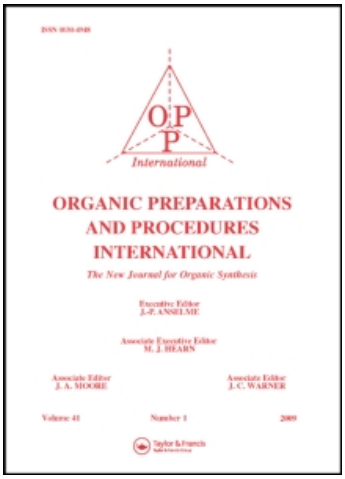

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3- AND 4-(7-BENZ[a]ANTHRACENYL)-N-BENZOYLAZIRIDINES AND 3- AND 4-(9-ANTHRACENYL)-N-BENZOYLAZIRIDINES

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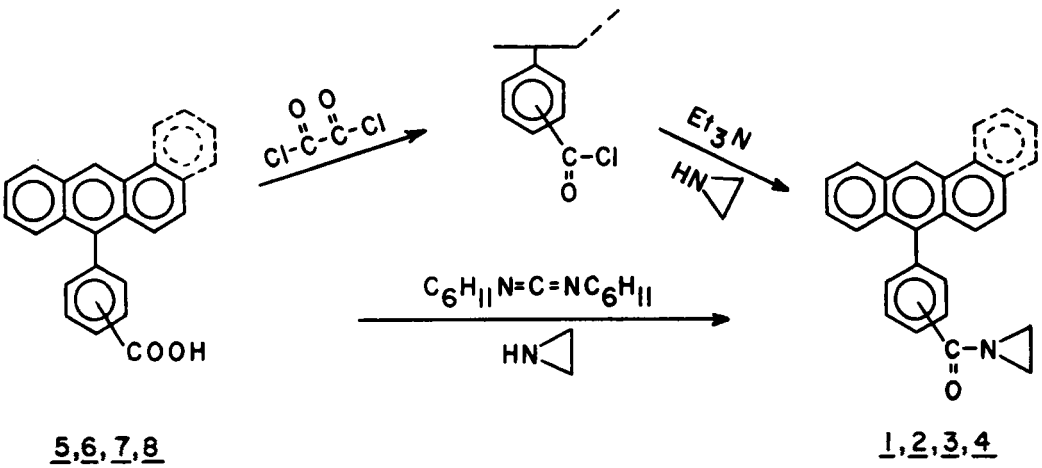
Although 1-aroylaziridines[2-5] are extremely useful in organic synthesis as starting materials for the preparation of various derivatives,[6-8] very little is known regarding the preparation of polycyclic 1-aroylaziridines. These polycyclic aziridines are themselves the basic building blocks for a variety of compounds some of which show significant anti-tumor activity.[9]

1-Aroylaziridines have generally been prepared by coupling acid chlorides with aziridine in the presence of a base, usually either sodium hydroxide or triethylamine.[3] By this method with triethylamine as base, 4-(7-benz[a]anthracenyl)-N-benzoylaziridine (1) and 4-(9-anthracenyl)-N-

CHART I



5,6,7,8 1,2,3,4

benzoylaziridine (2) were prepared as solids in 75% and 73% yields, respectively; 3-(7-benz[a]anthracenyl)-N-benzoylaziridine (3) and 3-(9-anthracenyl)-N-benzoylaziridine (4) were obtained as oils in approximately 78% and 76% yields, respectively (Chart I). The required acid chlorides were prepared in essentially quantitative yields by the reactions of the corresponding acids[10-13] with oxalyl chloride in benzene. The crude acid chlorides, isolated as greenish yellow solids,[14] were then treated with excess aziridine and triethylamine in benzene at room temperature to yield the benzoylaziridines 1-4 (Table I).

TABLE I

Physical Data for Polycyclic 1-Aroylaziridines

C'mpd.	Yield %	Mp, °C	Formula	% Calcd.			% Found		
				C	H	N	C	H	N
1	75[a], 70[b]	204-205.5[c]	$C_{27}H_{19}NO$	86.83	5.14	3.75	86.98	5.20	3.83
2	73[a], 68[b]	184-186	$C_{23}H_{17}NO$	85.41	5.31	4.33	85.34	5.21	4.15
3	78[a,d], 72[b,d]		$C_{27}H_{19}NO$	86.83	5.14	3.75	86.93	5.19	3.78
4	76[a,d], 71[b,d]		$C_{23}H_{17}NO$	85.41	5.31	4.33	85.40	5.28	4.21
4'	79[e]	146-147	$C_{23}H_{17}NO$	85.41	5.31	4.33	77.43	3.14	3.67

[a] From acid chlorides. [b] From carboxylic acids. [c] Reported mp 187-189.[15] [d] Isolated as oils which were not crystallized. [e] From acid chloride prepared with thionyl chloride; 1.04% of sulfur was found in the elemental analysis.

