Tetrahedron, 1966, Vol. 22, pp. 35 to 42. Pergamon Press Ltd. Printed in Northern Ireland

SYNTHESES FROM PYRIDINE ALDEHYDES—I

6[H]- AND 7[H]-PYRINDINES

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(Received 2 August 1965)

Abstract—High yield syntheses have been carried out of 6[H] and 7[H]-pyrindines. The former ring system has not been reported. The reaction routes are discussed in relation to the structural features present in the reagents employed.

COMPOUNDS derived from the 6[H]-pyrindine ring system do not appear to have been described and the only synthesis of a 7[H]-pyrindine derivative consists of a 5-stage synthesis of 7-carboxy-7[H]-pyrindine-5-sulphonic acid from 8- hydroxy quinoline in an overall yield of less than 3%.^{1,2} In the work here described derivatives of both these ring systems have been obtained in appreciable yields by the reaction of Grignard reagents with unsaturated azlactones derived from pyridine-3-and-4-aldehydes followed by a cyclization stage.

The unsaturated azlactones cannot be made by the usual procedures because condensation of a pyridine aldehyde with hippuric acid under Erlenmeyer conditions⁸ results only in low yields of tarry products. However the modification of Baltazzi and Davis⁴ was applicable to our problem and high yields of both azlactones and their sulfan adducts were obtained (Table 1).

Awad and Hafez⁵ reacted the analogous compounds derived from benzaldehyde with a series of Grignard reagents and obtained either a carbinol or an oxazoline, the products, they considered being dependent on the nature of the substituent group present in the Grignard reagent. They further showed the indenes could be made either (a) by dehydration of the carbinol or (b) by rearrangement of the oxazoline.

We considered that similar procedures with the azlactones derived from pyridine-3- and -4-aldehydes should give 7[H] and 6[H]-pyrindines respectively subject to any influence on the reaction route resulting from the presence of the electron withdrawing nitrogen atom and have obtained derivatives of both these systems in good yields.

¹ K. Matsumara, J. Amer. Chem. Soc. 49, 813 (1927).

^{*} O. Sus and K. Moller, Liebigs Ann 593, 91 (1955).

^{*} E. Erlenmeyer, Ber Dtsch. Chem. Ges. 33, 2036 (1900); 35, 2483 (1902).

⁴ E. Baltazzi and E. A. Davis, Chem & Ind. 929 (1962).

⁵ W. I. Awad and M. S. Hafez, J. Org. Chem. 25, 1180 (1960); 25, 1183 (1960)

The suggested reaction route in the case of the synthesis of 7[H]-pyrindines from pyridine -3-aldehyde is as follows:



Two products were isolated during the overall process. The first of these was a carbinol (II) or an oxazoline (III) either of which could be cyclized to a 7[H] pyrindine. The first stage proceeded as expected and the product (carbinol or oxazoline) isolated with a given Grignard reagent was analogous to that obtained by the previous workers (Table 2).

In the synthesis of 6[H]-pyrindines from pyridine-4-aldehyde, carbinols or oxazolines were obtained only when Grignard reagents containing an *o*-substituted aryl group (Table 6) were used and while *o*-chlorophenyl magnesium bromide reacts with benzaldehyde and pyridine-3-aldehyde to give a carbinol it reacts with pyridine-4-aldehyde to give an oxazoline. This suggests that the interconversion of II \rightarrow III is an equilibrium controlled process relying more on the relative thermodynamic stabilities of the carbinol and oxazoline than on the electronic effects associated with the substituents present. Such a situation is consistent with an observation of Pourrat⁶ (later queried ^{5,7,8}) that in the reaction of phenylmagnesium bromide with the unsaturated azlactone derived from benzaldehyde both oxazoline and carbinol are formed.

The second stage of the process depends on the de-activated 2-position of the pyridine nucleus undergoing cyclization with the side chain in a manner similar to that shown.

