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# Reactions of Acyl-aminoquinone Tosylhydrazones. I.[1] A New Synthesis of Pyrrolo[1,2-*a*]indoloquinones and Related Compounds

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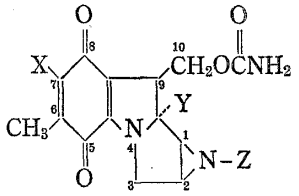
Novel synthesis of pyrrolo[1,2-*a*]indoloquinones, indazoloquinones, and related compounds, which seem to possess the same biological activities as those of mitomycins and rifamycin derivatives, are reported. 2-Acetyl-5-methylhydroquinone tosylhydrazone was oxidized with potassium nitrosodisulfonate affording 2-acetyl-5-methyl-1,4-benzoquinone tosylhydrazone (**9**). On treatment with amines (pyrrolidine (a), piperidine (b), morpholine (c), and diethylamine (d)), **9** gave 2-acetyl-3-amino-5-methyl-1,4-benzoquinone tosylhydrazones (**10a—d**). 2,3-Dihydro-6,9-dimethyl-5,8-dioxo-1*H*-pyrrolo[1,2-*a*]indole and the analogous products (**14a—d**) were obtained by heating **10a—d** at their melting points without a solvent. Along with **14a—d**, ditolyl disulfide, ditolyl thiolsulfonate and 4,7-dihydroxy-3,6-dimethyl-1-tosyl-1*H*-indazole (**16**) were obtained as minor products in all these cases.

**Keyword**——tosylhydrazones; thermolysis; indoloquinones; pyrroloindoloquinones; indazoloquinones

Mitomycins (**1a—e**)[3] are a group of anticancer antibiotics which contain a pyrroloindoloquinone skeleton. Since Webb, *et al.*[4] determined their structures in 1962, many attempts toward their synthesis have been reported. However, up to the present, no one seems to have reported their total synthesis.

In the present work, an attempt was made to establish new synthetic methods for pyrroloindoloquinones and related compounds as an approach to the synthesis of mitomycins. Pyrroloindoloquinone has the basic structure of mitomycins and very important for their biological activities, as Kinoshita, *et al.*[5] pointed out.



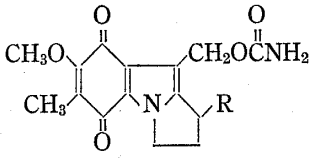
| | X | Y | Z |
|---|---|---|---|
| **1a** : mitomycin A | $OCH_3$ | $OCH_3$ | H |
| **1b** : mitomycin B | $OCH_3$ | OH | H |
| **1c** : mitomycin C | $NH_2$ | $OCH_3$ | H |
| **1d** : porfiromycin | $NH_2$ | $OCH_3$ | $CH_3$ |
| **1e** : 7-hydroxyporfiromycin | OH | $OCH_3$ | $CH_3$ |

Several compounds have been synthesized as the compounds related to mitomycins: The synthesis of 7-methoxymitosene (**2**) was reported by Lederle group.[6] Recently, 1-substituted

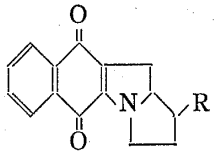
1) A part of this paper has been reported in a preliminary form; see T. Takada, Y. Kosugi, and M. Akiba, *Tetrahedron Lett.*, **1974**, 3283.
2) Location: *1432-1, Horinouchi, Hachioji-shi, Tokyo 192-03, Japan.*
3) *a*) T. Hata, Y. Sano, R. Sugawara, and A. Matsumae, *J. Antibiot.* (Tokyo) *Ser.A.*, **9**, 141 (1956); *b*) R. Sugawara and T. Hata, *ibid*, **9**, 147 (1956); *c*) S. Wakaki, H. Marumo, K. Tomioka, G. Shimizu, E. Kato, H. Kamada, S. Kudo, and Y. Fujimoto, *Antibiot. Chemother.*, **8**, 228 (1958); *d*) R.R. Herr, Abstr. papers, Conference on Antimicrobial Agents, 26 (1960); *e*) S. Wakaki, Y. Harada, K. Uzu, G.B. Whitfield, A.N. Wilson, A. Kalowsky, E.O. Stapley, F.J. Wolf, and D.E. Williams, *Antibiot. Chemother.*, **12**, 469 (1962).
4) *a*) J.S. Webb, D.B. Cosulich, J.H. Mowat, J.B. Patrick, R.W. Broschard, W.E. Meyer, R.P. Williams, C.F. Wolf, W. Fulmor, C. Pidacks, and J.E. Lancaster, *J. Am. Chem. Soc.*, **84**, 3185 (1962); *b*) A. Tulinsky, *J. Am. Chem. Soc.*, **84**, 3188 (1962).
5) S. Kinoshita, K. Uzu, K. Nakao, and T. Takahashi, *J. Med. Chem.*, **14**, 109 (1971).
6) *a*) W.A. Remers, R.H. Roth, and M.J. Weiss, *J. Org. Chem.*, **30**, 2910 (1965); *b*) G.R. Allen, Jr., J.F. Poletto, and M.J. Weiss, *ibid.*, **30**, 2997 (1965).

