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3*H*-INDOLES—II[*][1]

SYNTHESIS OF 3-ALKYL-3*H*-INDOLES BY THE ALKYLATION OF 2,3-DISUBSTITUTED INDOLES WITH POLYPHOSPHATE ESTER AND SOME REACTIONS OF THE 3*H*-INDOLE SYSTEM.

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Abstract—A reaction mixture of alcohol and phosphorus pentoxide, forming a new type of polyphosphate ester (PPE), is proposed as an alkylating agent of 2,3-disubstituted indoles for the synthesis of 3-alkyl-3*H*-indoles. Thus 1,2,3,4-tetrahydrocarbazole **1** and 2,3-dimethylindole **10** are methylated or ethylated to afford corresponding 3*H*-indoles in approx. 40–70% yield. The Plancher rearrangement of substituted 3*H*-indoles is realized including an interesting "carbazolenine ~ indolenine ring isomerism". Facile autoxidation of the methylene carbon at the 2-position of 3*H*-indole is observed and discussed.

CERTAIN 2,3-disubstituted indoles are ethylated at the β-position by means of polyphosphate ester (PPE) to afford corresponding 3-ethyl-3*H*-indoles.[1] The application of this method, however, has been restricted to the synthesis of 3-Et derivatives since the Langheld reagent[2a] initially carries only the Et group as its ester component insofar as it is conventionally prepared by the etherolysis of phosphorus pentoxide (P_4O_{10}) with diethyl ether.[2b] The present paper is primarily concerned with the extension of the process to a general procedure of alkylation of indoles by the use of a reaction mixture of alcohol and P_4O_{10} as a reagent, an extended type of PPE family. Secondly, in connection with elucidation of the structures of minor components produced in the previous ethylation method with ordinary PPE,[1] some novel chemical behaviour of 3*H*-indoles observed in the course of the alkylation are described.

In principle, it is expected that variation of the alkyl group of PPE would open the possibility of a variety of extended types of PPE, which might well be used as a series of synthetic agents with wide application.[3] Among many conceivable approaches to produce such a PPE family, three principal methods are mentioned here. First, etherolysis of P_4O_{10} with a variety of dialkyl (or aryl) ethers would produce various PPE carrying desirable alkyl (or aryl) groups as its ester component as formulated in Eq. (1).

$$P_4O_{10} + 2\,ROR \rightarrow (PO_3R)_4 \qquad (1)$$

However, variation of the ether component in the reaction (1) may in practice require respective adaptation of reaction conditions, and consequently, would lead to products of different compositions and reactivities. For example, attempt to prepare phenyl polyphosphate from diphenyl ether and P_4O_{10} was unsuccessful.[4] Secondly, a mixture of PPE with various average degrees of condensation could be made by

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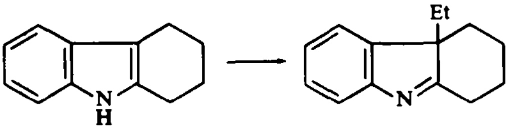
[*] Presented in part at the Annual Meeting of the Pharmaceutical Society of Japan, April 1967, Kyoto.

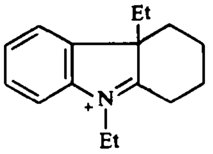
[†] Part X in the series Polyphosphate Ester as a Synthetic Agent; for a preceding paper see Ref. 1.

combining trialkyl orthophosphate with P_4O_{10}.[4,5] Schramm *et al.* recently prepared several PPEs by this method, some of which were utilized in polynucleotide synthesis as a condensation agent.[6] The third and most simple approach, which is adopted in this work, consists of forming a mixture of condensed phosphate esters as a synthetic agent simply by the reaction of an appropriate alcohol with P_4O_{10}. Mukaiyama *et al.* prepared mixtures of monohydric alcohol and P_4O_{10}, which were employed as dehydrating agents for oximes and other compounds.[7] Since such a mixture can be prepared very easily, the present study has been undertaken to utilize the ester alkyl groups in these mixtures for alkylation.

