Phenol Oxidation and Biosynthesis. Part XXIV.† Origin of Chirality in the Erythrinan System and Derivation of the Lactone Rings of α- and β-Erythroidine

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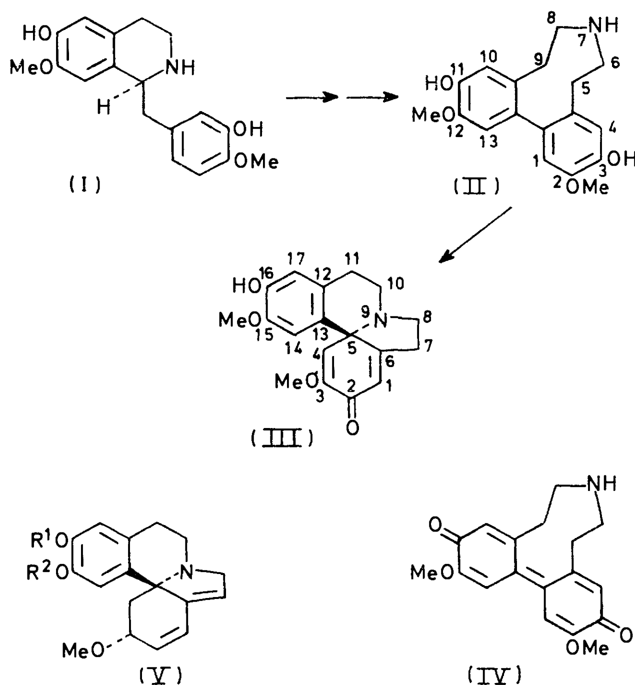
Erysodienone (III) has been resolved, and the laevorotatory (5*S*)-antipode is shown to be the precursor of the *Erythrina* alkaloids. Chiral 5,6,8,9-tetrahydro-2,12-dimethoxy-7*H*-dibenz[*d,f*]azonine-3,11-diol, derived from resolved erysodienone, is optically unstable at 20 and at 0°. The biosynthetic implications are discussed.

The aromatic *Erythrina* alkaloids are shown to be specifically incorporated into the lactone erythroidine alkaloids with retention of the 17-hydrogen atom. Cleavage of the aromatic ring in nature is discussed.

THE *Erythrina* alkaloids are derived *in vivo* (Scheme 1) from (*S*)-*N*-norprotosinomenine (I) by *p*–*p*-phenolic oxidative coupling and ring opening followed by reduction of the imine so generated, to give the dibenzazonine intermediate (II). This is further oxidised to erysodien-

† Part XXIII, ref. 8.

one (III) with presumed (5*S*) chirality.[1-3] *In vitro*, this latter oxidation proceeds *via* a planar diphenoquinone



SCHEME 1

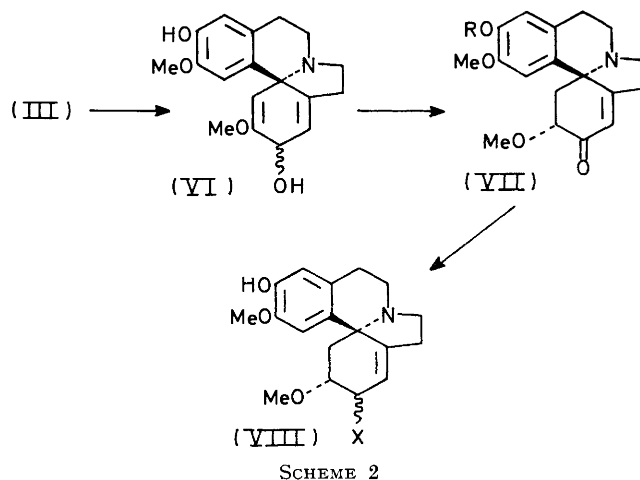
(IV) derived from (II).[4] *In vivo* the intermediacy of such a planar intermediate has not been demonstrated. However, in the biosynthetic process, the absolute stereochemistries of *N*-norprotosinomenine (I) and the *Erythrina* alkaloids [such as erythraline (V; $R^1R^2 = CH_2$)] are such that an apparent inversion of chirality has occurred.[1] This process could arise by a true inversion, if all the intermediates retained their steric integrity, or *via* a symmetrical intermediate, such as the diphenoquinone (IV) if this is indeed involved, or by a readily racemised intermediate which could be the dibenzazonine (II).