7-methoxymitosene[7] (**3**) was synthesized by the modified Lederle's method. Furthermore, Carelli, *et al.*[8] synthesized 1-substituted 1,2,5,10-tetrahydro-3*H*-pyrrolo[1,2-*a*]benzo[*f*]indole-5,10-diones (**4a—c**) from 1-acetamido-1,2-dihydropyrrolidine and phthalic anhydride by the Friedel-Crafts reaction. However, these methods are disadvantageous, for they require many reaction steps and the quinone structures are synthesized by oxidation at the last step. Changes in the reaction conditions of this oxidation give serious effects on the yield of the objective quinones and on the regioselectivity in the reaction. Therefore, the use of biosynthetic methods,[9] shortening of the synthetic route, and the development of new reactions may be required.

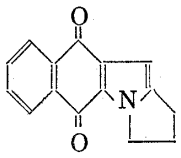
It was thought that the one-step synthesis of pyrroloindoloquinones and related compounds might be possible when 3-acetyl-2-amino-6-methyl-1,4-benzoquinone tosylhydrazones (**10a—d**), which can be synthesized easily in a high yield, were cyclized. At the same time, Moore, *et al.*[10] synthesized 1,2-dihydro-3*H*-pyrrolo[1,2-*a*]benzo[*f*]indole-5,10-dione (**5**) by a thermolytic cyclization of 2-azido-3-vinyl-1,4-quinones in a high yield. However, this elegant



**2**: R=H
**3**: R=$NH_2$



**4a** : R=$NHCOCH_3$
**4b** : R=$NH_2$
**4c** : R=OH



**5**

synthetic method has a disadvantage that the azidoquinones are obtained in a low yield and, especially, 2-azido-6-methyl-3-vinyl-1,4-benzoquinone is very difficult to synthesize.