Tetrahydrocarbazole **1** was heated with the new PPE prepared from ethanol and phosphorus pentoxide (4 : 1 molar ratio; P_4O_{10} taken as one mole) at 170° (bath-temp) for 40 min, these were similar conditions to those employed in the case of PPE obtained by etherolysis.[1] Gas chromatography (GC) of the basic reaction product showed the formation of 3-ethyl-2,3-tetramethylene-3*H*-indole **2** and its N-Et derivative **3** in 43 and 4% yields, respectively, accompanied by a small amount of the third component. Analysis of the neutral fraction showed the presence of 11% of N-ethyltetrahydrocarbazole **4**. Structural assignment of **2**, **3** and **4** was based on comparison of GC, TLC and UV spectra of the samples, obtained after separation of the basic mixture on TLC, with those of the authentic specimen.[1] This result, when compared with that obtained previously,[1] indicates that the new PPE, prepared from ethanol and P_4O_{10}, can also be used satisfactorily for the ethylation of **1** to afford the 3-ethylated 3*H*-indole.



1 **2**



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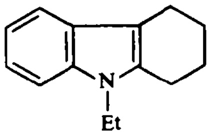

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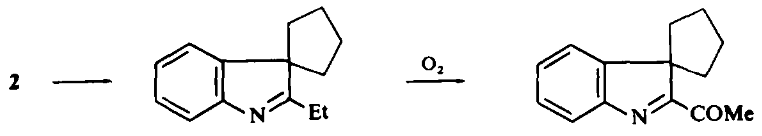
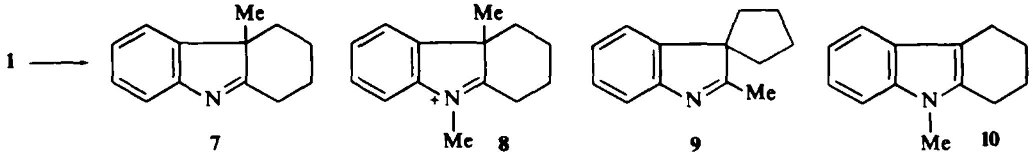
Since GC of the reaction products of **1** either with ordinary PPE[1] or the new PPE showed an identical pattern, careful re-analysis of the product, previously obtained from **1** with PPE, was attempted to elucidate the structure of the minor component. Although column chromatography (CC) of the basic mixture did not yield the minor base in a completely pure form, the NMR spectrum of the base indicated the presence of the 2-Et group, whose signals appeared distinctly downfield relative to those at the C-3 position. The mass spectrum showed a peak at *m/e* 199 in agreement with the composition of $C_{14}H_{17}N$. In addition, a non-basic crystalline material **6** was separated during the chromatography, which apparently formed as a result of some secondary change of the base **5**. This compound, m.p. 115–116°, had a composition of $C_{14}H_{15}NO$, determined by analysis and mass spectrum (*m/e* 213). The UV spectrum in ethanol soln showed maxima at 243 mμ (log ε 4·01) and 305 mμ (log ε 3·98), and the IR spectrum had a strong band at 1683 cm^{-1} both indicating the presence of a conjugated carbonyl group. The above data strongly pointed to the ketonic *spiro* structure **6** for this compound.

Recently, Evans *et al.* showed that 2-phenyl-3,3-dimethyl-3H-indole and 2,3-dimethyl-3-phenyl-3H-indole are interconvertible and equilibrated (3:7) under heating in the presence of polyphosphoric acid (PPA).[8] Therefore, a tentative rationalization of the formation of **6** by the ethylation of **1** may be made by assuming that 2-ethyl-3H-indole **5** of the *spiro* type is produced by the Plancher rearrangement[9] of initially formed **2**, followed by subsequent autoxidation. Indeed, preliminary experiments indicated that **2** was converted to **5** by heating in the presence of PPE or PPA as monitored by TLC or GC. Confirmative support of this view will be described in the following related experiments in which an analogous rearrangement and oxidation were repeatedly demonstrated.



5 **6**

In order to see whether the new approach could be extended to other monohydric alcohols in general, methylation of **1** was next examined. Compound **1** was thus treated at 170° for 20 min with PPE prepared from methanol and P_4O_{10} (4 : 1). As determined by GC, the expected 3-Me derivative **7** and its N-Me derivative **8** were obtained together with the third basic component and the N-Me indole **10**.