The prospect of electrophilic attack occurring at position 2 seems remote unless the unassessed effect of the azlactone side chain is sufficient to overcome the deactivating influence of the nitrogen atom and with this in mind an alternative route to the 7[H]-pyrindines was investigated viz:

 $\begin{array}{c} \text{Carbinol} & \longrightarrow & \begin{array}{c} \text{Carbinol} & \longrightarrow & \begin{array}{c} \text{Pyrindine} & \longrightarrow & \begin{array}{c} \text{Pyrindine} & & \\ \text{N-oxide} & \longrightarrow & \begin{array}{c} \text{N-oxide} & & \end{array} \end{array}$

which resulted in satisfactory yields (Table 3).

⁸ R. Filler and J. D. Wismer, J. Org. Chem. 22, 853 (1957).

⁶ H. Pourrat, Bull. Soc. Chim. Fr. 828 (1955).

⁷ A. Mustafa and A. H. E. Harhash, J. Org. Chem. 21, 575 (1956).

| | | | | | | | | | | | | - |
|---|-----------|---------------|---|-----------|---------|---------|------|---|--------|-------|--------|-------|
| | M.P. | | | | For | pu | | Analyses % empirical | | Requi | 'es | |
| Compound | ŝ | Yield% | UV spectral data | ပံ | H: | N: | S. | formula | ü | Н; | N; | S |
| (i) Benzaldehyde azlactone (Ref. Cnd.) | 167 | 61 | (a) λ_{max} 259 mµ, ε 15,620 (b) λ_{mxx} 364 mµ. ε 34.710 | | | | | | | | | |
| (ii) Pyridine-3-aldehyde | 163 | 55 | (a) $\lambda_{\text{max}} 257 \text{ m}\mu$, $\varepsilon 16,400$ | 71-74; | 4·16; | 11-08; | l | C18H102N1 | 72.0 ; | 4-03; | 11-20; | I |
| uzuucione (iii) Sulfan adduct of (ii) | 248 | 58 | (U) λmax 307 μμ, ε 30,100 (a) λmax 256 mμ, ε 15,900 (c) 1 250 mm, ε 23,000 | 54-20; | 3-70; | 8-60; | 07-6 | C ₁₈ H ₁₀ O ₆ N ₅ S | 54-50; | 3-30; | 8-50; | 9.70. |
| (iv) Pyridine-4-aldehyde | 168 | 76 | (U) λ_{max} 302 III μ , ε 34,200 (a) λ_{max} 260 m μ , ε 15,360 (b) 3 | 71.70; | 4·14; | 11-13; | 1 | C ₁₆ H ₁₀ O ₈ N | 72-0; | 4.03; | 11·20; | I |
| aziacione (v) Sulfan adduct of (iv) | 253 | 85 | (0) Λματ 300 Π/μ, ε 20, 740 (a) λματ 256 Π/μ, ε 14,900 (b) λματ 365 Π/μ, ε 29,600 | 54-0; | 3·20; | 8.60; 5 | 01.4 | C18H1008N2S | 54.5; | 3·30; | 8-50; | 9.70. |
| Notes: 1 Yields of azlactor | nes quote | cd in (ii) ar | id (iv) are overall from the col | rrespondi | ing ald | thyde. | | | | - | | |

Table 1. Formation of free azlactones and sulfan adducts derived from pyridine-3-and-4-aldehydes

2 Compounds (ii) and (iv) are obtained as buff crystals; compound (iii) as yellow crystals and compound (v) as orange crystals.

3 IR spectral data was obtained for compounds (ii) to (v) using the Perkin-Elmer Infracord (Nujol mulls) and characteristic frequencies of a trisubstituted olefin (870 cm⁻¹), a lactone carbonyl group (1790 cm⁻¹) and a >C = N linkage (1645 cm⁻¹) were observed.