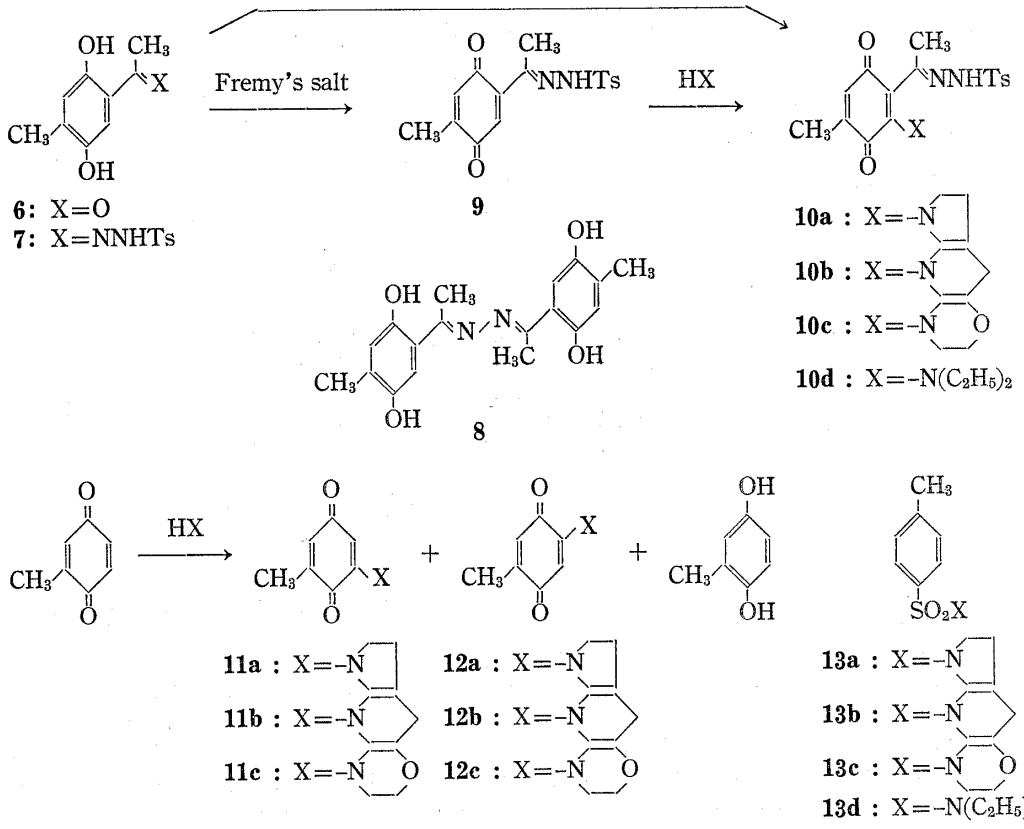



Chart 1

7) D.L. Fost, N.N. Ekwuribe, and W.A. Remers, *Tetrahedron Lett.*, **1973**, 131.
8) V. Carelli, M. Cardellini, and F. Morlacchi, *Tetrahedron Lett.*, **1967**, 765.
9) U. Hornemann, J.P. Kehrer, and C.S. Nunez, *J. Am. Chem. Soc.*, **96**, 320 (1974).
10) P. Germeraad and H.W. Moore, *J. Org. Chem.*, **39**, 774 (1974).

2-Acetyl-3-amino-5-methyl-1,4-benzoquinone tosylhydrazones are obtained as shown in Chart 1. 2,5-Dihydroxy-4-methylacetophenone[11] (**6**) reacted with tosylhydrazine to give tosylhydrazone (**7**) in a high yield, along with a small amount of a dimer (**8**). **7** gave the quinone (**9**) in 95% yield by oxidation with Fremy's salt in ethanol. Although **9** is reactive to the attacks of nucleophiles at the 2- and 5-positions of its quinone ring, a considerable difference in the reactivities of these two positions may be expected, considering the electron-donative effect of the methyl group and the —M effect of the imino group. In fact, reaction of toluquinone with amines (pyrrolidine, piperidine, and morpholine) under ice-cooling or at room temperature gave aminoquinone (**11a—c** and **12a—c**) in 1:3 ratio. As expected, **9** reacted with amines (pyrrolidine, piperidine, morpholine, and diethylamine) regio-selectively in chloroform under ice-cooling and formed aminoquinones (**10a—d**) in a moderate yield, with about the same amount of the starting material (**7**), which is the reduced product of **9**, and a small amount of tosyl amides (**13a—d**) as by-products. Only in the case of the reaction of **9** with morpholine, indazoloquinone (**15**) was obtained as a by-product. This fact suggests that the aminoquinones have somewhat different reactivities (as will be described later).

In order to prevent the formation of the reduced product (**7**), **9** was reacted with amines in the presence of Fremy's salt by which **10a—d** was obtained in a quantitative yield. When the amines were added to the aqueous ethanol solution of **7** in the presence of excess Fremy's salt for the purpose of shortening the reaction, **10a—d** were successfully synthesized by a one-step reaction.

Direct indoloquinone cyclization from **10a** was examined by the Bamford-Stevens method,[12] but an intractable reaction mixture resulted by the sensitivity of the quinone group to a base, and only a trace of indoloquinone (**14a**) was obtained subsequent silica gel chromatography. Many attempts were made to cyclize **10a** to **14a**. The mass spectrum of **10a** did not show the molecular ion peak at *m/e* 401 but a strong one at *m/e* 215,[13] which may agree with the molecular weight of the structure for **14a**. Moreover, **10a** gave a very strong peak of **14a** in gas–liquid chromatography (GLC). These facts suggest that the thermal decomposition of **10** is expected to proceed during the indoloquinone formation.

