Clemmensen Reductions.—The Clemmensen reductions of 2- and 3-acetylphenanthrenes gave poor yields (5–10%) of the ethylphenanthrenes, complex by-products being formed. Since we needed the hydrocarbons only for comparison, no attempts have been made to increase the yield in this procedure.

Summary

1. The preparation of 9-acetylphenanthrene by Claisen's condensation of phenanthrene-9-carboxylic acid methyl ester and ethyl acetate is described.

2. A comparison of Willgerodt and Albert's so-called 9-acetylphenanthrene with 2-, 3- and 9-acetylphenanthrenes is given.

3. The reduction products (phenanthrylmethylcarbinols and ethylphenanthrenes) of 2-, 3- and 9-acetylphenanthrene, obtained by different methods, are described.

UNIVERSITY, VIRGINIA

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Studies in the Phenanthrene Series. VI. ω-Aminoacetylphenanthrenes and Aminomethylphenanthrylcarbinols[1]

BY ERICH MOSETTIG AND JACOB VAN DE KAMP

For the preparation of phenanthrene derivatives with the pharmacologically interesting substituents $-COCH_2NR_2$ and $-CHOHCH_2NR_2$, the synthesis of ω-halogenated acetylphenanthrenes was undertaken. First the direct introduction of the $-COCH_2Cl-$ group into the phenanthrene nucleus with chloroacetyl chloride was attempted. The reaction runs smoothly under the conditions imposed in the acetylation of phenanthrene,[2] but the purification of the crude reaction mixture, apparently consisting only of the 2- and 3-ω-chloroacetylphenanthrenes, and the separation of the isomers offered experimental difficulties which obviously made this method practically useless. Very satisfactory results, however, were obtained by bromination of the acetylphenanthrenes in absolute ethereal solution. Thus the 2-, 3- and 9-ω-bromoacetylphenanthrenes, respectively, were obtained quantitatively, and in a very pure state.

The exchange of the ω-halogen atom with dimethylamine, diethylamine and piperidine goes smoothly, as does the catalytic reduction of the tertiary ω-amino ketones to the corresponding amino alcohols. In this way the 2-, 3- and 9-ω-dimethylamino-, -diethylamino- and -piperidinoacetylphenanthrenes and the corresponding amino alcohols were prepared for pharma-

(1) This investigation was supported by a grant from the Committee on Drug Addiction of the National Research Council from funds provided by the Bureau of Social Hygiene, Inc., and the Rockefeller Foundation.

(2) Mosettig and van de Kamp, THIS JOURNAL, **52**, 3704 (1930).

cological investigation,[3] in the form of their well-crystallized and water-soluble hydrochlorides.

The direct replacement of the halogen atom in the ω-bromoacetylphenanthrenes with the $—NH_2$ and —NHR group has not been accomplished satisfactorily as yet, and for the preparation of the primary and secondary amino ketones and amino alcohols in this series we have turned to other methods worked out in recent years for the preparation of adrenalin and adrenalin-like compounds.

The possibilities for optical resolution of some of the amino alcohols described are under investigation.

Experimental

Bromination of 2-, 3- and 9-Acetylphenanthrenes

TABLE I

2-, 3- AND 9-ω-BROMOACETYLPHENANTHRENES, $C_{14}H_9COCH_2Br$

Position of side chain	Solvent of recrystn.	Crystal form	Yield, %	M. p., °C.	Analyses, % Br Calcd.	Found
2[a]	C_2H_5OH or CH_3OH	White diamonds	Quant.	142.5–143	26.73	27.02
3[a]	CH_3OH or benz.–pet. ether	White needles	Nearly quant.	87–88	26.73	26.97
9[b]	C_2H_5OH or CH_3OH	White needles	Quant.	93–93.5	26.73	26.92
		PICRATES, $C_{22}H_{14}O_8N_3Br$			% N	
3		Yellow needles		104.5–105.5	7.96	8.26
9		Yellow needles		122–122.5	7.96	8.07

[a] To a suspension of 5.0 g. of 2-acetylphenanthrene in 200 cc. of absolute ether, cooled down to 0°, a cold solution of 3.7 g. (1 mole) of bromine in 200 cc. of absolute ether was added all at once. The mixture was vigorously shaken and after five minutes decolorization was complete. After the mixture had stood at 0° for one-half hour, the sediment which was filtered off and thoroughly washed with ether, proved to be pure 2-ω-bromoacetylphenanthrene. The filtrate was freed from hydrogen bromide with anhydrous potassium carbonate and the residue obtained after evaporation of the solvent combined with the first fraction. The bromo ketone is sparingly soluble.