7 **8** **9** **10**

In CC of the reaction mixture, the minor fraction was eluted after the major base **7**. This base, isolated in 4% yield, had the same composition as **7** ($C_{13}H_{15}N$), formed a different picrate, and the UV and IR spectra of the base or its perchlorate showed evident 3H-indole character. The NMR spectrum showed a peak (2·27 δ, 3 protons, singlet), which is assigned to a Me group attached to the 2-position of the 3H-indole. Table 1 lists the NMR data of several 2- and 3-Me groups of 3H-indoles and indicates the clear distinction between their chemical shifts. Signals due to 3-Me protons are always shifted upfield relative to those of 2-Me protons. Related examples of 2- and 3-Et groups are also included. According to the above evidences, 2-methyl-3H-indole of *spiro* structure **9** is again assigned to this minor basic product.

In a similar manner, 2,3-dimethylindole **11** was subjected to reaction with PPE (MeOH, P_4O_{10}). The basic reaction mixture was applied to silica gel CC to separate **12** and **13**, in 73 and 6% yields, respectively, whose structures were confirmed by conversion to picrate or perchlorate and comparison with those of the authentic specimen.

TABLE 1. NMR DATA OF 2- AND 3-SUBSTITUENTS OF 3*H*-INDOLES*

2-Me	2·27	**9**	2·45	**12**†	2·17	**15**					
3-Me	1·30	**7**	1·28	**12**†	1·25	**15**	1·32	**17**	1·32‡	1·36§	
	CH_3¶				CH_2‖		CH_3¶			CH_2‖	
2-Et	1·34 (7·4)				2·46 (7·4)	**5**	1·41 (7·4)			2·56 (7·4)	**17**
3-Et[1]	0·33 (7·7)				—	**2**	0·38 (7·8)			—	**15**

* δ values taken in CCl_4; *J* (c/s) given in parenthesis.

† Taken in $CDCl_3$.[10]

‡ 3-Methyl-3-isopropyl-3*H*-indole in $CDCl_3$.[11]

§ 3-Methyl-3-benzyl-3*H*-indole in $CDCl_3$.[11]

¶ Triplet.

‖ Quartet.

Since GC of the reaction products of **11** either with the ordinary PPE[1] or the new PPE (EtOH, P_4O_{10}) also showed identical pattern, analysis of the product, previously obtained from **11** with PPE, was repeated. The first fraction of silica gel CC was converted to picrate, which was identical with the picrate of 2-ethyl-3,3-dimethyl-3*H*-indole **17** prepared from phenylhydrazine and ethyl isopropyl ketone by the Fischer synthesis. The free base **17** was obtained from the picrate and its structure was further confirmed by the fact that the NMR spectrum had a signal of two equivalent Me groups (1·32 δ, 6 protons, singlet) to be assigned to two 3-Me groups of 3*H*-indole. Signals of 2-Et protons also appeared downfield relative to those of 3-Et of **15** in accord with the assignment as listed in Table 1.