The direct reaction of the carboxylic acids with aziridine in the presence of dicyclohexylcarbodiimide[2] was also used to prepare the benzoylaziridines 1-4. Somewhat surprisingly, essentially the same yields were obtained as in the acid chloride route (Chart I and Table I). The reactions were carried out by stirring a mixture of the respective

carboxylic acids with equimolar amounts of aziridine and dicyclohexylcarbodiimide in anhydrous tetrahydrofuran at room temperature for several hours; within minutes after the reactants were mixed, dicyclohexylurea began to precipitate. This method also gave 3 and 4 as oils which could not be crystallized.

EXPERIMENTAL

The mps of all compounds melting below 300° were taken on a Fisher-Johns melting point block; those melting above 300° were taken on a Mel-Temp capillary melting point apparatus; all melting points are uncorrected. Analyses were performed by Galbraith Labs., Knoxville, Tennessee; M-H-W labs., Garden City, Michigan; and on a departmental F and M Scientific Corp., Model 185, C, H, and N analyzer. The IR spectra were recorded on a Beckman IR-5 infrared spectrophotometer or a Perkin-Elmer Model 621 spectrophotometer. The spectra were obtained using 10-20% chloroform solutions or potassium bromide disks. The nmr spectra were recorded on a Varian A-60 spectrophotometer, using 10% deuterated chloroform or DMSO solutions with tetramethylsilane (TMS) as an internal standard. The chromatography columns were 1 1/2 in. in diameter and 11 in. in length, and were wet packed with Baker's Silica Gel, powder, "Suitable for Chromatographic Use," with benzene, and were eluted with benzene.

3- and 4-(7-Benz[a]anthracenyl)- and 3- and 4-(9-Anthracenyl)-benzoyl Chlorides.

The acid chloride of carboxylic acids 5, 6, 7 and 8 were prepared by refluxing the acids in benzene (200-400 ml) for 6 hr with a 10 molar excess of thionyl chloride. The acid chlorides were isolated as oils, except for 4-(9-anthracenyl)benzoyl chloride, which was isolated as a green solid, mp 287-298°. All four acid chlorides contained impurities that were difficult to remove. They were prepared as solids and in purer form by refluxing with a 1 molar excess of oxalyl chloride in 300-500 ml of dry benzene for a minimum of 10 hrs. After concentration of the benzene solution, any unreacted oxalyl chloride remaining was removed azeotropically by the addition of 100 ml of chloroform to the acid chloride and removing the solvent under reduced pressure. This procedure was repeated three times. The two para acid chlorides,

4-(7-benz[a]anthracenyl)benzoyl chloride, mp 180-185° and 4-(9-anthracenyl)-benzoyl chloride, mp 213-218°, were isolated as yellowish green solids when the solutions were concentrated; the two meta acid chlorides, 3-(7-benz[a]anthracenyl)benzoyl chloride, mp 137-143° and 3-(9-anthracenyl)-benzoyl chloride, mp 120-125°, precipitated on standing overnight. These four acid chlorides were used in subsequent reactions without further purification.

3- and 4-(7-Benz[a]anthracenyl)- and 3- and 4-(9-Anthracenyl)-N-benzoyl-aziridines (3, 1, 4 and 2) from Acid Chlorides.

A mixture of 0.027 mole of acid chloride, 1.4 g (0.033 mole) of aziridine, and 3.3 g (0.033 mole) of triethylamine in 400 ml of dry benzene was magnetically stirred for 3 hr as the temperature was allowed to rise from an initial 0° to room temperature. The precipitated triethylamine hydrochloride was filtered and the filtrate concentrated. The resulting solid or oil was dissolved in 60 ml of benzene, placed in two 30 ml portions onto silica gel columns, and eluted with 300 ml of benzene. The eluted solutions were combined and concentrated to give the products.