[b] To a solution of 10 g. of the acetylphenanthrene in 250 cc. of absolute ether at 0°, a cold solution of 7.3 g. (1 mole) of bromine was added all at once. The mixture was shaken vigorously and almost immediately, or in some cases after five to ten minutes, decolorization took place. The mixture was kept at 0° for fifteen to thirty minutes and treated as described in the foregoing experiment. After evaporation of the ether, an oily residue resulted which solidified upon cooling and scratching.

By oxidizing the 2-, 3- and 9-ω-bromoacetylphenanthrenes with 2% sodium hypochlorite solution, phenanthrene-2-, 3- and 9-carboxylic acids, respectively, were obtained, showing that no nucleus bromination had taken place.

Preparation of ω-Amino Ketones and ω-Amino Alcohols from 2-, 3- and 9-ω-Bromoacetylphenanthrenes

General Procedure for the Preparation of the Tertiary Amino Ketones.—To an absolute ethereal solution of one part of the ω-bromoacetylphenanthrene in 30 parts of

(3) The pharmacological action of these products will be reported in later papers from the Department of Pharmacology of the University of Michigan by N. B. Eddy and co-workers.

absolute ether, a 10% absolute ethereal solution of the amine (dimethylamine, diethylamine or piperidine, respectively), in 200% excess, was added all at once. The temperature was kept at 0° for one-half hour, during which time the major part of the reaction took place. The mixture was then allowed to stand at room temperature for fifteen hours to complete the reaction.[4] After filtering from the amine hydrobromide, the filtrate, containing the free amino ketone, was treated in the following way. In the case of dimethyl- or diethylamine, the ethereal solution was evaporated to dryness on the steam-bath, thus removing the excess of dimethyl- or diethylamine, respectively; in the case of piperidine, the latter was removed by extracting the ethereal solution two or three times with water, and drying over sodium sulfate. Since none of the amino ketones except one (the 2-ω-piperidinoacetylphenanthrene) could be obtained in a crystalline state, they were converted to their hydrochlorides or perchlorates, respectively. The hydrochlorides were prepared by adding an absolute ethereal hydrogen chloride solution to the solution of the amino ketones in absolute ethyl alcohol, carefully avoiding an excess of hydrogen chloride, or by precipitating the hydrochloride from the dry ethereal solution of the amino ketones with absolute alcoholic hydrogen chloride. The hydrochlorides were purified by recrystallization from alcohol–ether mixture. The perchlorates were obtained by adding an absolute ethereal solution of perchloric acid carefully to the absolute alcoholic solution of the amino ketones, and were similarly purified by recrystallization from alcohol–ether mixture.

Preparation of Aminomethylphenanthrylcarbinols from ω-Aminoacetylphenanthrenes

General Procedure.—The free ω-aminoacetylphenanthrenes were reduced catalytically, dissolved in the ten- to fifteen-fold amount of absolute ethyl alcohol, with platinum oxide as a catalyst.

In general it took about twenty-four hours to reduce 5 g. of the ketone to the corresponding amino alcohol. The reduction was stopped when no more hydrogen was absorbed. The catalyst was filtered off and the solvent was evaporated. The amino alcohols crystallized immediately upon cooling. They were recrystallized from ethyl alcohol, in some cases with the addition of a few drops of water.

The amino alcohol hydrochlorides were prepared by the addition of absolute ethereal hydrogen chloride, carefully avoiding an excess, to the absolute alcoholic solution of the free base. The hydrochlorides were recrystallized from alcohol–ether.

