378. *Polycyclic Aromatic Hydrocarbons. Part XII. The Orientation of Derivatives of* 1 : 2-*Benzanthracene, with Notes on the Preparation of Some New Homologues, and on the Isolation of* 3 : 4 : 5 : 6-*Dibenzphenanthrene.*

By J. W. Cook.

Methods of orientation of derivatives of 1 : 2-benzanthracene are becoming increasingly necessary, and the method used in the case of 5 : 6-*cyclo*penteno-1 : 2-benzanthracene (J., 1931, 2529) has been extended. Thus, oxidation of both 6 : 7-dimethyl- and 6 : 7-

*cyclo*penteno-1 : 2-benzanthraquinones led to an *anthraquinonetetracarboxylic acid* which differed from anthraquinone-1 : 2 : 5 : 6-tetracarboxylic acid and also from *anthraquinone-1 : 2 : 7 : 8-tetracarboxylic acid*, which was prepared by oxidation of 1 : 2 : 7 : 8-dibenzanthraquinone (J., 1932, 1472). These experiments provide conclusive proof of the correctness of the structures assigned to 6 : 7-dimethyl-1 : 2-benzanthracene (J., 1932, 471) and 6 : 7-*cyclo*penteno-1 : 2-benzanthracene (J., 1931, 2529), both of which hydrocarbons have cancer-producing activity,* although they are considerably less potent than the 5 : 6-*cyclo*penteno-compound (compare Cook, *Proc. Roy. Soc.*, 1932, *B*, **111**, 485; 1933, **113**, 275). The tetracarboxylic acids were all very high-melting substances and for comparative purposes their tetramethyl esters were employed.

By oxidation of various monomethyl derivatives of 1 : 2-benzanthraquinone a set of reference samples of trimethyl anthraquinone-1 : 2 : *x*-tricarboxylates has been obtained. The following esters (melting points in parentheses) are now available: 1 : 2- (208°); 1 : 2 : 3- (184—185°); 1 : 2 : 5- (212—213°); 1 : 2 : 6- (233·5—234·5°); 1 : 2 : 7- (204—204·5°); 1 : 2 : 5 : 6- (292—293°); 1 : 2 : 6 : 7- (193—194°); 1 : 2 : 7 : 8- (237—239°). These have been used in determining the orientation of acetylbenzanthracenes (Cook and Hewett, this vol., p. 1408) and will also be of service in elucidating the constitution of the dehydrogenation products of certain bile acid derivatives (compare Cook and Haslewood, *Chem. and Ind.*, 1933, **52**, 758).

The formation of 4-methyl-1 : 2-benzanthracene by pyrolysis of 1-benzoyl-2 : 3-dimethylnaphthalene was described by Fieser and Peters (*J. Amer. Chem. Soc.*, 1932, **54**, 3742), who gave the m. p. as 107° (picrate, 119—120°). It has now been found that the pure hydrocarbon has m. p. 124·5—125·5° (picrate, 149—150°), and it should be stated again that the principal constituents of the crude mixtures of benzanthracene hydrocarbons formed by this type of reaction can be obtained pure only by repeated crystallisation of the picrates from benzene (J., 1932, 456); the use of alcohol as a solvent is ineffectual. The isolation of 4-methyl-1 : 2-benzanthracene in this experiment was advanced by Fieser and Peters as evidence against the generalisation of the present author that α-methyl groups are normally eliminated during the pyrolysis. But it had already been pointed out (Cook, J., 1930, 1088) that this loss of α-methyl groups is not universal. The modified generalisation of Fieser and Peters is certainly inadequate, and for the present there are insufficient data to warrant definition of the circumstances under which elimination does *not* occur.

A similar pyrolytic experiment with 1-α (or β)-*naphthoyl*-2 : 3-*dimethylnaphthalene* led to a crude hydrocarbon mixture from which 4-*methyl*-1 : 2 : 5 : 6-*dibenzanthracene* was isolated by purification through its *picrate*. The formation of this hydrocarbon from the α-naphthyl ketone is due to a molecular rearrangement, the nature of which has already been discussed (J., 1931, 487).