4 UV spectra were determined in glacial acetic acid using a Unicam SP500 spectrophotometer.

Syntheses from pyridine aldehydes-I

| Grignard | Product | М.р. | Yield | | Fou | рц | | Analyses % empirical | | Requires | | |
|--|-------------------|-----------|------------|-----------|----------|--------|----------------|---|------------|-----------|-----------|----------|
| substituent | obtained | °ċ | % | ċ | H; | N; | CI. | formula | ÿ | H; N; | CI. | |
| (i) C ₆ H ₆ - | Carbinol | 148 | 70 | 79-20; | 5:20; | 6·80; | 1 | C _{ir} H _i O _i N _i | 79-80; 5 | 0.42; 6-8 | | |
| (ii) C ₆ H ₄ Cl (o)- | Carbinol | 167 | 36·1 | 68·10; | 4-60; | 5.70; | 14-70 | C ₁ ,H ₁₀ O ₁ N ₁ Cl ₁ | 68-20; 4 | 1-30; 5-9 | 0; 14-90. | |
| (iii) C ₆ H ₆ Cl (p)- | Carbinol | 165 | 52·1 | 68-00; | 4-50; | 5-80; | 14-90 | C,H,O,N,CI | 68-20; 4 | 1-30; 5-9 | 0; 14-90 | |
| (iv) C ₆ H ₄ OCH ₈ (0)- | Carbinol | 155 | 52·1 | 73-90; | 5.80; | 6·1; | I | C"H"O,N, | 74-40; 5 | 560; 6-0 | | |
| (v) $C_{\mathbf{H}} OCH_{\mathbf{I}} (p)$ - | Oxazoline | 175 | 48·2 | 75-40; | 5:40; | 6.30; |] | C _a H ₃ ,O ₃ N ₃ | 75-50; 5 | 5·30; 6·3 | ÷ | |
| (vi) CH _r | Oxazoline | 146 | 67·2 | 80-80; | 6.90; | 5.60; | I | C ₁ ,H ₁ ,ON | 81-30; 6 | 5.70; 5.5 | 1 | |
| Notes: (1) Compou | unds (i) to (iv) | were obt | ained as v | vhite cry | stals; | compo | v) spun |) and (vi) as pale yell | ow crystal | 5 | | |
| (2) IR spectral | data was obtai | ned for a | Il compoi | inds usin | ig the 1 | Unicar | n SP200 | (KBr wafer discs), | • | | | |
| Commund | s (i) to (iv) sho | wed char | acterietic | requenci | | HO | (3450 cm | -1) -NH 3250 cm- | 1). amide | T (1600 | hue (I-ma | amide II |

TABLE 2. REACTION OF AZLACTONE DERIVED FROM PYRIDINE-3-ALDRHYDE WITH GRIGNARD REAGENTS

amide II 5 đ OH (3450 cm⁻¹), - NH 3250 cm⁻¹); Compounds (i) to (iv) showed characteristic frequencies of -OH (3450 cm⁻¹), -NH 3 (1620 cm⁻¹). Compounds (v) and (vi) showed the characteristic frequency of >C = N (1650 cm⁻¹).