From three of the nine amino alcohols the benzoyl derivatives have been prepared. Only one of these could be obtained in a crystalline state. Their hydrochlorides crystallized readily.

2-ω-Chloroacetylphenanthrene, $C_{14}H_9COCH_2Cl$, crystallizes in white needles of m. p. 139–139.5°. It is sparingly soluble in ethyl or methyl alcohol, petroleum ether or ligroin.

Anal. Calcd. for $C_{16}H_{11}OCl$: Cl, 13.93. Found: Cl, 14.14.

3-ω-Chloroacetylphenanthrene, $C_{14}H_9COCH_2Cl$, forms silky white needles of m. p. 93.5–94°. It is easily soluble in ethyl or methyl alcohol, petroleum ether or ligroin.

Anal. Calcd. for $C_{16}H_{11}OCl$: Cl, 13.93. Found: Cl, 14.05.

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(4) Because of the insolubility of 2-ω-bromoacetylphenanthrene in ether, in the preparation of 2-ω-aminoacetylphenanthrenes the mixture was allowed to stand for twenty-four hours at room temperature, with frequent shaking.

The preparation on a larger scale of the 3-ω-aminoacetylphenanthrenes was simplified. To the reaction mixture obtained in the bromination of 3-acetylphenanthrene a sufficient quantity of potassium carbonate was added to neutralize the hydrogen bromide formed, dry sodium sulfate was added and then the amine hydrochloride (in the case of the dimethylamino ketones). This mixture was shaken at room temperature for twelve hours. After filtering from the solid material, the ethereal solution was worked up as described in the other experiments.

TABLE II

2-, 3- AND 9-ω-AMINOACETYLPHENANTHRENES, $C_{14}H_9COCH_2NR_2$

	M. p., °C.	Crystal form	Formula	Analyses, % Cl Calcd.	Cl Found	N Calcd.	N Found
2-ω-Dimethylaminoacetylphenanthrene		Liquid	$C_{18}H_{17}ON$				
-Hydrochloride	227–228	White diamonds	$C_{18}H_{18}ONCl$	11.84	11.71	4.68	4.61
-Picrate	198–199	Yellow diamonds	$C_{24}H_{20}O_8N_4$			11.38	11.40
2-ω-Diethylaminoacetylphenanthrene		Liquid	$C_{20}H_{21}ON$				
-Perchlorate	182–182.5	White diamonds	$C_{20}H_{22}O_5NCl$			3.58	3.76
-Picrate	176.5–178	Yellow plates	$C_{26}H_{24}O_8N_4$			10.77	10.65
2-ω-Piperidinoacetylphenanthrene	94–95	White leaflets[a]	$C_{21}H_{21}ON$			4.62	4.79
-Hydrochloride	276–277	White prisms	$C_{21}H_{22}ONCl$	10.44	10.62		
-Picrate	192–193	Yellow plates	$C_{27}H_{24}O_8N_4$			10.53	10.56
3-ω-Dimethylaminoacetylphenanthrene		Liquid	$C_{18}H_{17}ON$				
-Hydrochloride	228–230	White needles	$C_{18}H_{18}ONCl$	11.84	11.80	4.68	4.81
-Picrate	189–189.5	Yellow plates	$C_{24}H_{20}O_8N_4$			11.38	11.47
3-ω-Diethylaminoacetylphenanthrene		Liquid	$C_{20}H_{21}ON$				
-Hydrochloride	231–232	White prisms	$C_{20}H_{22}ONCl$	10.82	10.57		
-Picrate	181–182	Yellow plates	$C_{26}H_{24}O_8N_4$			10.77	10.93
3-ω-Piperidinoacetylphenanthrene		Liquid	$C_{21}H_{21}ON$				
-Hydrochloride	259.5–261	White needles	$C_{21}H_{22}ONCl$	10.44	10.43		
-Picrate	189–190	Yellow prisms	$C_{27}H_{24}O_8N_4$			10.53	10.78
9-ω-Dimethylaminoacetylphenanthrene		Liquid	$C_{18}H_{17}ON$				
-Hydrochloride	199–201	White needles	$C_{18}H_{18}ONCl$	11.84	11.83	4.68	4.90
-Picrate	189–190	Yellow needles	$C_{24}H_{20}O_8N_4$			11.38	11.59
9-ω-Diethylaminoacetylphenanthrene		Liquid	$C_{20}H_{21}ON$				
-Hydrochloride	158–159	White diamonds	$C_{20}H_{22}ONCl$	10.82	10.85		
-Picrate	138–139	Yellow needles	$C_{26}H_{24}O_8N_4$			10.77	10.90
9-ω-Piperidinoacetylphenanthrene		Liquid	$C_{21}H_{21}ON$				
-Hydrochloride	250–251	White needles	$C_{21}H_{22}ONCl$	10.44	10.47		
-Picrate	150–151	Yellow needles	$C_{27}H_{24}O_8N_4$			10.53	10.65