The suggestion (J., 1932, 461) that the yellow colour of the hydrocarbons obtained by pyrolysis of derivatives of 1-benzoyl-2-methylnaphthalene is due to slight contamination with orange derivatives of 2 : 3-benzanthracene formed by migration of the benzoyl group has now received experimental verification by the isolation of 2 : 3-benzanthracene as one of the products of pyrolysis of 1-benzoyl-2 : 3-dimethylnaphthalene (migration of benzoyl with elimination of one methyl group).

The 5-*methyl*-1 : 2-*benzanthracene* necessary for the production of anthraquinone-1 : 2 : 5-tricarboxylic acid was prepared by selenium dehydrogenation of the crude carbinol arising from the interaction of methylmagnesium iodide and 5-keto-5 : 6 : 7 : 8-tetrahydro-1 : 2-benzanthracene † (Haworth and Mavin, this vol., p. 1012). 1 : 2-Benzanthracene was the only hydrocarbon which could be isolated in the pure state when a similar experiment was performed with *iso*propylmagnesium bromide.

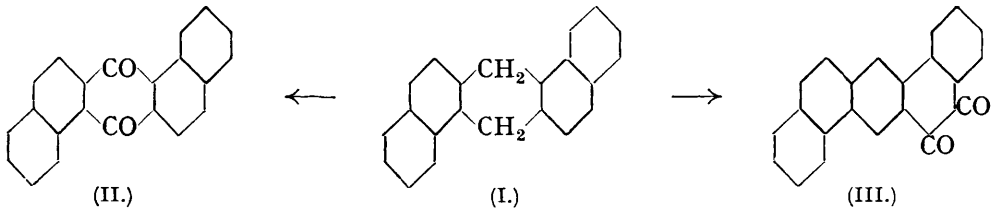
Attempted oxidation of 1-*p*-toluoyl-2-methylnaphthalene and 1-β-naphthoyl-2 : 6-

* A sample of 6 : 7-dimethyl-1 : 2-benzanthracene (m. p. 166—168°) gave 3 cancers and 1 papilloma in 10 mice in 15 months. The pure compound (m. p. 173—174°) has at the present time given only papillomata in 14 months, but a heavy death rate had reduced the original 20 mice to 5 after one year.

† Dr. R. D. Haworth was kind enough to supply complete details of the preparation of this ketone some time before his paper was published.

dimethylnaphthalene with aqueous selenious acid at 240° (compare J., 1932, 1476) gave dark-coloured amorphous acidic products, whereas 1-α-naphthoyl-2 : 6-dimethylnaphthalene gave a non-acidic crystalline substance, probably 1-α-*naphthoyl*-6-*methyl*-2-*naphthaldehyde*. These and other experiments appeared to indicate that this type of reaction would not furnish a convenient route to carboxy-derivatives of 1 : 2-benzanthracene and 1 : 2 : 5 : 6-dibenzanthracene.

The loss of carcinogenic activity consequent on the reduction of 1 : 2 : 5 : 6-dibenzanthracene to an octahydro-derivative (J., 1931, 498; *Proc. Roy. Soc.*, 1932, *B*, **111**, 494) made it desirable to study less highly reduced compounds, and it has been found that 9 : 10-*dihydro*-1 : 2 : 5 : 6-*dibenzanthracene* (I) may be obtained by catalytic hydrogenation of 1 : 2 : 5 : 6-dibenzanthracene in presence of nickel. This hydrocarbon (0·3% solution in benzene) has been applied to a series of 10 mice, of which 7 were still alive after 6 months, and has given one epithelioma; only one mouse, which bears a papilloma, remains alive after 11 months. Reduction to the dihydro-compound therefore appears to lessen the carcinogenic activity of 1 : 2 : 5 : 6-dibenzanthracene, but does not destroy it. The constitution of the dihydro-compound follows from its oxidation to 1 : 2 : 5 : 6-dibenz-9 : 10-anthraquinone (II), which is accompanied by appreciable amounts of a red *o*-quinone. The latter substance is also formed to a very minor extent by the chromic acid oxidation of 1 : 2 : 5 : 6-dibenzanthracene. It is a monoquinone and hence must be 1 : 2 : 5 : 6-*dibenz*-3 : 4-*anthraquinone* (III).



(II.) (I.) (III.)