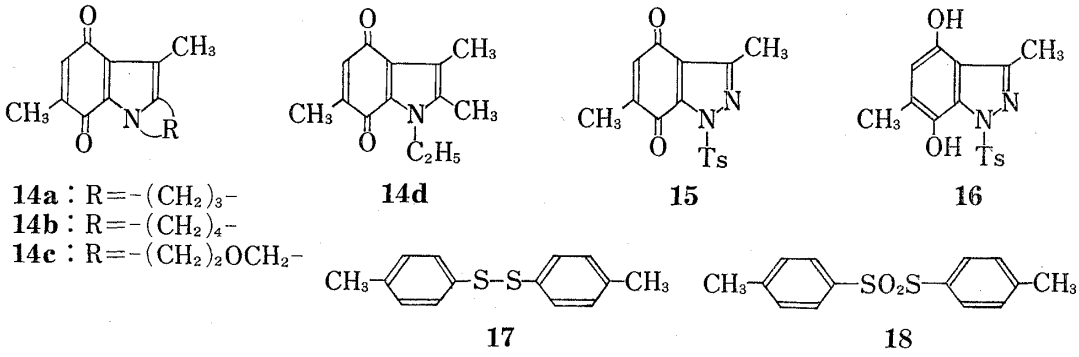



Chart 2

Heating of **10a** at 150° without a solvent for a few minutes gave **14a** in 37% yield. The structure of **14a** was confirmed by the elementary analysis and from its spectral data. Piperidino- (**10b**), morpholino- (**10c**), and N,N-diethylamino-quinones (**10d**) were thermolyzed similarly giving **14b**, **14c**, and **14d**, respectively as a major product. Disulfide (**17**), thiolsulfonate (**18**), and dihydroxyindazole (**16**) were obtained as minor products in all these cases along with **14**, but, in the case of **10c**, a small amount of sulfonamide (**13c**) and indazoloquinone (**15**) were

11) E. Kurosawa, *Bull. Chem. Soc. Jpn.*, **34**, 300 (1961).
12) W.R. Bamford and T.S. Stevens, *J. Chem. Soc.*, **1952**, 4735.
13) M. Akiba, Y. Kosugi, M. Okuyama, and T. Takada, Abstracts of the 95th Annual Meeting of Pharmaceutical Society of Japan, Nishinomiya, Vol. II, 1975, p. 115.

also isolated. Reduction of **15** with sodium hydrosulfite in water–ethyl acetate afforded **16** in a quantitative yield (Chart 2). Tables I and II summarize the results of thermolysis and physical constants of 1,2-disubstituted quinones.

Table I. Physical Constants of Pyrrolo[1,2-*a*]indoloquinones (**14**)

| Compd. No. | mp (°C) | IR $cm^{-1}$ (KBr) | NMR (ppm) | Mass (*m/e*) |
|---|---|---|---|---|
| **14a** | 153—155 | 1640 | 2.02 (3H, d, $J$=1.8 Hz, $-CH_3$)<br>2.22 (3H, s, $-CH_3$)<br>2.50—2.70 (4H, m, $-(CH_2)_2-$)<br>4.20 (2H, t, $J$=7.5 Hz, $>NCH_2-$)<br>6.27 (1H, q, $J$=1.8 Hz, olefinic H) | 215 |
| **14b** | 166—167 | 1638 | 2.04 (3H, d, $J$=1.8 Hz, $-CH_3$)<br>2.27 (3H, s, $-CH_3$)<br>4.23 (2H, t, $J$=7.5 Hz, $>NCH_2-$)<br>6.30 (1H, q, $J$=1.8 Hz, olefinic H) | 229 |
| **14c** | 195—197 | 1639 | 2.04 (3H, d, $J$=1.8 Hz, $-CH_3$)<br>2.20 (3H, s, $-CH_3$)<br>3.90—4.50 (4H, m, 2 $>CH_2$)<br>4.80 (2H, s, $-CH_2O-$)<br>6.33 (1H, q, $J$=1.8 Hz, olefinic H) | 231 |
| **14d** | 112—114 | 1630 | 1.33 (3H, t, $J$=7 Hz, $-CH_2\underline{CH_3}$)<br>2.03 (3H, d, $J$=1.8 Hz, $-CH_3$)<br>2.22 (3H, s, $-CH_3$)<br>2.26 (3H, s, $-CH_3$)<br>4.35 (2H, q, $J$=7 Hz, $-C\underline{H_2}CH_3$)<br>6.30 (1H, q, $J$=1.8 Hz, olefinic H) | 217 |