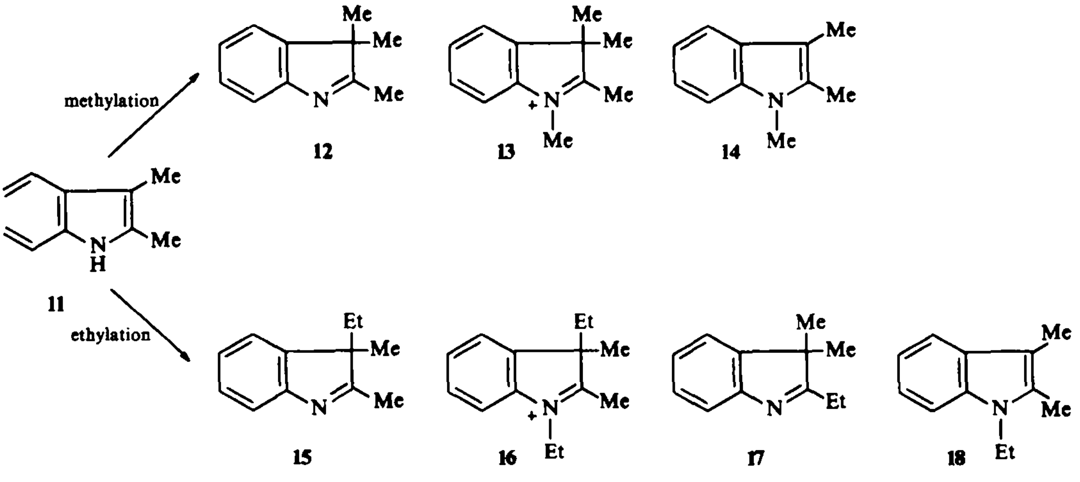


Table 2 summarizes the product distribution of the alkylation of **1** and **11** with the new PPE (MeOH or EtOH, P_4O_{10}) as determined by GC. From the foregoing results in Table 2, it may be concluded that the new type of PPE can be employed as an alkylating agent for 2,3-substituted indoles to afford corresponding 3-alkyl-3*H*-indoles. The reaction procedure is very simple, and the major product is invariably the 3-alkyl-3*H*-indole though it is accompanied by some minor N-alkylated or rearranged products. Although the nature of the reaction products of alcohol and P_4O_{10} is uncertain at present, it may be tentatively assumed that these are complex mixtures of condensed phosphate esters formed by alcolysis of the cyclic structure of P_4O_{10} and re-organized in equilibrium.*[2] This method would also be of potential use for indole substrates of more complex structures and studies along this line are in progress.

TABLE 2. PRODUCT DISTRIBUTIONS OF THE ALKYLATION OF 2,3-DISUBSTITUTED INDOLES*

Substrate	Alkyl group	3*H*-Indole 3-Alkyl	1,3-Dialkyl	rearranged	N-alkylindole
1	Me†	48 (1·38) **7**	17 (2·12) **8**	4 (1·59) **9**	6 **10**
	Et†	43 (1·86) **2**	4 (3·71) **3**	2 (2·32) **5**	11 **4**
11	Me‡	73 (0·29) **12**	8 (0·45) **13**		4 **14**
	Et§	59 (0·58) **15**	7 (1·13) **16**	13 (0·63) **17**	3 **18**

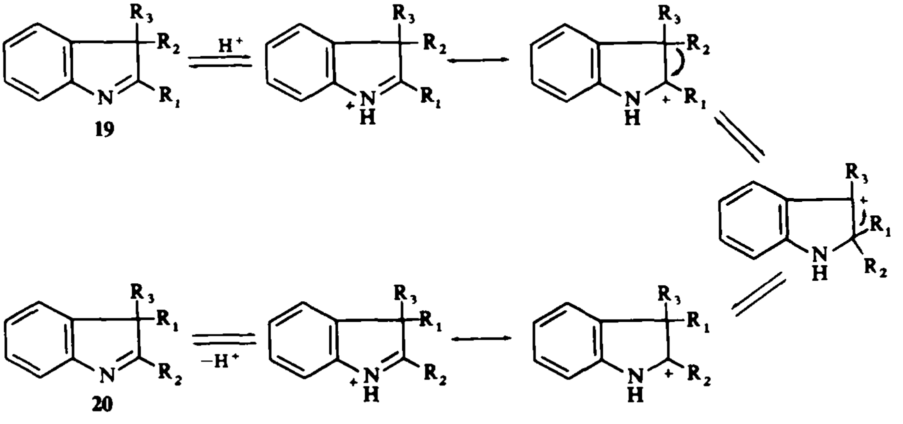
* Yield (%) determined by GC. Retention times relative to 1-dimethylaminonaphthalene are given in parentheses. In every experiment, retention times are compared with those of authentic samples for identification. Quantitative analysis was performed with 1-dimethylaminonaphthalene as internal standard.

† Column temp 134°; carrier gas flow rate 35 ml/min.

‡ Column temp 113°; carrier gas flow rate 30 ml/min.

§ Column temp 117°; carrier gas flow rate 35 ml/min.

The formation of **5** and **9** from **1** and of **17** from **11** in the course of alkylation is not surprising since they are apparently typical products of the Plancher rearrangement of 3-alkyl-3*H*-indole derivatives which formed initially. In fact, in the related example of the rearrangement reported by Lyle *et al.*[8] reaction conditions were close to those of this alkylation except that PPA is replaced by PPE. Two-fold Wagner–Meerwein type rearrangement, originally recognized by Witkop in indole series[13] and further illustrated later,[8, 14] as outlined in the accompanying scheme, may be the probable path of the rearrangement observed (**19** → **20**).