Syntheses from pyridine aldehydes-I

| | | | | 7- | -[H]-p | YRIND | INE-N- | OXIDE | | | | |
|-------|--|------|-------|----------------|------------|------------------------|----------------|---|---------------|------------|-----------------|-------|
| | Grignard | М.р. | Yield | | F | ound | | Analyses % empirical | - | Requ | ires | |
| | substituent | °C | % | C; | <i>H</i> ; | N; | Cl | formula | С; | <i>H</i> ; | N; | Cl |
| (i) | C _s H _s - | 237 | 56·2 | 79 ·20; | 5.20; | 6 ∙ 8 0; | | C17H20O2N2 | 80-20 | ; 5.00; | 7.00; | _ |
| (ii) | $C_{\bullet}H_{\bullet}Cl(o)$ - | 192 | 35 | 67.90; | 3.80; | 5.90; | 15.1 | C ₂₇ H ₁₈ O ₂ N ₂ Cl ₂ | 68·80 | ; 3.60; | 5-90; | 15-10 |
| (iii) | $C_{\theta}H_{4}Cl(p)$ - | 207 | 50 | 67.80; | 4.00; | 5-90; | 15-1 | C ₂₇ H ₁₈ O ₂ N ₂ Cl ₂ | 68·80 | ; 3.60; | ; 5 ∙90; | 15.10 |
| (iv) | C ₆ H ₄ OCH ₃ - | 235 | 52·1 | 74.70; | 5.60; | 6 ∙20; | | $C_{29}H_{34}O_4N_3$ | 75-00 | ; 5·20; | 6· 0 0; | |
| | | | | | 7-[| Н}-рү | RINDIN | B | | | | |
| (i) | C _a H _s - | 218 | 60 | 83·10; | 5.00; | 7.20; | | C ₂₇ H ₂₀ ON ₂ | 83 ·50 | ; 5.20 | 7·20; | — |
| (ii) | C.H.Cl (o)- | 176 | 41 | 69.80; | 4.50; | 6.20; | 1 4 ·90 | C ₁₇ H ₁₈ ON ₁ Cl ₁ | 70.00 | ; 4.00; | 6.10; | 15-40 |
| (iii) | $C_{H_{4}}Cl(p)$ - | 179 | 42 | 69.10; | 4.40; | 6 ·20; | 15.10 | C _{a7} H ₁₈ ON ₂ Cl ₂ | 70.00 | ; 4-00; | 6.10; | 15.40 |
| (iv) | C.H.OCH. | 214 | 60 | 78-00; | 5.10; | 6.40; | | $C_{39}H_{34}O_{3}N_{3}$ | 77.70 | ; 5.40; | 6 ·30; | |

TABLE 3. CONVERSION OF CARBINOLS TO 7-[H]-PYRINDINES BY WAY OF N-OXIDE FORMATION

Notes: (1) Yields of the 7-[H]-pyrindines are calculated on the basis of the removal of 0 from the N-oxide.

- (2) All compounds in this Table are obtained as white crystals.
- (3) IR spectral data was obtained for all compounds using the Perkin-Elmer Infracord (Nujol mulls).

The N-oxides show the characteristic N-O band at 1230 cm⁻¹ in addition to the N-H at 3250 cm^{-1} , amide I at 1690 cm⁻¹ and amide II at 1620 cm⁻¹.

- The 7-[H]-Pyrindines show the bands characteristic of N-H at 3250 cm^{-1} , amide I at 1690 cm⁻¹ and amide II at 1620 cm⁻¹.
- (4) Only in the case of series (i) was the carbinol-N-oxide isolated.
- (5) 7-[H]-Pyrindines of series (i) and (iv) were oxidized by mercuric sulphate and conc. H₃SO₄ to the anhydride of quinolinic acid m.p. 156°.

Subsequently it was found that cyclization of the carbinol or oxazoline does take place directly with the 2-position with resulting improved yields of the 7[H]-pyrindines (Table 4).

In the case of analogous reactions with the azlactone derived from pyridine-4aldehyde cyclization with the less deactived 3-position occurs so rapidly that in four of the examples studied the 6[H]-pyrindines were obtained directly in high yield (Table 5).

The position at which cyclization occurred and the structure of the pyrindines obtained was investigated by oxidation, two of the 7[H]-pyrindines synthesized yielding quinolinic acid anhydride, m.p. 156°, one of the 6[H]-pyrindines synthesized yielding pyridine-3,4-dicarboxylic acid.

EXPERIMENTAL

General procedure for the preparation of azlactones—(I). A mixture of freshly distilled pyridine aldehyde (6.65 g), hippuric acid (11.2 g) and the sulfan-dimethylformamide complex (52 ml⁴) was heated 1 hr during which time crystallization of the sulfan adduct occurred. After standing overnight the crystalline product was filtered, washed with ice cold EtOH (20 ml \times 4) and dried at 110°. The yield was supplemented by addition of ether to the filtrate.

The sulfan adduct was converted to the free azlactone by shaking with NaOAc (20 ml of saturated solution) for 10 min. The product was filtered, washed on the filter with water (20 ml \times 4), ether (20 ml) and recrystallized from 95% EtOH.