Table II. Thermolysis of Aminoquinones (**10**)

| Compd. No. | Thermolysis temp. (°C) | Yield of product (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **13** | **14** | **15** | **16** | **17** | **18** |
| **10a** | 150 | — | 37 | — | 8 | 9 | 2 |
| **10b** | 155 | — | 15 | — | trace | 5 | 1 |
| **10c** | 180 | trace | 7 | 2 | trace | 10 | 1 |
| **10d** | 150 | — | 17 | — | trace | 5 | trace |

The present investigation has established that 1,2-disubstituted indoloquinones are produced by thermolysis of monoaminoquinone tosylhydrazones. Further observations on the thermolysis of diaminoquinone tosylhydrazones and discussions on its mechanism will be the subject of future communications.

## Experimental

All melting points were measured on a Yanagimoto Micro Melting Point Apparatus, and are uncorrected. Nuclear magnetic resonance (NMR) spectra were taken on a JEOL PS-100 at 100 MHz using tetramethylsilane as an internal standard. Mass spectra were taken with a Hitachi Model RMU-7L.

**2,5-Dihydroxy-4-methylacetophenone Tosylhydrazone (7)**——A solution of 1.5 g of tosyl hydrazide dissolved in 50 ml of EtOH was added to a solution of 1 g of 2,5-dihydroxy-4-methylacetophenone[11] (**6**) in 10 ml of EtOH and the mixture was heated on a water bath for 2 hr. Crystals separated out were collected by filtration and recrystallized from EtOH to orange needles, mp >300°. Yield, 40 mg. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3350 (OH), 1623 (C=N). UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$): 237 (4.24), 260 (4.10), 307 (4.38), 406 (4.27). Mass Spectrum *m/e*: 328. *Anal.* Calcd. for $C_{18}H_{20}O_4N_2$: C, 65.84; H, 6.14; N, 8.53. Found: C, 65.78; H, 6.22; N, 8.45. These data show that the product is a ketazine (**8**). The mother liquor was then concentrated *in vacuo* and the residue was recrystallized from EtOH to colorless needles, mp 242°. Yield, 1.80 g (89.5%). IR $\nu_{max}^{KBr}$ $cm^{-1}$:

3470 (OH), 3180 (NH), 1160 ($SO_2$). Mass Spectrum *m/e*: 334 ($M^+$). *Anal.* Calcd. for $C_{16}H_{18}O_4N_2S$: C, 57.48; H, 5.43; N, 8.38; S, 9.58. Found: C, 57.38; H, 5.03; N, 8.28; S, 9.74.

**2-Acetyl-5-methyl-1,4-benzoquinone Tosylhydrazone (9)**——A solution of 500 mg of tosylhydrazone (**7**) in 20 ml of EtOH was added, with stirring, to a solution of 2 g of potassium nitrosodisulfonate in 20 ml of 1/6 M $KH_2PO_4$ and 80 ml of water. The color of the solution turned to yellow from light blue. After the reaction mixture was stirred further for 1 hr, the resulting yellow precipitate was collected and dried to give 473 mg (95% yield) of quinone (**9**), mp 147—150° (decomp.). **9** is thermally and photolytically quite unstable and prevented satisfactory combustion analysis. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3220 (NH), 1658 (CO), 1167 ($SO_2$). NMR ($CDCl_3$) $\delta$: 8.10 (1H, broad NH), 7.90 (2H, d, $J$=8 Hz, aromatic proton), 7.35 (2H, d, $J$=8 Hz, aromatic proton), 6.74 (1H, s, -C=C-H), 6.58 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 2.46 (3H, s, $CH_3$), 2.07 (6H, s, $CH_3$). Mass Spectrum *m/e*: 332 ($M^+$), 334 ($M^+$+2).

**General Procedure for the Preparation of 2-Acetyl-3-amino-5-methyl-1,4-benzoquinone Tosylhydrazones (10)**——A solution of 1 g of tosylhydrazone (**7**) in 50 ml of EtOH was added to a stirred solution of 4 g of potassium nitrosodisulfonate in 300 ml of water and 40 ml of 1/6 M $KH_2PO_4$. After 1 hr 1 g of potassium nitrosodisulfonate was added and then 700 mg of amines (pyrrolidine, piperidine, morpholine, and diethylamine) was added dropwise with stirring and ice-cooling for 10 min to the reaction solution. The solution was extracted with $CHCl_3$. The extract was dried over $Na_2SO_4$. The solvent was evaporated and the residue was purified through silica gel chromatography. Reliable combustion analysis could not be obtained owing to the instability of the title compounds.