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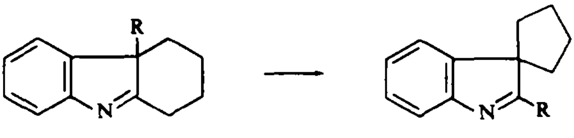
* Presumably the chemical and physical properties of the new PPE may be situated somewhere between those of the ordinary PPE[2] and PPA.[12]

It is noteworthy that the formation of **5** and **9** from **2** and **7**, respectively, provides the first characterized example of the *carbazolenine* ~ *indolenine* interconversion relationship in the Plancher rearrangement.[13c] Further studies on some quantitative aspects of the rearrangement are under way in this laboratory.



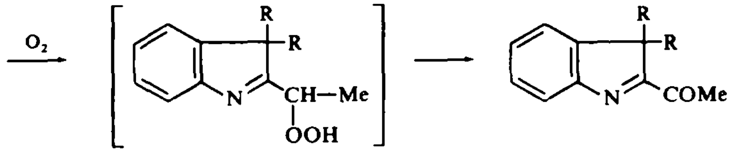
2: R = Et; **7**: R = Me 5: R = Et; **9**: R = Me

In an experiment of the ethylation of **11**, when the first basic fraction was left overnight after purifying through CC, it was transformed into a non-basic crystalline material **21**, m.p. 129–130·5°, with a composition of $C_{12}H_{13}NO$. The UV and IR spectra indicated the presence of a conjugated carbonyl group. The NMR spectrum showed a new singlet (3 protons) at 2·63 δ to be assigned to the Me group adjacent to the carbonyl group, while peaks of the 2-Et group in **17** disappeared. As in the case of **6**, the above data confirmed the ketonic structure **21** for this compound, which is obviously formed from **17** by autoxidation.

It is a remarkable observation that **5** and **17** underwent such a facile autoxidation since autoxidation of 3*H*-indole has not been recorded in the literature,* whereas there have been reported many papers about the autoxidation of indoles.[16] Though **17** was oxidized at room temperature it worked-up rapidly, a sample of **17**, purified through picrate, was more stable and oxidized more slowly. Preliminary experiments indicated that the oxidation of **17** to **21** is accelerated by the addition of a radical initiator such as benzoyl peroxide, as well as irradiation with UV light. As generally accepted in the indole series,[16] the oxidation of **5** and **17** may probably proceed by way of hydroperoxide **22** as an intermediate, which has not as yet been isolated.

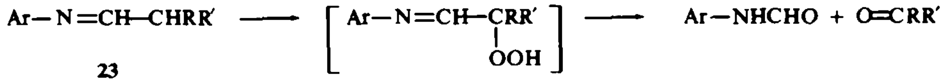
The α-methylene carbon is (i) at the β-position of the enamine–imine system involving the nitrogen atom of 3*H*-indole, and (ii) at an allylic position of the styrene-type conjugation system of the 3*H*-indole. The marked reactivity of the carbon is obviously due to this *polarized allylic character* of the 2-substituted 3*H*-indole system.

5 or **17**



22: R—R = $(CH_2)_4$ or R = Me **6**: R—R = $(CH_2)_4$; **21**: R = Me

Facile air-oxidation of anils **23**, reported earlier by Witkop,[17] may be an example of the non-cyclic analogue of the system.



$$\text{Ar—N=CH—CHRR}' \longrightarrow \left[\text{Ar—N=CH—}\underset{\text{OOH}}{\underset{|}{\text{C}}}\text{RR}'\right] \longrightarrow \text{Ar—NHCHO} + \text{O=CRR}'$$

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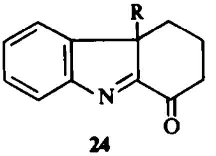
* Subsequent to the preparation of this manuscript, there appeared a paper reporting that autoxidation of **17** was similarly observed.[15]