General procedure for the reaction of 2-phenyl-3-picolyidene-5(4H)-oxazolone with Grignard reagents—(II). To an ethereal solution of Grignard reagent prepared from Mg (3.65 g) and alkyl or aryl halide (6.15 mole) in ether (50 ml) was added a fine suspension of the oxazolone (12.5 g) in ether

| | Γ' | TABLE 4 | I. DIRECT | FORMATION OF 7-[H]-1 | PYRUNDINES | FROM | CARBIN | OLS OR | OXAZOLINES | : | : | | |
|---|---|---|---|---|--|---|-------------------------------|---|---|----------------------------|-------------------------------|-----------------------|------|
| | | | | -[H]- | PYRINDINE | | | | | | | | |
| Grignard Substituent | Starting material | $^{M.p.}_{\circ C}$ | Yield % | UV spectral data | ن: | Foi H; | .N | CI | Analyses % empirical formula | Ċ | Requir H; | N; C | r |
| (i) C.H (ii) C.H.Cl (o)- (iii) C.H.Cl (o)- | Carbinol Carbinol Carbinol | 217 176 179 | 88·11 68 78 | λmax 236 mμ, ε 24,600 λmax 235 mμ, ε 27,000 λmax 235 mμ, ε 29,200 | 83.10 69.80 69.10 | ; 5:00; ; 4:50; ; 4:40; | 7·20; 6·20; 6·20; | | C ₃₇ H ₄₀ ON ₄ C ₃₇ H ₁ ,ON ₅ Cl ₅ C ₂₇ H ₁₈ ON ₅ Cl ₅ | 83·50; 70-00; 70-0; | 5·20; 7 4·00; 6 4·00; 6 | 10; 1 10; 1 | 540 |
| (iv) C ₆ H ₄ OCH ₅ (<i>ø</i>)- (v) C ₆ H ₄ OCH ₅ (<i>p</i>)- (vi) CH ₅ - | Carbinol Oxazoline Oxazoline | 214 182 216 | 72·1 51 60 | λ _{max} 223 mμ, ε 33,300 λ _{max} 225 mμ, ε 31,000 λ _{max} 225 mμ, ε 24,000 | 00.78-00 16-90 11-80 | ; 5·10; ; 5·80; ; 6·80; | 6.40; 6.10; 9.65; | | C,,H,O,N, C,,H,O,N, C ₁₇ H,0N, | 77·70; 77·70; 72·30; | 5-40; 6 5-40; 6 6-90; 1 | ·30; ·10; 0-00; | |
| Notes: (1) The 7-[H]. (2) IR spectra The comp (3) UV spectr TABLE 5. | pyrindines v ul data was o ounds show a were deteri DIRECT FORI | were obl btained the ban mined i MATTON | for all co for all co ds charac n spectron or 6-[H] | white crystals. ompounds using the Per steristic of N-H at 3250 sol MeOH using a Perk PPYRINDINES BY REACTI | rkin-Elmer cm ⁻¹ , amia cin-Elmer J ion of THE | Infraco de I at 137 UV 1 AZLAC | ord (Nu 1690 cm spectro | ijol mul n ⁻¹ and ophoton JERIVED | ls). amide II at 1620 . neter. FROM PYRUDINE-4 | ст-1. | DB WIT | н | |
| Grienard | M.P. | Yiek | P | | | Found | | | Analyses % empirical | | Reaui | s | |
| substituent | °ċ' | % | | UV spectral data | C; H | | G | | formula | ن | Н; | N; | G |
| (i) C ₆ H ₅ - (ii) C ₆ H ₄ CI (<i>p</i>)- | 212 193 | 66-1 47-2 | Ав Хв | ax 234 mμ, ε 18,900 ax 232 mμ, ε 29.000 | 83-30; 5- 71-60; 4: | 14; 7-3 20; 6·1 | 0; 15-4 | . 9 | C ₁ ,H ₂₀ ON ₂ C ₁ ,H ₁₀ ON ₂ CI ₂ | 83-50; 70-90; | 5-20; 3 3-93; 6 | 7-20; 5-12; 1 | 5.50 |
| (iii) C ₆ H,OCH, (<i>p</i>)- (iv) CH ₈ - | 187 216 | 57-1 60-7 | λm λm | ax 224 mμ, ε 29,000 ax 222 mμ, ε 22,300 | 77-10; 5- 72-30; 6-9 | 90; 6·2 | 88 | | C ₁₇ H ₁₈ ON | 77-70; 72-30; | 5.40; 6 6-90; 6 | .;30; 9.90; | |
| | | - | | | | | | | | | | | |