**2-Acetyl-5-methyl-3-pyrrolidino-1,4-benzoquinone Tosylhydrazone (10a)**——The title compound was prepared in a quantitative yield by the general procedure. mp 124—125° (decomp.). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3050 (NH), 1660 (C=O), 1535 (N-C=C-C=O), 1165 ($SO_2$). NMR ($CDCl_3$) $\delta$: 7.80 (2H, d, $J$=8 Hz, aromatic proton), 7.25 (2H, d, $J$=8 Hz, aromatic proton), 6.40 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 3.12—3.54 (4H, m, $CH_2$-N-$CH_2$), 2.40 (3H, s, $CH_3$), 2.03 (3H, s, $CH_3$), 1.95 (3H, d, $J$=1.8 Hz, $CH_3$-C=C-H), 1.47—1.87 (4H, m, -$CH_2$-$CH_2$-). UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$): 234 (4.45), 274 (4.00), 515 (3.46).

**2-Acetyl-5-methyl-3-piperidino-1,4-benzoquinone Tosylhydrazone (10b)**——The title compound was prepared in 48.8% isolated yield as described above. mp 172—175° (decomp.). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3200 (NH), 1660 (C=O), 1565 (N-C=C-C=O), 1165 ($SO_2$). NMR ($CDCl_3$) $\delta$: 7.90 (2H, d, $J$=8 Hz, aromatic proton), 7.35 (2H, d, $J$=8 Hz, aromatic proton), 6.42 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 2.75 (4H, broad, -$CH_2NCH_2$-), 2.43 (3H, s, $CH_3$), 2.05 (3H, s, $CH_3$), 2.00 (3H, d, $J$=1.8 Hz, $CH_3$), 1.55 (6H, broad, -$(CH_2)_3$-). UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$): 231 (4.43), 513 (3.37).

**2-Acetyl-5-methyl-3-morpholino-1,4-benzoquinone Tosylhydrazone (10c)**——The title compound was prepared in 71.9% isolated yield as described above. mp 180—181° (decomp.). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3240 (NH), 1660 (C=O), 1620, 1575 (N-C=C-C=O), 1165 ($SO_2$). NMR ($CDCl_3$) $\delta$: 7.90 (2H, d, $J$=8 Hz, aromatic proton), 7.35 (2H, d, $J$=8 Hz, aromatic proton), 6.45 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 3.63 (4H, t, $J$=5 Hz, -$CH_2$-), 2.83 (4H, t, $J$=5 Hz, -$CH_2$-), 2.45 (3H, s, $CH_3$), 2.05 (3H, s, $CH_3$), 2.00 (3H, d, $J$=1.8 Hz, $CH_3$). UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$): 229 (4.43), 504 (3.41).

**2-Acetyl-3-diethylamino-5-methyl-1,4-benzoquinone Tosylhydrazone (10d)**——The title compound was prepared in 50.6% isolated yield as described above. mp 134—135° (decomp.). IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3200 (NH), 1650 (C=O), 1555 (N-C=C-C=O), 1160 ($SO_2$). NMR ($CDCl_3$) $\delta$: 7.85 (2H, d, $J$=8 Hz, aromatic proton), 7.27 (2H, d, $J$=8 Hz, aromatic proton), 6.38 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 3.13 (4H, q, $J$=7 Hz, -$CH_2CH_3$), 2.40 (3H, s, $CH_3$), 2.01 (3H, s, $CH_3$), 1.98 (3H, d, $J$=1.8 Hz, $CH_3$), 1.05 (6H, t, $J$=7 Hz, -$CH_2CH_3$).