We therefore sought to resolve erysodienone and generate from this the chiral dibenzazonines (II) in order to investigate these points. Synthetic (±)-erysodienone [5a,6] was converted into the (+)-3-bromocamphor-9-sulphonate salt which was crystallised from ethanol to a constant optical rotation of $[\alpha]_D^{20}$ +44·8°. The dienone, regenerated from the salt, showed $[\alpha]_D^{19}$ −27·0°. Corresponding treatment of (±)-erysodienone with the (−)-3-bromocamphorsulphonic acid similarly gave erysodienone with $[\alpha]_D^{21}$ +25·1°.

At this stage, there was no guarantee of the optical purity of the isomers nor any indication of the absolute configurations. Therefore we converted (−)-erysodienone into the alkaloids erythratidinone [7] (VII; R = Me) and dihydroerysodine [4] (VIII; X = H) of known absolute configurations,[2] essentially by the method [5a] of Mondon and Ehrhardt (Scheme 2).

(−)-Erysodienone was reduced to a C-2 epimeric mixture of alcohols (VI) with sodium borohydride in 95% yield. The dienols (VI) were isomerised with hydrogen chloride in anhydrous ether–methanol to erysotinone (VII; R = H) in 64% yield. Methylation of this with diazomethane in ether gave (+)-erythratidinone (VII; R = Me), m.p. 160—161°, $[\alpha]_D^{21}$ +335°, in 67% yield. Alternatively, further reduction of the enone (VII; R = H) with sodium borohydride gave, in 80% yield, a second mixture of C-2 epimeric alcohols (VIII; X = OH). This was converted into the mixed chlorides (VIII; X = Cl) (65%) without separation, by using thionyl chloride in pyridine. Hydrogenolysis of the chloride mixture gave dihydroerysodine in 96% yield, m.p. 206—208°, $[\alpha]_D^{21}$ +218°. The reported values for the rotations of natural erythratidinone [7] and dihydroerysodine [4] are +358 and +224° respectively. The dienones (III) were thus fully resolved and the (−)-isomer has the (5*S*)-chirality of the natural series.

As an initial check on the optical stability of the dibenzazonine (II), the partially resolved dienone (III) from the filtrate of the resolution experiment was reduced at 0° with chromium(II) chloride as previously reported.[1] However, at this temperature the reduction was slow (1·5 h). Reduction with titanium(III) chloride in an analogous manner at 0° was faster. The dibenzazonine produced racemised rapidly with $t_{\frac{1}{2}}$ ~1·2 min at 20° and



SCHEME 2

~8·2 min at 0°. This precluded any biosynthetic experiments with the antipodal dibenzazonines and indicates a probable racemisation *in vivo* at this stage of the biosynthetic process.

[1] D. H. R. Barton, R. B. Boar, and D. A. Widdowson, *J. Chem. Soc. (C)*, 1970, 1213.
[2] D. H. R. Barton, R. James, G. W. Kirby, D. W. Turner, and D. A. Widdowson, *J. Chem. Soc. (C)*, 1968, 1529.
[3] V. Boekelheide and G. R. Wenzinger, *J. Org. Chem.*, 1964, **29**, 1307.
[4] D. H. R. Barton, R. B. Boar, and D. A. Widdowson, *J. Chem. Soc. (C)*, 1970, 1208.
[5] (*a*) A. Mondon and M. Ehrhardt, *Tetrahedron Letters*, 1960, 2557; (*b*) D. S. Millington, D. H. Steinman, and K. L. Rinehart, *J. Amer. Chem. Soc.*, 1974, **96**, 1909.
[6] J. E. Gervay, F. McCapra, T. Money, G. M. Sharma, and A. I. Scott, *Chem. Comm.*, 1960, 142.
[7] D. H. R. Barton, A. A. L. Gunatilaka, R. M. Letcher, A. M. F. T. Lobo, and D. A. Widdowson, *J.C.S. Perkin I*, 1973, 874.