Notes: (1) The 6-[H]-pyrindines were obtained as white crystals..

(2) IR spectra data was obtained for all compounds using the Perkin–Elmer Infracord (Nujol mulls). The compounds show the bands characteristic of N-H at 3250 cm⁻¹, amide I at 1690 cm⁻¹ and amide II at 1620 cm⁻¹.

Compound (i) was oxidized by mercuric sulphate and conc. H_aSO₄ to cinchomeric acid (pyridine-3,4-dicarboxylic acid) m.p. 262° dec.
 UV spectra were determined in spectrosol MeOH using a Perkin-Elmer 137 UV spectrophotometer.

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| | puires N: Cl | ; 6-10; 15-50 ; 6-00; — | | | C: H; N; Cl | -90; 3-93; 6-10; 15-50 -70; 5-40; 6-30; — | btained as white crystals. 1 SP200 (KBr wafer discs) 620 cm ⁻¹) were observed. 0 cm ⁻¹). [(1620 cm ⁻¹). |
|---------------|------------------------------------|--|--------------|--------------|--------------------------------|--|--|
| ARD REAGENTS | C; H; | 70-90; 3-93 74-40; 5-60 | 3 | | ilyses % ipirical rrmula | [180N2Cl3 70 | i 6 and 7 were o (ii) the Unicarr and amide II (1 1 amide II (162 ¹) and amide I |
| DE WITH GRIGN | Analyses % empirical formula | C ₃ ,H ₁₆ ON ₅ Cl ₅ C ₃₆ H ₃₆ O ₄ N ₃ | ANTOLINE | | And en CI fo |); 15:30 C ₄ ,H); C ₂₉ H | ported in Tables arbinol Table 6 e I (1690 cm ⁻¹) 6 (1690 cm ⁻¹) and nide I (1690 cm ⁻¹ trophotometer. |
| NE-4-ALDEHYI | СІ | ; 15-30. (| OM CARBINOL | 8 | Found: H; N; | 9; 4-30; 6-20 0; 5-70; 6-20 | compounds re care of the c cm ⁻¹), arnide was used. n^{-1}), annide I 250 cm ⁻¹), arr |
| FROM PYRIDI | Found: H; N; | 4·50; 6·00 5·74; 6·12 | KINDINES FRO | H]-PYRINDINI | C: | 000 70-00 000 77-10 | ; the other c und 7. In the -NH (3250 er Infracord NH (3250 cn of -NH (32 or rkin-Elmer |
| e derived 1 | ki C; | 71·50; 6 74·30; | 0F 6-H-PY | 6-[] | pectral data | 6 тµ, ε 27,8 24 тµ, ε 31,0 | low crystals in Tables 6 a 3450 cm ⁻¹), Perkin-Elm rristic of -1 arracteristic H using a Pe |
| F AZLACTON | M.p. Yie °C % | 158 49 157 44· | Formation | | UVs | д _{шах} 23 Д _{шах} 22 | d as pale yel compounds c of -OH (5 5 and 7 the nds charack ed bands ch rosol MeOF |
| IO NOLL | V I | ne I | BLE 7. | | Yield % | 65-2 54·1 | bbtained for all c cteristic fables (wed bau wed bau o showen n spect |
| . REAC | Product obtained | O xazoli Carbino | TA | | $^{W.p.}_{\circ C}$ | 198 184 | 6 was contained otained s charac as charac as charac nds in 7 (i) shou (i) shou Table 7 mined i |
| TABLE 6 | trd ent | (o)- CH _a (o)- | | | Starting material | Oxazoline Carbinol | id (i) in Table al data was ol red and band ther compou oline Table 6 J-pyrindines (ra were deter |
| | Grigna substitu | (i) C ₆ H ₄ Cl (ii) C ₆ H ₄ OC | | | Grignard substituent | (i) C₆H₄Cl (<i>θ</i>)- (ii) C₆H₄OCH₄ (<i>θ</i>)- | Notes: (1) Compour (2) IR spectrives was employ For the o The oxazi The 6-[H] (4) UV specti |