**Thermolysis of 2-Acetyl-5-methyl-3-pyrrolidino-1,4-benzoquinone Tosylhydrazone (10a). Formation of 2,3-Dihydro-6,9-dimethyl-5,8-dioxo-1*H*-pyrrolo[1,2-*a*]indole (14a), 4,7-Dihydroxy-3,6-dimethyl-1-tosyl-1*H*-indazole (16), Tolyl Disulfide (17), and Tolyl Thiolsulfonate (18)**——50 mg of pyrrolidinoquinone (**10a**) was heated at 150° in an oil bath for a few minutes, at which time all the starting material had been consumed (TLC, silica gel). Upon cooling, the reaction mixture was chromatographed over silica gel, using $C_6H_6$-$CHCl_3$. 1.3 mg (9%) of disulfide (**17**)[14] and 0.4 mg (2%) of thiolsulfonate (**18**)[14] were obtained from the initial fraction, 10 mg (37%) of pyrroloindoloquinone (**14a**) from the second fraction and 3 mg (8%) of indazole (**16**) from the final fraction. Characteristic properties of these compounds follow. Pyrroloindole (**14a**); Recrystallization from $C_6H_6$-*n*-hexane gave red needles, mp 153—155°. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 2950, 1640 (C=O), 1605, 1485, 1225, 885. NMR ($CDCl_3$) $\delta$: 6.27 (1H, q, $J$=1.8 Hz, $CH_3$-C=C-H), 4.20 (2H, t, $J$=7.5 Hz, N-$CH_2$-), 2.50—2.70 (4H, m, -$CH_2CH_2$-), 2.22 (3H, s, $CH_3$), 2.02 (3H, d, $J$=1.8 Hz, $CH_3$). Mass Spectrum *m/e*: 215 ($M^+$). UV $\lambda_{max}^{EtOH}$ nm: 230, 265, 360, 453. *Anal.* Calcd. for $C_{13}H_{13}O_2N$: C, 72.56; H, 6.05; N, 6.51. Found: C, 72.55; H, 6.05; N, 6.30. Indazole (**16**): Recrystallization from $CHCl_3$ gave colorless needles, mp 191—193°. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 3380 (OH), 3250 (OH), 1625, 1610, 1600, 1520, 1445, 1400, 1360, 1240, 1165 ($SO_2$), 1120, 1060, 805. NMR (acetone-$d_6$) $\delta$: 8.73 (1H, s, OH), 8.51 (1H, s, OH), 7.75 (2H, d, $J$=8 Hz, aromatic proton), 7.48 (2H, d, $J$=8 Hz, aromatic proton), 6.59 (1H, s, aromatic proton), 2.50 (3H, s, $CH_3$), 2.37 (3H, s, $CH_3$), 2.29 (3H, s, $CH_3$). Mass Spectrum *m/e*: 332 ($M^+$). *Anal.* Calcd. for $C_{16}H_{16}O_4N_2S$: C, 57.83; H, 4.85; N, 8.43; S, 9.63. Found: C, 57.75; H, 4.75; N, 8.97; S, 9.48.

14) *a*) L. Horner and O.H. Basedow, *Ann. Chem.*, **612**, 108 (1958); *b*) L. Bauer and J. Cymerman, *J. Chem. Soc.*, **109** (1950).

**Thermolysis of 2-Acetyl-5-methyl-3-piperidino-1,4-benzoquinone Tosylhydrazone (10b). Formation of 1,2,3,4-Tetrahydro-7,10-dimethyl-6,9-dioxopyrido[1,2-*a*]indole (14b), 4,7-Dihydroxy-3,6-dimethyl-1-tosyl-1*H*-indazole (16), Ditolyl Disulfide (17), and Ditolyl Thiolsulfonate (18)**——100 mg of piperidinoquinone (**10b**) was heated at 155° in an oil bath for a few minutes. GLC and TLC analysis of the reaction mixture showed peaks and spots corresponding to **14b**, **16**, **17**, and **18**. The reaction mixture was chromatographed over silica gel, using $C_6H_6$–$CHCl_3$. 8.3 mg of pyridoindole (**14b**) and 3 mg of disulfide (**17**) were isolated. Characteristic properties of pyridoindole (**14b**) follow. Recrystallization from *n*-hexane gave red needles, mp 166—167°. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 2950, 1640 (C=O), 1610, 1480, 1255, 1220, 1180, 870. NMR ($CDCl_3$) $\delta$: 6.30 (1H, q, $J$= 1.8 Hz, $CH_3$–C=C–H), 4.23 (2H, t, N–$CH_2CH_2$–), 2.27 (3H, s, $CH_3$), 2.04 (3H, d, $J$=1.8 Hz, $CH_3$). Mass Spectrum *m/e*: 229 ($M^+$).