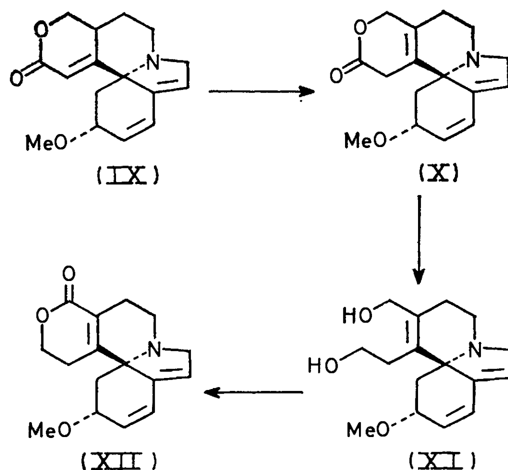
For the feeding experiments, (+)-, (−)-, and (±)-erysodienone (III) were tritiated at C-1 and C-17 as previously described.[1] Samples of the labelled materials were fed by the wick method to 6 month old *Erythrina crista galli* and *E. berteroana* seedlings for 6 and 14 days respectively. The whole plants were macerated and worked up as previously described [1,8] for erythraline or α- and β-erythroidines respectively. After dilution with radioinactive material, the alkaloids were purified by crystallisation of their hydrohalide salts to constant activity. α- and β-Erythroidine co-crystallise and no attempt was made to separate these at this stage. The incorporations are given in Table 1. The ready asimilation of (−)-erysodienone, which had been related to the natural alkaloids above, and the non-incorporation of the (+)-isomer, confirms the former to be the *in vivo* progenitor of the *Erythrina* alkaloids.

TABLE 1

Feedings of isomeric erysodienones

Precursor	Incorporation (%) Erythraline (V; R^1R^2=CH_2)	Erythroidines (IX) and (X)
(+)-[1,17-$^3H_2$]Erysodienone [as (III)]	⩽0·0006	⩽0·045
(−)-[1,17-$^3H_2$]Erysodienone (III)	0·27	0·33
(±)-[1,17-$^3H_2$]Erysodienone [as (III)]	0·10	0·20

The relationship between (−)-erysodienone and the erythroidines is thus established, but the precise origin of the lactone ring in the erythroidines is not unambiguously determinable from this or any other reported data.[8,9] For an initial study of this problem we required a degradative process for the erythroidines which would locate the hydrogen atom at C-17. The route is given in Scheme 3.



SCHEME 3

The mixture of α- and β-erythroidines was converted totally into the β-isomer (X) by treatment with base.[10] Reduction of this with lithium aluminium hydride in refluxing tetrahydrofuran gave a 74% yield of β-erythroidinol (XI).[11] Selective oxidation of the allylic alcohol group of (XI) with chromium trioxide in acetone gave a 25% yield of a lactone (XII), isomeric with β-erythroidine. This lactone lacks the hydrogen atoms originally present at C-17 in β-erythroidine and enables the retention or loss of a C-17 label of a precursor to be determined.

[17-^{3}H]Erysodine (V; $R^1 = H$, $R^2 = Me$), [14,17-$^3H_2$]-erysopine (V; $R^1 = R^2 = H$), and (±)-[1,17-$^3H_2$]-erysodienone (III) were fed to *E. berteroana* plants as above. In parallel, [2-^{14}C]tyrosine and (±)-[5-^{3}H]-*N*-norprotosinomenine (I) were fed as a check on the metabolic assimilation in these plants. The erythroidines were isolated, after dilution, as before and crystallised to constant activity as the hydrohalides. The incorporations are given in Table 2.