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(70 ml). The reaction mixture was refluxed for 2 hr, left overnight and hydrolysed with water. Most products, soluble in the ether layer were dried over anhydrous Na₃SO₄ and most of the ether removed. The oily residues obtained were triturated with pet. ether (b.p. 40°-60°) or EtOH and allowed to cool. The products were filtered and recrystallized from 95% EtOH or, exceptionally benzene or pet. ether.

Ether insoluble products were filtered directly, washed and recrystallized as before.

'The purity of the products obtained was investigated by TLC. There was no evidence of mixed oxazoline-carbinol products and in instances where the product was contaminated with unchanged starting material separation was effected using adsorption chromatography on an alumina column.

Cyclization of carbinols or oxazolines derived from a 2-phenyl-picolylidene-5 (4H)-oxazolone (III). To a fine suspension of carbinol or oxazoline $(1 \cdot 0 \text{ g})$ in acetic acid (20 ml) HCl (10 ml), S.G. $1 \cdot 18$) was added slowly. The solid dissolved (brown solution) and the mixture was kept at 40° for 30 min. A white precipitate (the pyrindine) separated after addition of a saturated solution of NaOAc. This was filtered, washed with water and recrystallized from 95% EtOH.

General procedure for the reaction of 2-phenyl-4-picolydene-5 (4H)-oxazolone with Grignard reagents (IV). To an ethereal solution of Grignard reagent (prepared as in II above) was added a fine suspension of the oxazolone (12.5 g) in ether (70 ml). The reaction mixture was refluxed for 2 hr, left overnight, then hydrolysed with water. Most products were insoluble and precipitated. These were filtered, washed with water and recrystallized from 95% EtOH. The products which were ether soluble (i.e. those formed using o-anisyl and o-chlorophenyl magnesium bromide) were treated as in II above.

Conversion of carbinols to pyrindine-N-oxides (V). (procedure of Katritsky and Monro⁹). To the carbinol (1 g) was added $H_{3}O_{3}$ (2.0 ml, 100 vols) and acetic acid (10 ml). The mixture was heated for 2 hr at 40° after which further acetic acid (10 ml) and HCl (10 ml, S.G. 1.18) was added. The reaction mixture was kept at room temp for 30 min. A white precipitate separated after addition of a saturated solution of NaOAc which was filtered off and washed with water.

Formation of pyrindines from the corresponding N-oxides (VI) (Procedure of Schweizer, O'Neill and Wemple¹⁰). The N-oxide $(2 \cdot 0 \text{ g})$ in anhydrous dimethylene glycol contained in a suitable equipped 3-necked flask (250 ml) was heated until distillation of dimethylene glycol (5 ml) took place. A solution of 9-diazofluorene (15.5 g) in dimethylene glycol (200 ml) was then added dropwise with concurrent distillation. A white-yellow distillate was obtained from which a white precipitate separated after dropwise addition of water. The precipitate was recrystallized using the solvents employed in II.

Acknowledgement-One of the authors (G. S.) is grateful to the S.R.C. for a Research Studentship.

- * A. R. Katritsky and A. M. Monro, J. Chem. Soc. 150 (1958).
- ¹⁰ E. E. Schweizer, G. J. O'Neill and J. M. Wemple, J. Org. Chem. 29, 1744 (1964).