A NEW VARIATION OF THE PSCHORR SYNTHESIS

By B. CHAUNCY* and E. GELLERT*

[Manuscript received December 24, 1968]

Summary

A new variation of the Pschorr phenanthrene synthesis giving improved yields is described. In addition, the ester of the newly prepared by-product of this reaction, 2-iodo-4,5-dimethoxy-α-phenylcinnamic acid, cyclizes to the corresponding phenanthrene-9-carboxylic acid derivative on irradiation with ultraviolet light.

In connection with our work on the synthesis of phenanthroindolizidine derivatives to correlate physiological activity with chemical work relating to the Tylophora alkaloids, it was necessary to prepare derivatives of substituted phenanthrene-9-carboxylic acids. The commonly used Pschorr phenanthrene synthesis gave not only variable yields but yields which diminished considerably with an increase in the number of methoxyl substituents. The synthesis we envisaged was intended to proceed through 2-amino-α-phenylcinnamic acid to 2-iodo-α-phenylcinnamic acid by the Sandmeyer reaction, followed by cyclization by means of irradiation with ultraviolet light. Photocyclization of ortho-iodostilbenes has recently been discussed in a review and was used during the synthesis of aristolochic acid. The yields recorded in these experiments indicated a promising approach.

The reaction sequence followed the usual steps for the preparation of substituted 2-amino-α-phenylcinnamic acids. However, when replacement of the amino group by iodine was attempted by diazotization with isopentyl nitrite in acetone followed by addition of sodium iodide, only a small yield of the 2-iodo-α-phenylcinnamic acids could be isolated. The main product obtained was identified as the corresponding phenanthrene-9-carboxylic acid derivative, indicating that in acetone solution the diazonium salt in the presence of iodide underwent spontaneous cyclization to the phenanthrene ring. As this reaction is practically instantaneous, while decomposition of the diazonium salt with copper powder (as in the Pschorr synthesis) usually requires more than 10 hr, and as this reaction gives better overall yields, this variation provides an important new procedure. The yields achieved with the variously substituted compounds are listed in Table 1.

* Department of Chemistry, Wollongong University College, Wollongong, N.S.W. 2500.

2-Iodo-α-phenylcinnamic acid derivatives can be isolated from the reaction mixture both when the diazotization is carried out in acetone or in water. However, the yield of phenanthroic acid is less than 5% if the reaction is carried out in water. These 2-iodo-α-phenylcinnamic acids can, after esterification, be cyclized to the corresponding substituted phenanthrene-9-carboxylates by irradiation with ultraviolet light, thereby further increasing the overall yield of the phenanthrene derivative obtained by the variation described.

### Table 1

<table>
<thead>
<tr>
<th>Substituents in 2-Amino-α-phenylcinnamic Acid</th>
<th>Isopentyl Nitrite (ml)</th>
<th>20% aq. H₂SO₄ (ml)</th>
<th>Substituents in Phenanthrene-9-carboxylic Acid</th>
<th>Yield of 9-Carboxylic Acid by Pschorr Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil a</td>
<td>1.0</td>
<td>2.0</td>
<td>Nil</td>
<td>70%    93%</td>
</tr>
<tr>
<td>4,5-(OMe)₂ b</td>
<td>0.9</td>
<td>1.8</td>
<td>2,3-(OMe)₂</td>
<td>72     55</td>
</tr>
<tr>
<td>4,5,4',(OMe)₉ c</td>
<td>1.0</td>
<td>0.2</td>
<td>2,3,6-(OMe)₃</td>
<td>60     55</td>
</tr>
<tr>
<td>4,5,3',(OMe)₄ d</td>
<td>1.0</td>
<td>0.2</td>
<td>2,3,5,6- and</td>
<td>45     25</td>
</tr>
<tr>
<td>4,5,(OMe)₂,4'-Me e</td>
<td>1.0</td>
<td>1.8</td>
<td>2,3,6-(OMe)₈,6-Me</td>
<td>55     —</td>
</tr>
<tr>
<td>2'-Me f</td>
<td>1.0</td>
<td>1.3</td>
<td>8-Me</td>
<td>65     65</td>
</tr>
</tbody>
</table>


### Experimental

Microanalyses were carried out by Dr E. Challen, School of Chemistry, University of New South Wales, Kensington, N.S.W. Ultraviolet irradiation was carried out using an internally mounted Hanovia photochemical reactor. The procedure followed in all preparations was identical with the one described in the example below.

#### 2,3-Dimethoxyphenanthrene-9-carboxylic Acid

2-Amino-4,5-dimethoxy-α-phenylcinnamic acid (1 g, 3.3 mmole; prepared according to Pschorr⁷) was dissolved in acetone (100 ml) and 20% sulphuric acid (1.8 ml) added. The white suspension of the hydrogen sulphate was diazotized between 5 and 10° with 0.9 ml of isopentyl nitrite; stirring was continued for 1 hr. Solid sodium iodide (2 g) was then added to the solution and, after evolution of gas ceased, the mixture was poured into hot water. On cooling, the precipitated solid was filtered off, dried, and recrystallized from alcohol to yield 700 mg (72%) of 2,3-dimethoxyphenanthrene-9-carboxylic acid, m.p. 272° (lit.7 272°). The mother liquors were concentrated and a small amount of water added. On standing, a further 0.15 g of needles separated, which after recrystallization twice from toluene (charcoal), then from ethyl acetate, yielded 0.10 g of 2-iodo-4,5-dimethoxy-α-phenylcinnamic acid, m.p. 223°-224° (Found: C, 50.0; H, 4.0. C₁₇H₁₅I₀₄ requires C, 49.8; H, 3.7%).

The methyl ester, prepared from the acid by treatment with diazomethane, melted at 125-126° after crystallization from methanol-water (Found: C, 50.9; H, 4.0. C₁₈H₁₇I₂O₄ requires C, 51.0; H, 4.0%).

On irradiation with ultraviolet light at room temperature, the ester (0.10 g in 200 ml cyclohexane) was converted into methyl 2,3-dimethoxyphenanthrene-9-carboxylate, m.p. 136–137° (lit. 137°), in 61% yield in 3 hr. The progress of the reaction was followed semiquantitatively by the intensity of the strong absorption band at 262 μ (log ε 4.6).

ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support provided for this work by the Australian Research Grants Committee. They also wish to thank Mr W. Liao for his assistance.