TABLE 2

Feedings to *E. berteroana*

Precursor	Incorporation (%) [a]
[2-^{14}C]Tyrosine	0·32 [b]
[5-^{3}H]-*N*-Norprotosinomenine (I)	0·96 [b]
[1,17-$^3H_2$]-(±)-Erysodienone [as (III)]	0·078 [b]
	0·28 [c]
[17-^{3}H]Erysodine (V; $R^1 = H$, $R^2 = Me$)	0·50 [b]
	0·12 [c]
[14,17-$^3H_2$]Erysopine (V; $R^1 = R^2 = H$)	0·21 [b]
	0·15 [c]

[a] Into erythroidines. [b] Feeding for 33 days. [c] Feeding for 11 days.

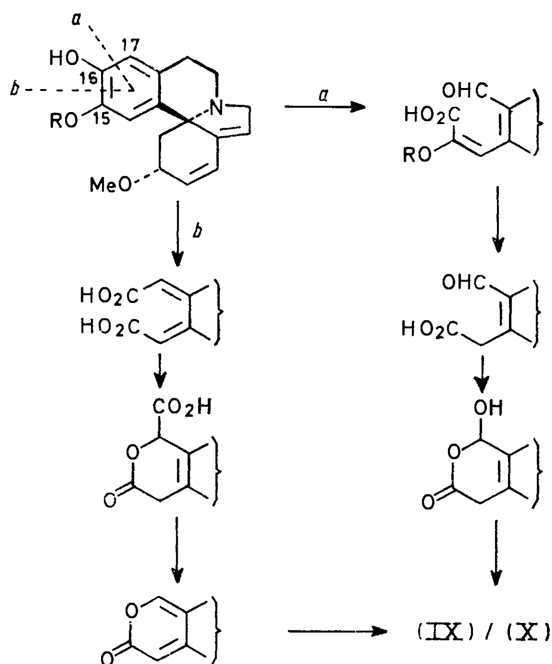
All compounds were eventually incorporated to acceptable levels. The erythroidines biosynthesised from erythrinans which were tritium labelled solely in the (aromatic) ring D clearly retained the label, but the possibility of scrambling of this label still remained. We therefore subjected the product of the [17-^{3}H]erysodine feeding to the degradation outlined in Scheme 3. The lactone (XII) produced had lost 99% of the activity of the erythroidine. The original label was therefore retained at C-17 throughout the metabolism of ring D of erysodine to the lactone ring D of the erythroidines.

These data do not allow the precise point of cleavage of the aromatic ring to be determined. Intradiol [C(15)–C(16)] or extradiol [C(16)–C(17)] cleavage would both lead to retention of the 17-hydrogen atom and loss of C-16 (Scheme 4). It follows that the mode of aromatic ring fission can only be determined by use of the labelled intermediates of Scheme 4.

The cleavage of aromatic rings by higher plants is rare but has been proven unambiguously for the betalains.[12,13]

[8] D. H. R. Barton, C. J. Potter, and D. A. Widdowson, *J.C.S. Perkin I*, 1974, 346.
[9] A. Ahmad and E. Leete, *J. Amer. Chem. Soc.*, 1966, **88**, 4722.
[10] V. Boekelheide and G. C. Morrison, *J. Amer. Chem. Soc.*, 1958, **80**, 3905.
[11] M. F. Grundon, G. L. Sauvage, and V. Boekelheide, *J. Amer. Chem. Soc.*, 1953, **75**, 2541.
[12] H. E. Miller, H. Rosler, A. Wohlport, H. Wyler, M. E. Wilcox, H. Frohfer, T. J. Mabry, and A. S. Dreiding, *Helv. Chim. Acta*, 1968, **51**, 1470.
[13] G. Impellizzeri and M. Piattelli, *Phytochemistry*, 1972, **11**, 2499.

The reference markers, tyrosine and *N*-norprotosinomenine were only acceptably incorporated after a 33 day feeding but the aromatic *Erythrina* alkaloid precursors were assimilated in 11 days. The general experience of the necessity for a long feeding time with *E. berteroana* plants is therefore probably associated with a low efficiency at generating the erythrinan skeleton rather than a slow cleavage of the aromatic ring.