3- and 4-(7-Benz[a]anthracenyl)- and 3- and 4-(9-Anthracenyl)-N-benzoyl-aziridines (3, 1, 4 and 2) from Carboxylic Acids.

A mixture of 0.057 mole of carboxylic acid (5, 6, 7 or 8), 11.7 g (0.0057 mole) of dicyclohexylcarbodiimide, and 2.5 g (0.057 mole) of aziridine in 450 ml of anhydrous THF was magnetically stirred at room temperature for 5 hrs. The precipitated dicyclohexylurea was filtered and the filtrate concentrated to give in each case a viscous oil. The oil was dissolved in 100 ml of benzene and passed in four portions through silica gel columns with benzene (300 ml) as eluant. Concentration of the combined eluted solutions gave the product.

3- AND 4-(7-BENZ[a]ANTHRACENYL)-N-BENZOYLAZIRIDINES

4-(7-Benz[a]anthracenyl)-N-benzoylaziridine (1).

This product was prepared by the first method as a light yellow crystalline solid, mp 175-180°; yield 7.5 g (75%). This material was used with excellent results in subsequent reactions. An analytical sample was prepared by four recrystallizations from ethyl acetate, and the product was obtained as light yellow crystals, mp 204-205° (lit.[15] 187-189°).

By the second method this product was obtained as a clear viscous oil which readily crystallized when 25 ml of ethyl acetate was added. This product was isolated as light yellow crystals, mp 173-180°; yield 15 g (70%). This material was used in subsequent reactions without further purification. A portion was purified by four recrystallizations from ethyl acetate, and the product was isolated as light yellow crystals, mp 204-205°; ir ($CHCl_3$) 1690 cm^{-1} (C=O); nmr ($CDCl_3$) δ 4.8-3.7 (m, 15, Ar H), 1.2 (s, 4, $N(CH_2)_2$).

3-(7-Benz[a]anthracenyl)-N-benzoylaziridine (3).

This product was prepared by both the first [8 g (78%)] and the second method [15.5 g (72%)] as a light yellow viscous oil which could not be crystallized. However, the oil from either preparation was used with good results in subsequent reactions; ir ($CHCl_3$) 1690 cm^{-1} (C=O); nmr ($CDCl_3$) δ 4.8-3.7 (m, 15, Ar H), 1.2 (s, 4, $N(CH_2)_2$).

4-(9-Anthracenyl)-N-benzoylaziridine (2).

This product was synthesized by the first method as greenish yellow crystals, mp 173-178°; yield 6.4 g (73%). This material was used in subsequent reactions without further purification. A portion was purified for analysis by four recrystallizations from chloroform-absolute ethanol (3:7), and the product was obtained as bright greenish yellow crystals, mp 185-186°.

By the second method this product was obtained as a clear viscous oil which readily crystallized when 25 ml of ethyl acetate was added, and the product was obtained as bright greenish yellow crystals, mp 165-169°; yield 12.6 g (68%). This material was used with good results in subsequent reactions without further purification. A portion was recrystallized four times from chloroform-absolute ethanol (3:7), mp 184-186°; ir ($CHCl_3$) 1690 cm^{-1} (C=O); nmr ($CDCl_3$) δ 4.4-3.4 (m, 13, Ar H), 1.2 (s, 4, $N(CH_2)_2$).

3-(9-Anthracenyl)-N-benzoylaziridine (4).

Prepared by the first method [7 g (76%)] as a light yellow viscous oil, and by the second method [13 g (71%)] as a clear viscous oil, both of which could not be crystallized. However, the oil from either preparation was used with good results in subsequent reactions; ir ($CHCl_3$) 1690 cm^{-1} (C=O); nmr ($CDCl_3$) δ 4.4-3.7 (m, 13, Ar H), 1.2 (s, 4, $N(CH_2)_2$).

3-(9-Anthracenyl)-N-benzoylaziridine (4').

The reaction of 0.027 mole of 3-(9-anthracenyl)benzoyl chloride (prepared with thionyl chloride), 1.4 g (0.033 mole) of aziridine and 3.3 g (0.033 mole) of triethylamine in benzene by the same procedure used in the first method above, gave here a yellow solid, mp 140-143°. The compound was purified by three chromatography procedures through silica gel, with benzene as eluant (250 ml), seven recrystallizations from ethyl acetate, and four treatments with charcoal. The product was isolated as yellow needles, mp 146-147°, but still contained impurities as evidenced by the analysis (Table I).

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