In spite of this reactivity of certain carbons of the 2-substituent of 3*H*-indole, autoxidation of 2,3-polymethylene-3*H*-indoles, familiar compounds in the field of both natural and synthetic products, are still unknown. For example, autoxidation of 2,3-tetramethylene-3-alkyl-3*H*-indole like **2** or **7** has not been encountered in the literature. This distinct difference in susceptibility to oxidation of α-methylene group would be, at least in part, attributable to whether the α-carbon concerned is a member of a ring or not. In a 2-acyl-3*H*-indole such as **6** or **21**, an oxidized product, 2-acyl group is involved in the conjugation system of the 3*H*-indole ring and must keep coplanarity to gain resonance stabilization. When a α-methylene carbon is a member of a less than seven-membered ring, which is **24**, the ring strain caused by the α-keto group would not be negligible as suggested by a molecular model and could be responsible for the resistance to oxidation. In addition, it must be noted that there is no evidence of involvement of 2-Me group in aerial oxidation in contrast to the 2-Et group. Studies of scope and limitation of the autoxidation of 3*H*-indole system are in progress.



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EXPERIMENTAL

All m.p.s were uncorrected. IR spectra were taken on a JASCO DS-301 spectrophotometer. UV spectra were taken on a Hitachi EPS-3T spectrophotometer. NMR spectra were determined on a NMR Hitachi H-60 spectrophotometer; chemical shifts are in ppm (δ) from TMS as the internal standard. Mass spectra were determined with a Hitachi RMU-6E spectrometer. GC was obtained using a Shimadzu Gaschromatograph GC-1B attached to a Flame Ionization Detector HFD-1, with column of 3% OV-1 (Applied Science Lab. Inc.). Nitrogen was used as carrier gas. For CC and TLC, SiO_2 (E. Merck), GF_{254} and 0·05–0·2 mm, were used respectively.

Preparation of new PPE; a reaction mixture of phosphorus pentoxide and alcohol

Alcohol (1 mole) was added drop-wise to a suspension of P_4O_{10} (0·25 mole) in $CHCl_3$ (100 g) and the mixture stirred and cooled for 1 hr. The internal temp was kept below 30°. After stirring for an additional hour at room temp, an almost clear soln was obtained. When MeOH was used the reaction mixture separated into two layers since the product does not dissolve in $CHCl_3$. The upper layer was decanted off and the remaining layer was decanted from a small amount of unreacted P_4O_{10}, and, to remove dissolved $CHCl_3$, evaporated *in vacuo* at room temp to leave PPE (MeOH, P_4O_{10}) as a colourless viscous syrup. When EtOH was used, a homogeneous soln was obtained, this was decanted and evaporated as above. These reagents can be employed for alkylation without further purification.

General procedure of alkylation

A mixture of an indole (1 part) and a reagent (10 parts) was heated with mechanical stirring at 170° (bath-temp) for 20–30 min. After the reaction, the mixture was treated as described previously[1] to give basic and netural fractions, which were subjected to CC or GC as appropriate.

Ethylation of **1**: *Isolation of* spiro-(*cyclopentane*-1,3′-2-*acetyl*-3*H*-*indole*) **6** *and attempted separation of* spiro-(*cyclopentane*-1,3′-2-*ethyl*-3*H*-indole) **5**

The basic product (6·91 g) obtained by treating **1** with ordinary PPE[1] was applied to CC and eluted with benzene–AcOEt (10 : 1 v/v). The initial fraction (1·30 g) obtained on removal of the solvent *in vacuo* still contained several species showing spots corresponding to **2**, **3** and others in TLC. Repetition of CC separated the unknown basic mixture from **2**. The third CC resulted in isolation of a non-basic solid **6** (73 mg), whereas picrate of the basic fraction (134 mg) was still impure having m.p. 129–135° (lit.,[13c] picrate of **5**: m.p. 142–144°). A sample of the picrate was treated with an anion exchange resine (Amberlite IRA-400) to produce a free base. NMR (CCl_4): 7·50–6·90 δ (4 aromatic H); 2·28–1·60 (8H, multiplet) (3,3-tetramethylene). Compound **6** forms colourless prisms of m.p. 115–116° from EtOH. UV(EtOH) λ_{max}: 237 mμ (log ε3·99), 243 (4·01), 305 (3·98). IR (Nujol): 1683 cm^{-1} (conjugated C=O). Mass: *m/e* 213 (M^+). (Found: C, 78·97; H, 7·21; N, 6·33. $C_{14}H_{15}NO$ requires: C, 78·87; H, 7·04; N, 6·57%).