SCHEME 4

EXPERIMENTAL

Unless otherwise stated, m.p.s were determined on a Kofler hot stage apparatus. N.m.r. spectra were run for solutions in deuteriochloroform, and i.r. spectra and optical rotations for solutions in chloroform. T.l.c. and preparative t.l.c. (p.l.c.) were run on alumina G.F. plates unless otherwise stated.

Resolution of (±)-*Erysodienone* [*as* (III)].—Racemic erysodienone [5a,6] (250 mg) was refluxed with (+)-3-bromocamphor-9-sulphonic acid (250 mg) in chloroform (75 ml). Evaporation of the solvent and crystallisation of the product from ethanol (150 ml) gave, after several days at 0°, erysodienone bromocamphorsulphonate as a white crystalline salt. After repeated recrystallisation the salt had m.p. 203—204° (decomp.), and $[\alpha]_D^{20}$ constant at +44·8° (*c* 0·98). The resolved erysodienone was recovered from this salt by treatment with aqueous sodium hydrogen carbonate and extraction with chloroform. Evaporation of the solvent gave (−)-erysodienone $[\alpha]_D^{19}$ −27·0 (*c* 0·8).

(±)-Erysodienone enriched with the (+)-enantiomer, recovered from the above mother liquors, was treated in an analogous manner with (−)-3-bromocamphor-9-sulphonic acid to give the salt, m.p. 197—198° (decomp.), $[\alpha]_D^{20}$ −43·5° (*c* 1·4) and thence (+)-erysodienone $[\alpha]_D^{21}$ +25·1° (*c* 0·9).

Conversion of (−)-*Erysodienone* (III) *into* (+)-*Erythratidinone* (VII; R = Me).—(−)-Erysodienone (100 mg) in ethanol (5 ml) was treated with sodium borohydride (110 mg) with stirring at room temperature until all the erysodienone had reacted (3 h). The solution was evaporated to dryness and the residue treated with water and extracted with chloroform. The extracts were dried (Na_2SO_4) and evaporated to give a white foam (93·5 mg, 95%), m.p. 128—130° (lit.,[5a] 131°). T.l.c. (silica) showed the product to be a mixture of the two epimeric dienols (VI).

The mixture of the erysodienols (VI) (93 mg) in absolute methanol was treated at 0° with dry ether saturated with gaseous hydrogen chloride (3 ml). The solution was allowed to warm to room temperature and left overnight. Evaporation gave a white foam which was basified with sodium hydrogen carbonate solution and extracted with chloroform. The extracts were dried (Na_2SO_4) and evaporated at reduced pressure. The residue was separated by p.l.c. (silica) to give erysotinone (VII; R = H), m.p. 196—198° (from acetone) [lit., 196—197° (racemic) [5a] 177—179° (+) [5b]] (600 mg, 64%).

Finally, erysotinone (VII; R = H) (30 mg) in methanol (2 ml) was treated with an ice-cooled ethereal solution of diazomethane (6 ml) and kept overnight at 0°. The mixture was evaporated to *ca.* 1/3 its volume and the residue separated by t.l.c. using benzene–ethyl acetate (1 : 2) to give (+)-erythratidinone (VII; R = Me), as pale yellow needles (20·0 mg, 67%), m.p. 160—161° (120—121°) $[\alpha]_D^{21}$ +335° (*c* 1·2) (lit.,[7] m.p. 119—120°, $[\alpha]_D$ +358°).

Conversion of (−)-*Erysodienone* (III) *into* (+)-*Dihydroerysodine* (VIII; X = H).—Erysotinone (VII; R = H) [29 mg, obtained as before from (−)-erysodienone] in ethanol (2 ml) was treated with sodium borohydride (30 mg) with stirring at room temperature for 3 h. The solution was evaporated to dryness and the residue treated with water and extracted with chloroform. The extracts were dried (Na_2SO_4) and evaporated to give the alcohol (VIII; X = OH) (23·3 mg, 80%), m.p. 189—190° [lit., 188° (racemic),[5a] 225—227° (natural) [5b]]. Erysotine (VIII; X = OH) (23·0 mg) in dry pyridine (1 ml) was stirred with thionyl chloride overnight at 0°, then at room temperature for 4 h. The mixture was diluted with water (40 ml), neutralised with aqueous sodium carbonate, and extracted with chloroform (10 × 10 ml). The extract was dried (Na_2SO_4) and the solvent evaporated under reduced pressure. P.l.c. of the residue gave the chloride (VIII; X = Cl) (15·8 mg, 65%), m.p. 175—177° (lit.,[5a] 177°).

