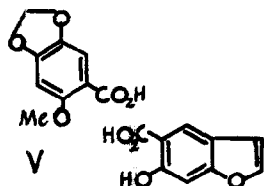
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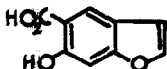
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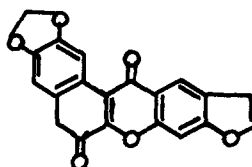
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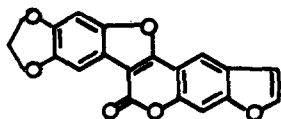
V



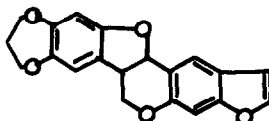
VI



VII



VIII



IX

spectrum of neotenone<sup>4</sup> is in complete accord with structure (II).

Supplis of dolichone,  $C_{19}H_{12}O_6$ , m.p.  $235^\circ$ ,  $[\alpha]_D^{20} +135^\circ$  ( $CHCl_3$ ),  $\nu_{max}$   $1684\text{ cm}^{-1}$  were limited ( $\sim 100\text{ mg}$ ). Its ultra-violet spectrum closely simulated that of neotenone and taking into account this, and the infra-red data, the nuclear magnetic resonance spectrum led at once to structure (III) [ $\tau$  value: methylene dioxy 4.16, 4.07; 1,4,8 and 11-aromatic hydrogens 3.44,

<sup>4</sup> L. Crombie and J.W. Lown, J. Chem. Soc. 775 (1962).

3.50, 2.79 and 1.85 respectively (no spin coupling); 5',4', furanhydrogens 2.10, 3.04,  $\int 2$  c/s]. The mass spectral mol. wt. agreed exactly with that proposed (336) and Dr. R.I. Reed and Dr. J.M. Wilson (University of Glasgow) who kindly measured this, have told us that the cracking pattern agrees with structure (III). The presence of the 12,12a,6a,6 and 5 sequence of atoms was supported by dehydrogenating dolichone at 6a and 12a with manganese dioxide. The 6a,12a-dehydro compound, m.p. 270° decomp.,  $\nu_{\max}$  1639  $\text{cm}^{-1}$ , was oxidized with lead tetraacetate and the unpurified product now had  $\nu_{\max}$  1658 and 1748  $\text{cm}^{-1}$  as expected for the 12-ketone and  $\alpha$ -pyrone carbonyl of the keto-lactone (VII).

The presence of the deoxybenzoin fragment (IV) in dolichone was confirmed by treating the latter with zinc and alkali to give (IV, R = H), which was partially methylated. In thin-layer chromatography the product was identical (three solvent systems and three spray reagents) with the specimen of the deoxybenzoin (IV, R = Me) isolated from neotenone. The  $r$  value (3.44) for the 1-hydrogen in dolichone is as expected for a *cis*-fused B/C system<sup>4</sup> and Professor C. Djerassi kindly informs us that the Cotton effect is positive with the first extremum near 362  $\text{m}\mu$ :<sup>5</sup> this indicates that it has the same absolute configuration at 6a and 12a as rotenone<sup>6</sup> and hence is (6a $\underline{S}$ , 12a $\underline{S}$ ) as in (III).

N. pseudopachyrrhiza, N. edulis and P. erosus are closely related members of the tribe Phaseoleae of the sub-family Papilionatae. Besides pachyrrhizin (I),<sup>3</sup> the lactone erosnin (VIII),<sup>7</sup> and the 8-methoxy derivative of (III), pachyrrhizone,<sup>8</sup> have been isolated from P. erosus seeds. In

<sup>5</sup> Cf. C. Djerassi, W.D. Ollis and R.C. Russell, J. Chem. Soc. 1448 (1961).

<sup>6</sup> G. Büchi, L. Crombie, P.J. Godin, J.S. Kaltenbronn, K.S. Siddalingaiah and D.A. Whiting, J. Chem. Soc. 2843 (1961).

<sup>7</sup> J. Eisenbeiss and H. Schmid, Helv. Chim. Acta 42, 61 (1959).

<sup>8</sup> H. Bickel and H. Schmid, Helv. Chim. Acta 36, 664 (1953).

collaboration with Dr. P.J. Godin we have shown that neotenone and dolichone are also present.\* Seven compounds are reported from N. edulis but only one, edulin (IX) has been formulated.<sup>9</sup> "Substance 1" (neorautone)<sup>9</sup> and "substance 3" (neorautenone)<sup>9</sup> seemed to us, despite discrepancies, to be pachyrrhizin and ( $\pm$ )-neotenone respectively, and mixed m.p.'s with samples generously supplied by Dr. Van Duuren have confirmed this. An unusually comprehensive pattern of variations on a basic furanoisoflavanoid theme is emerging in this closely related group of plants.

We thank Dr. J.W. Lown for the nuclear magnetic resonance data. Financial support from Shell Research Ltd., and the University of London Research Fund is gratefully acknowledged.

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\* The description of "compound VI"<sup>2</sup> and its degradation product from zinc and alkali treatment had led us to suspect that P. erosus also contains dehydroneotenone. The "compound VI" has lately been re-isolated by Dr. W.D. Ollis and Dr. K. Robinson (personal communication), who have arrived at the same conclusion by direct examination: mixed m.p. with our dehydroneotenone has confirmed the identity.

<sup>9</sup> B.L. Van Duuren, J. Org. Chem. **26**, 5013 (1961).