[a] Calcd. for $C_{21}H_{21}ON$: C, 83.12; H, 6.98. Found: C, 82.99; H, 7.11.

TABLE III

AMINOMETHYLPHENANTHRYLCARBINOLS, $C_{14}H_9CHOHCH_2NR_2$

The chlorine determinations in the hydrochlorides of Tables II and III were carried out by precipitation of silver chloride from the aqueous solutions of the salts

	M. p., °C.	Crystal form	Formula	Analyses, % C Calcd.	C Found	H Calcd.	H Found	N Calcd.	N Found	Cl Calcd.	Cl Found
Dimethylaminomethyl-2-phenanthrylcarbinol	100–101	White plates	$C_{19}H_{19}ON$	81.46	81.26	7.22	7.10	5.28	5.44		
-Hydrochloride	222–223	White needles	$C_{19}H_{20}ONCl$							11.76	11.94
-Picrate	235–236	Yellow plates	$C_{24}H_{22}O_8N_4$					11.34	11.45		
Diethylaminomethyl-2-phenanthrylcarbinol	75–76	White plates	$C_{20}H_{23}ON$	81.86	81.57	7.91	7.94	4.78	4.93		
-Hydrochloride	194–195	White needles	$C_{20}H_{24}ONCl$							10.76	10.75
-Picrate	154–155	Orange needles	$C_{26}H_{26}O_8N_4$					10.73	11.00		
Piperidinomethyl-2-phenanthrylcarbinol	126–127	White needles	$C_{21}H_{23}ON$	82.57	82.53	7.60	7.69	4.59	4.77		
-Hydrochloride	254.5–255.5	White leaflets	$C_{21}H_{24}ONCl$							10.38	10.44
-Picrate	180.5–181.5	Yellow diamonds	$C_{27}H_{26}O_8N_4$					10.49	10.69		
Dimethylaminomethyl-3-phenanthrylcarbinol	76–76.5	White plates	$C_{19}H_{19}ON$	81.46	81.13	7.22	7.26	5.28	5.39		
-Hydrochloride	179.5–180.5	White plates	$C_{19}H_{20}ONCl$							11.76	11.91
-Picrate	218–218.5	Yellow needles	$C_{24}H_{22}O_8N_4$					11.34	11.57		
Diethylaminomethyl-3-phenanthrylcarbinol	59–60	White diamonds	$C_{20}H_{23}ON$	81.86	81.63	7.91	7.99	4.78	5.02		
-Hydrochloride	168–169	White needles	$C_{20}H_{24}ONCl$							10.76	10.83
-Picrate	163–164	Yellow needles	$C_{26}H_{26}O_8N_4$					10.73	10.77		
Piperidinomethyl-3-phenanthrylcarbinol	108–109	White prisms	$C_{21}H_{23}ON$	82.57	82.39	7.60	7.68	4.59	4.60		
-Hydrochloride	242–243	White prisms	$C_{21}H_{24}ONCl$							10.38	10.51
-Picrate	174–175	Yellow prisms	$C_{27}H_{26}O_8N_4$					10.49	10.76		
Dimethylaminomethyl-9-phenanthrylcarbinol	93–94	White prisms	$C_{19}H_{19}ON$	81.46	81.53	7.22	7.16	5.28	5.30		
-Hydrochloride	211–211.5	White prisms	$C_{19}H_{20}ONCl$							11.76	11.85
-Picrate	210–211	Yellow needles	$C_{24}H_{22}O_8N_4$					11.34	11.37		
Diethylaminomethyl-9-phenanthrylcarbinol	87–88	White diamonds	$C_{20}H_{23}ON$	81.86	81.74	7.91	7.97	4.78	4.98		
-Hydrochloride		Oily	$C_{20}H_{24}ONCl$								
-Picrate	178.5–179.5	Yellow needles	$C_{26}H_{26}O_8N_4$					10.73	10.99		
Piperidinomethyl-9-phenanthrylcarbinol	111.5–112	White prisms	$C_{21}H_{23}ON$	82.57	82.60	7.60	7.58	4.59	4.61		
-Hydrochloride	216–216.5	White plates	$C_{21}H_{24}ONCl$							10.38	10.61
-Picrate	196–196.5	Yellow needles	$C_{27}H_{26}O_8N_4$					10.49	10.35		
Dimethylaminomethyl-2-phenanthrylcarbinol benzoate	108.5–109	White needles	$C_{25}H_{23}O_2N$					3.79	3.98		
Hydrochloride of dimethylaminomethyl-2-phenanthrylcarbinol benzoate	244–245	White needles	$C_{25}H_{24}O_2NCl$					3.45	3.75		
Hydrochloride of dimethylaminomethyl-3-phenanthrylcarbinol benzoate	223–224	White needles	$C_{25}H_{24}O_2NCl$					3.45	3.66		
Hydrochloride of dimethylaminomethyl-9-phenanthrylcarbinol benzoate	228–229	White plates	$C_{25}H_{24}O_2NCl$					3.45	3.77		