The chloride (VIII; X = Cl) (15·0 mg) in methanol (2 ml) containing 10% palladium on charcoal (5 mg), was exhaustively hydrogenated (20 min) at atmospheric pressure and room temperature. The solution was heated to boiling, filtered hot, and the catalyst washed thoroughly with hot methanol. The combined filtrates were evaporated to dryness and the residue recrytallised from acetone to give dihydroerysodine (VIII; X = H) (13·0 mg, 96%), m.p. 206—208°, $[\alpha]_D^{21}$ +218° (*c* 0·9 MeOH) {lit.,[5a] m.p. 208—209°, $[\alpha]_D$ +224° (MeOH)}.

Synthesis of the Chiral Dibenzazonine (II).—(*a*) Partially resolved erysodienone (III) (30 mg) was stirred with a 1M-solution of chromium(II) chloride in 3% hydrochloric acid (6 ml) under nitrogen at 0° (1·5 h). Air was allowed to enter the system and the pH was adjusted to *ca.* 9 with sodium carbonate. The precipitated solid was filtered off and washed thoroughly with ethanol. The filtrate was extracted with chloroform and the combined chloroform and ethanolic extracts were evaporated. The residue was treated with water and re-extracted with chloroform. All manipulations were carried out in a cold-room at 0°.

Finally, the chloroform solution was dried (Na_2SO_4) and evaporated under reduced pressure at 0° to give the dibenzazonine (II), m.p. 220° (lit.,[2] 222—224°). At room temperature the compound racemised rapidly ($t_{\frac{1}{2}} \sim 1{\cdot}2$ min).

(*b*) Reduction with titanium(III) chloride was made as for the chromium(II) chloride process described above. Polarimetric studies on this sample at 0° indicated that racemisation was again rapid ($t_{\frac{1}{2}} \sim 8{\cdot}2$ min).

Feeding of (+)-, (−)-, *and* (±)-[1,17-^{3}H]*Erysodienone to* E. crista galli.—The hydrochlorides of (−)-, (+)-, and (±)-erysodienone (1·03 mg, 10·61 ± 0·2 × 10^6 disint. s^{-1}; 3·35 mg, 2·15 ± 0·1 × 10^6 disint. s^{-1}; and 3·34 mg, 4·12 ± 0·1 × 10^6 disint. s^{-1} respectively) were each fed to one *E. crista galli* plant in June. After 6 days the whole plants (21, 20, and 18 g respectively, wet weight) were worked up as before.[1] The three samples of erythraline (V; $R^1R^2 = CH_2$) isolated were each diluted with inactive erythraline (31·7, 16·5, and 21·26 mg respectively), and converted into their hydrobromide salts. Each sample was then recrystallised several times to a constant specific activity. From (−)-erysodienone the erythraline obtained showed an activity of 899 ± 6·5 disint. s^{-1} mg^{-1} (0·27% incorporation). That from (±)-erysodienone showed a constant specific activity of 199·4 distint. s^{-1} mg^{-1} (0·10% incorporation). Finally the activity of the (+)-erythraline obtained from (+)-erysodienone was too low to be assayed accurately, corresponding to less than 10^{-3}% incorporation.