Methylation of **1**: *2,3-Tetramethylene-3-methyl-3H-indole* **7**, *1-methyl-2,3-tetramethylene-3-methyl-3H-indolium salt* **8**, *spiro-(cyclopentane-1,3'-2-methyl-3H-indole)* **9** *and 9-methyl-1,2,3,4-tetrahydrocarbazole* **10**

Compound **1** (3·70 g) was methylated as in the general procedure. Results of GC of the products are given in Table 2. The basic fraction (3·10 g) was applied to a silica gel column and eluted with benzene–AcOEt (10 : 1) to give **7** (1·63 g or 41%), which formed a picrate, m.p. 170–171·5°, identical with the authentic specimen prepared from 2-methyl-cyclohexane by the Fischer synthesis.[18] (Found: C, 55·03; H, 4·53; N, 13·31. $C_{13}H_{15}N \cdot C_6H_3N_3O_7$ requires: C, 55·07; H, 4·34; N, 13·52%). NMR (CCl_4) of the free base **7** obtained from picrate: 1·30 δ (3*H*, singlet) (3-Me). Perchlorate, colourless prisms from EtOH–ether, m.p. 147–149°. UV (EtOH) λ_{max}: 231 mμ (log ε 3·87), 237 (3·84), 277 (3·89). IR (Nujol): 1642 cm^{-1} ($C{=}N^+$). (Found: C, 54·37; H, 5·68; N, 4·93. $C_{13}H_{15}N \cdot HClO_4$ requires: C, 54·64; H, 5·60; N, 4·90%). The following eluate gave **9** (0·17 g or 4%). Picrate, yellow needles from acetone, m.p. 185–187·5° (lit.[13c] m.p. 188–192°). (Found: C, 55·10; H, 4·54. Calc. for $C_{13}H_{15}N \cdot C_6H_3N_3O_7$: C, 55·07; H, 4·34%). Perchlorate, colourless prisms from EtOH–ether, m.p. 169–170·5°. UV (EtOH) λ_{max}: 232 mμ (log ε 3·96), 238 (3·92), 282 (3·73). NMR (CCl_4) of the free base **9** obtained from the picrate: 7·5–7·0 δ (4 aromatic H): 2·27 (3*H*, singlet) (2-Me); 2·25–1·60 (8H, multiplet) (3,3-tetramethylene). (Found: C, 54·57; H, 5·53; N, 4·96. $C_{13}H_{15}N \cdot HClO_4$ requires: C, 54·64; H,5·60; N, 4·80%). Subsequent elution with AcOEt gave **8** as a brownish oil (0·52 g or 12%), which formed a picrate, yellow prisms from EtOH, m.p. 158–159°, undepressed by admixture with the specimen prepared from methiodide of **7**. (Found: C, 55·84; H, 4·77; N, 12·91. $C_{14}H_{17}N \cdot C_6H_3N_3O_7$ requires: C, 56·07; H, 4·67; N, 13·08%). Perchlorate, colourless prisms from EtOH, m.p. 180–182°. UV (EtOH) λ_{max}: 232 mμ (log ε 3·80), 238 (3·77), 276 (3.79). IR (Nujol): 1637 cm^{-1} ($C{=}N^+$). (Found: C, 55·81; H, 6·09; N, 4·97. $C_{14}H_{17} \cdot HClO_4$ requires: C, 56·09; H, 6·01; N, 4·67%). CC of the neutral fraction, eluted with benzene–hexane (1 : 1), gave **10** (0·33 g or 8%), which formed colourless blades from MeOH, m.p. 51° (lit.[19], m.p. 51°).

Ethylation of **11**: *2-Ethyl-3,3-dimethyl-3H-indole* **17** *and 2-acetyl-3,3-dimethyl-3H-indole* **21**