By treating the 2- and 3-ω-chloroacetylphenanthrenes with piperidine, 2- and 3-ω-piperidinoacetylphenanthrenes, respectively, were obtained. Their structure was proved by direct comparison (melting points and mixed melting points) of their hydrochlorides and picrates, with the corresponding derivatives obtained from the ω-bromoacetylphenanthrenes.

Summary

1. The preparation of 2-, 3- and 9-ω-bromoacetylphenanthrenes is described.

2. The preparation of 2-, 3- and 9-ω-dimethylamino-, -ω-diethylamino- and -ω-piperidinoacetylphenanthrenes is described.

3. The preparation of dimethylaminomethyl-, diethylaminomethyl- and piperidinomethyl-2-, 3- and 9-phenanthryl carbinols, by catalytic reduction of the corresponding ω-amino ketones, is described.

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A New Reaction of 1-Iodoacetylenes and Some New Mercury Acetylides

BY THOMAS H. VAUGHN

It has been pointed out by Johnson and McEwen[1] that the substitution of mercury for an acetylenic hydrogen by means of an alkaline solution of a mercuric salt produces compounds which are readily crystallizable and which possess sharp, definite melting points. They have advocated the use of these mercury derivatives as a general means of identifying and characterizing monosubstituted acetylenes.

We have found that substituted iodoacetylenes react with both Nef's alkaline mercuric iodide solution[2] and the mercuric cyanide reagent of Hofmann and Kirmreuther[3] producing the same compounds as do the acetylenes themselves. The reaction in the case of mercuric cyanide solution may be represented as

$$2RC{\equiv}CI + 2Hg(CN)_2 \longrightarrow (RC{\equiv}C)_2Hg + 2(CN)_2 + HgI_2$$

The reaction is easily carried out and gives a high yield of the mercury derivative. It is obvious that a determination of the melting point of the mercury compound affords a suitable means of identifying iodoacetylenes. The mercuric iodide which precipitates along with the mercury acetylide serves to distinguish between the iodoacetylenes and the acetylenes. The mercuric iodide usually separates as the yellow variety but is occasionally obtained in the red form. There is no apparent reason why the

(1) Johnson and McEwen, THIS JOURNAL, **48**, 469 (1926).
(2) Nef, *Ann.*, **308**, 299 (1899).
(3) Hofmann and Kirmreuther, *Ber.*, **41**, 314 (1908).