Feedings of (+)-, (−)-, *and* (±)-[1,17-$^3H_2$]*Erysodienone to* E. Berteroana.—The hydrochlorides of (−)-, (+)-, and (±)-erysodienone (2·70 mg, 27·7 ± 0·4 × 10^6 disint. s^{-1}; 5·11 mg, 3·28 ± 0·3 × 10^6 distint. s^{-1}; and 7·35 mg, 9·10 ± 0·1 × 10^6 disint. s^{-1} respectively) were each fed to one *E. berteroana* plant in June and harvested after 14 days. Each alkaloid sample (obtained as before [8]) was diluted with inactive α-erythroidine (47·6, 40·3, and 40·8 mg respectively) and converted into the hydrochloride salt. Each sample was then recrystallised several times. That from (−)-erysodienone showed a constant specific activity of 1913 ± 12 disint. s^{-1} mg^{-1} (0·33% incorporation). That from (±)-erysodienone had 467·0 ± 6·5 disint. s^{-1} mg^{-1} (0·20% incorporation), and that from (+)-erysodienone showed a barely detectable activity consistent with an incorporation of $\leqslant$0·045%.

Feedings of [2-^{14}C]*Tyrosine and* [5-^{3}H]-N-*Norprotosinomenine to* E. berteroana.—The precursors (1·92 ± 0·04 × 10^5 and 5·0 ± 0·2 × 10^4 disint. s^{-1} respectively), were fed in parallel to 6 month old *E. berteroana* plants as before in June. The plants were harvested after 33 days, and a crude basic extract was obtained.[8] The extracts were diluted with α-erythroidine (14·6 and 13·8 mg respectively) and crystallised as the hydrochloride salts to constant activities of 4·1 ± 0·2 (0·032% incorporation) and 2·16 disint. s^{-1} mg^{-1} (0·06% incorporation) respectively.

Feeding of [1,17-$^3H_2$]-(±)-*Erysodienone* [*as* (III)], [17-^{3}H]-*Erysodine* (V; R^1 = H, R^2 = Me), *and* [14,17-$^3H_2$]*Erysopine* (V; $R^1 = R^2$ = H) *to* E. berteroana.—[1,17-$^3H_2$]Erysodienone (III) (2·36 mg, 2·8 ± 0·15 × 10^5 disint. s^{-1}), [17-^{3}H]-erysodine (V; R^1 = H, R^2 = Me) (1·81 mg, 1·40 ± 0·08 × 10^5 disint. s^{-1}), and [14,17-$^3H_2$]erysopine (V; $R^1 = R^2$ = H) (1·60 mg, 1·81 ± 0·09 × 10^5 disint. s^{-1}) were fed in parallel to 6 month old *E. berteroana* plants in June as before.[8] The plants were harvested after 33 days and the crude alkaloids extracted. Each extract was diluted with inactive α-erythroidine (14·4, 15·4, and 14·8 mg respectively) and the erythroidines purified *via* crystallisation of the hydrochloride salts to constant activities of 15·1 ± 0·08 (0·078% incorporation), 43·9 ± 3 (0·50% incorporation), and 28·7 ± 1·5 disint. s^{-1} mg^{-1} (0·21% incorporation) respectively. A similar feeding which was harvested after 11 days gave incorporations of 0·28, 0·12, and 0·15% respectively.

Isomerisation of α-*Erythroidine to* β-*Erythroidine*.[10]—α-Erythroidine hydrochloride (IX) (25 mg) was added to a 10% solution of AnalaR sodium hydroxide in water (5 ml) and refluxed for 3 h under an atmosphere of nitrogen. The solution was acidified with dilute hydrochloric acid and left at room temperature for 2 h. Solid sodium hydrogen carbonate was added and the basic solution was extracted with chloroform (4 × 5 ml). The combined extracts were dried (Na_2SO_4), filtered, and the solvent removed under reduced pressure to give β-erythroidine (X) (16·2 mg, 65%) which had an n.m.r. spectrum identical with that of authentic material.