**Thermolysis of 2-Acetyl-5-methyl-3-morpholino-1,4-benzoquinone Tosylhydrazone (10c). Formation of Sulfonamide (13c), 3,4-Dihydro-7,10-dimethyl-6,9-dioxo-1*H*-[1,4]oxazino[3,4-*a*]indole (14c), 3,6-Dimethyl-4,7-dioxo-1-tosyl-1*H*-indazole (15), 4,7-Dihydroxy-3,6-dimethyl-1-tosyl-1*H*-indazole (16), Ditolyl Disulfide (17), and Ditolyl Thiolsulfonate (18)**——100 mg of morpholinoquinone (**10c**) was heated at 180° in an oil bath for a few minutes. GLC and TLC analysis of the reaction mixture showed peaks and spots corresponding to **13c**, **14c**, **15**, **16**, **17**, and **18**. Upon cooling, the reaction mixture was chromatographed over silica gel, using $C_6H_6$–$CHCl_3$. 4 mg of oxazinoindole (**14c**), 1.3 mg of dioxoindazole (**15**), and 6 mg of disulfide (**17**) were isolated. Characteristic properties of oxazinoindole (**14c**) follow. Recrystallization from *n*-hexane gave orange needles, mp 195—197°. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 2925, 1660 (C=O), 1640, 1610 1100. NMR ($CDCl_3$) $\delta$: 6.33 (1H, q, $J$=1.8 Hz, $CH_3$–C=C–H), 4.80 (2H, s, –$OCH_2$–), 3.90—4.50 (4H, m, $2CH_2$), 2.20 (3H, s, $CH_3$), 2.04 (3H, d, $J$=1.8 Hz, $CH_3$). Mass Spectrum *m/e*: 231 ($M^+$). *Anal.* Calcd. for $C_{13}H_{13}O_3N$: C, 67.52; H, 5.67; N, 6.06. Found: C, 67.25; H, 5.43; N, 6.30.

**Thermolysis of 2-Acetyl-3-diethylamino-5-methyl-1,4-benzoquinone Tosylhydrazone (10d). Formation of 1-Ethyl-2,3,6-trimethyl-4,7-dioxoindole (14d), 4,7-Dihydroxy-3,6-dimethyl-1-tosyl-1*H*-indazole (16), Ditolyl Disulfide (17), and Ditolyl Thiolsulfonate (18)**——80 mg of diethylaminoquinone (**10d**) was heated at 150° in an oil bath for a few minutes. GLC and TLC analysis of the reaction mixture showed peaks and spots corresponding to **14d**, **16**, **17**, and **18**. Upon cooling, the reaction mixture was chromatographed over silica gel, using $C_6H_6$–$CHCl_3$. 7.1 mg of dioxoindole (**14d**) and 2.4 mg of disulfide (**17**) were isolated. Characteristic properties of dioxoindole (**14d**) follow: Recrystallization from *n*-hexane gave orange needles, mp 112—114°. IR $\nu_{max}^{KBr}$ $cm^{-1}$: 1630 (C=O). NMR ($CDCl_3$) $\delta$: 6.30 (1H, q, $J$=1.5 Hz, $CH_3$–C=C–H), 4.53 (2H, q, $J$=7 Hz, –$\underline{H}_2CH_3$), 2.26 (3H, s, $CH_3$), 2.22 (3H, s, $CH_3$), 2.03 (3H, d, $J$=1.5 Hz, –$CH_2$–$C\underline{H}_3$). Mass Spectrum *m/e*: 217 ($M^+$).

**Conversion of Dioxoindazole (15) to Dihydroxyindazole (16)**——A solution of 20 mg of dioxoindazole (**15**) in 4 ml of $CHCl_3$ was added to excess aqueous $Na_2S_2O_4$ solution and the two phase mixture was vigorously stirred until the color stopped fading. The organic layer was separated and the aqueous layer was washed several times with $CHCl_3$. The combined organic layer was then dried and the solvent was removed *in vacuo*. The resulting residue was recrystallized from $CHCl_3$ to give dihydroxyindazole (**16**), which was identical in all respects with the compound described above, in a quantitative yield.

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