The basic product (1233 mg) obtained by treating **11** with ordinary PPE was applied to a silicagel column (40 g) and eluted with CH_2Cl_2.[1] The initial fraction collected from 140 ml of eluate, on evaporation of the solvent *in vacuo*, gave crude **17** as crystalline solid (106 mg or 8%). A portion of the base was immediately converted to picrate, which formed yellow feathers of m.p. 136·5–138°. The mixed m.p. of the picrate, with that of the base, obtained from phenylhydrazine and ethyl isopropyl ketone by refluxing in HOAc for 1 hr, showed no depression. When a sample of **17** was left after CC in a vacuum dessicator overnight, it was almost completely transformed into non-basic crystalline solid. Recrystallization from EtOH gave colourless rods of m.p. 129–130·5°. UV (EtOH) λ_{max}: 235 mμ (log ε 3·85), 240 (3·87), 303 (4·00). IR (Nujol): 1680 cm^{-1} (conjugated C=O). NMR (CCl_4): 7·80–7·20 δ (4 aromatic H); 2·63 (3H, singlet) (2-COMe); 1·50 (6H, singlet) (3-Me × 2). (Found: C, 76·82; H, 6·89; N, 7·42. $C_{12}H_{13}NO$ requires: C, 77·00; H, 6·95; N, 7·48%). Semicarbazone, m.p. 239–242° (lit.[20], m.p. 242°).

Methylation of **11**: *2,3,3-trimethyl-3H-indole* **12**. *1-methyl-2,3,3-trimethyl-3H-indolium salt* **13** *and 1,2,3-trimethylindole* **14**

Compound **11** (3·00 g) was methylated as in the general procedure. Results of GC of the products are given in Table 2. Basic fraction (b.p. 105–107°/13 mm) was obtained in a yield of 2·76 g, which was applied to a silica gel column. Elution with CH_2Cl_2–AcOEt (10 : 1), gave **12** (2·41 g or 73%), which formed picrate of m.p. 156–158°, identical with the authentic specimen.[19] Subsequent elution with AcOEt gave **13** as a reddish oil (0·20 g or 6%). Picrate, m.p. 145–147°, yellow needles from EtOH. (Found: C, 53·65; H, 4·49; N, 14·09. $C_{12}H_{15}N \cdot C_6H_3N_3O_7$ requires: C, 53·63; H, 4·47; N, 13·90%). Perchlorate, m.p. 193–195°, colourless needles from EtOH. IR (Nujol): 1636 cm^{-1} ($C{=}N^+$). UV (EtOH) λ_{max}: 230 mμ (log ε 3·78), 238 (3·74) 270 (3·77). (Found: C, 52·50; H, 5·98; N, 5·45. $C_{12}H_{15}N \cdot HClO_4$ requires: C, 52·65; H, 5·88; N, 5·15%). The mixed m.p. with the sample, prepared from the methiodide of **12**, m.p. 253–255° (lit.[19], m.p. 253°), by an anion exchange, showed no depression. Silicagel CC of the neutral fraction, eluted with benzne–hexane (1 : 1) gave **14** (0·16 g or 5%), which was shown to be identical with the authentic samples prepared from N-methylphenylhydrazine and methyl ethyl ketone by the Fischer synthesis by IR comparison.

Preliminary experiments on the autoxidation of 2-*ethyl*-3,3-*dimethyl*-3*H*-*indole* **17**

(a) *By irradiation.* A soln of **17** (4·8 μmol) in cyclohexane (20 ml) was saturated with O_2 and irradiated with UV light (100 w high-pressure Hg lamp). In 30 min **17** was almost completely converted to **21** as detected by UV spectra.

(b) *By benzoyl peroxide.* Benzoyl peroxide (3 mg; 0·5 eq) was added to a soln (10^{-3} M) of **17** (4·2 mg) in cyclohexane (25 ml), and refluxed by air-bubbling. In a period of 1·5 hr the oxidized product **21** was detected by TLC. After 3 hr, about a half of **17** had been converted to **21** as detected by TLC and UV spectra. When a soln of **17** (200 mg) in hexane (100 ml) was bubbled with air in the absence of an initiator at room temp, oxidation proceeded slowly after an induction period of several days.

Preliminary experiments on the Plancher rearrangement of **2**

(a) *With PPE.* Compound **2** (100 mg) was heated with an excess of PPE at 160° for 30 min. After cooling, ice was added followed by ether, and the whole was made alkaline with KOH. The ether layer was separated and dried (K_2CO_3). TLC (benzene–AcOEt, 10 : 1) of the soln was indicated by the presence of **5** and **2** and **3**.

(b) *With PPA.* Compound **2** (100 mg) was heated with PPA (1 g) at 160–165° for 30 min. After working-up as above, the product was shown by GC to consist of a mixture of **2** and **5** (1 : 0·06). The ratio was unchanged when the heating was continued for 3 hr indicating that this is an equilibrated mixture.

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