β-*Erythroidinol* (XI).—β-Erythroidine (21 mg) in dry, redistilled tetrahydrofuran (6 ml) was refluxed for 3 h with lithium aluminium hydride (6 mg) under an atmosphere of nitrogen. Wet tetrahydrofuran was added, and the precipitate was filtered off and washed with hot tetrahydrofuran. The combined filtrate and washings were dried (Na_2SO_4), filtered, and the solvent removed under reduced pressure to give β-erythroidinol (XI) (15·6 mg, 74%), m.p. 168—170°, softening 163° (from Et_2O) (lit.,[11] m.p. 168°, softening 163°), $\nu_{max.}$ 3420 and 1110 cm^{-1}, τ 3·60 (1H, dd, $J_{1,2}$ 10, $J_{2,3}$ 2·5 Hz, H-2), 5·5—6·8 (9H, complex), 6·64 (3H, s, OMe), 7·08 (4H, m, CH_2), and 8·0—8·5 (2H, complex, H-4), *m/e* 277, 275, 262, 260, 245, 243, 228, and 130 (100%).

15-*Deoxy*-17-*oxoerythroidine* (XII).—β-Erythroidinol (XI) (44 mg) was stirred in acetone (2 ml) with a solution of 0·18M-chromic acid (7·1 ml) for 38 h. The solution was made basic with solid sodium hydrogen carbonate and extracted with chloroform (4 × 5 ml). The combined chloroform layers were dried (Na_2SO_4), filtered, and the solvent was removed under reduced pressure to give an oily residue. This was separated on t.l.c. (two systems: 50% ethyl acetate–benzene and silica with 5% chloroform–methanol), to give 15-*deoxy*-17-*oxoerythroidine* (XII) (11·1 mg, 25%) as its *hydrochloride monohydrate*, needles, m.p. 190—193° (decomp.) (from EtOH). The hydrochloride monohydrate salt had $\nu_{max.}$ (Nujol) 3450, 2500, 2450, and 1708 cm^{-1}, $\lambda_{max.}$ 229 nm (ε 12,000), $[\alpha]_D^{22}$ +86° (*c* 0·048 methanol), *m/e* 273 (M^+), 258, 243, 242 (100%), 240, and 228 (Found: C, 58·6; H, 6·7; N, 3·95. $C_{16}H_{22}ClNO_4$ requires C, 58·65; H, 6·75; N, 4·25%). The water of crystallisation was not removed by drying at 60 °C *in vacuo* for 2·5 days. The free base had τ 3·53br (1H, d, $J_{1,2}$ 10 Hz, H-2), 4·09 (1H, m, $J_{1,2}$ 10 Hz, H-1), 4·20 (1H, m, H-7), 5·80—6·20 (3H, complex, H-15 and H-3), 6·40 (2H, m, H-8), 6·60 (3H, s, OMe), 6·60—7·20 (2H, complex, CH_2), and 7·40—8·50 (6H, complex, CH_2).

Degradation of the Active Erythroidine Biosynthesised from [17-^{3}H]*Erysodine* (V; R^1 = H, R^2 = Me).—[17-^{3}H]Erythroidine hydrochloride (2·3 mg, 45·1 disint. s^{-1} mg^{-1}) from the feeding of [17-^{3}H]erysodine (V; R^1 = H, R^2 = Me) to *E. berteroana* for 33 days was further diluted by the addition of inactive α-erythroidine hydrochloride (18·0 mg). The specific activity was now 5·1 disint. s^{-1} mg^{-1}. This was converted into β-erythroidine (13·3 mg, 78%) as above. Without further purification the β-erythroidine was reduced with lithium aluminium hydride (6 mg) in dry tetrahydrofuran to β-erythroidinol (XI) (7·9 mg, 60%). This was oxidised without purification by 4·5 × 10^{-4}M-chromic acid (0·36 ml)

in AnalaR acetone (1 ml) at room temperature for 3 days to a product which had six components (t.l.c.). The major component was separated by p.l.c. (50% ethyl acetate–benzene) to give 15-deoxy-17-oxoerythroidine (XI) (1·6 mg, 20%) as its hydrochloride monohydrate. It was crystallised 3 times from absolute ethanol, and the specific activity was measured as $\leqslant 0{\cdot}06$ disint. s^{-1} mg^{-1} (1%) which was at the limit of the sensitivity of the assay ($\equiv$ loss of 99% of the original activity in erythroidine).

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