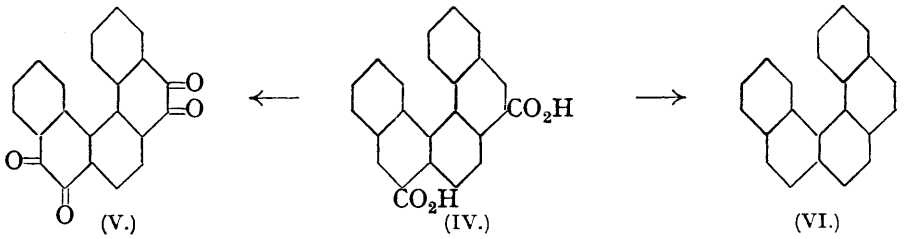
The formation of the 3 : 4-quinone by oxidation of 1 : 2 : 5 : 6-dibenzanthracene is of interest, for this is the first example in which there is any evidence that oxidation of a phenanthrene ring-system can occur while there is still an anthracene system unattacked in a molecule which contains both systems. Nevertheless, it remains true that the anthracenoid system is the more reactive, for the 9 : 10-quinone is the predominating oxidation product.

Eleven of the fifteen hydrocarbons consisting of five benzene rings condensed in the molecule have already been described in the literature and tested in this Institute for carcinogenic properties. The remaining four compounds would all contain the ring-system of 3 : 4-benzphenanthrene, which, moreover, is the simplest hydrocarbon yet found to have pronounced cancer-producing activity, and is also the only carcinogenic hydrocarbon yet encountered which is not derived from 1 : 2-benzanthracene.

Weitzenböck and Klinger (*Monatsh.*, 1918, **39**, 315) claimed to have isolated one of the four remaining pentacyclic hydrocarbons from the mother-liquors of the crystallisation of 1 : 2 : 5 : 6-dibenzanthracene, which they synthesised from *p*-phenylenediacetic acid and *o*-nitrobenzaldehyde by the well-known Pschorr series of reactions. They were unable to obtain sufficient of the dibenzphenanthrene for analysis and complete characterisation, and experiments now recorded have shown that their material was extremely impure.

In the first instance, an attempt was made to separate the mixture of 1 : 2 : 5 : 6-dibenzanthracene-4 : 8-dicarboxylic acid and 3 : 4 : 5 : 6-dibenzphenanthrene-1 : 8-dicarboxylic acid which arises in the Weitzenböck and Klinger synthesis, making use of the method of fractional crystallisation of salts which proved successful in an analogous case (Cook, J., 1931, 2525). This attempt did not succeed, but it was found possible to extract from the mixture of acids a fraction which consisted chiefly of the dibenzphenanthrene acid (IV). This acid, which was oxidised to a characteristic *diquinone* (V), was decarboxylated by heat to yield a product from which pure 3 : 4 : 5 : 6-*dibenzphenanthrene* (VI) was readily obtained. It is of interest that the sparingly soluble diquinone (V) was not

formed by oxidation of the hydrocarbon. This oxidation led to a mixture of quinones from which no pure constituent could be isolated, but analysis of the mixture of phenazine



derivatives arising from interaction with *o*-phenylenediamine showed that the mixture contained only monoquinones.

If 3 : 4 : 5 : 6-dibenzphenanthrene has any carcinogenic activity, it is of a very low order, for the hydrocarbon (0·3% solution in benzene) has now been applied to a series of 10 mice for 18 months and 2 of the mice are still alive (6 were alive after 1 year) but so far only one transient papilloma has appeared.

Experimental.

Oxidation of the benzanthraquinone derivatives to anthraquinonepolycarboxylic acids, with subsequent conversion through the silver salts into the methyl esters, was carried out exactly as described for the preparation of tetramethyl anthraquinone-1 : 2 : 5 : 6-tetracarboxylate (J., 1931, 2531). Except where otherwise stated, the esters formed pale yellow, microcrystalline powders. The following compounds were obtained :—

Dimethyl anthraquinone-1 : 2-*dicarboxylate*, pale yellow needles, from ethyl acetate, m. p. 208° (Found : C, 66·65; H, 3·8. $C_{18}H_{12}O_6$ requires C, 66·65; H, 3·7%). *Trimethyl anthraquinone*-1 : 2 : 3-*tricarboxylate*, m. p. 184—185°, from benzene–*cyclo*hexane (*Found : C, 62·9; H, 3·8. $C_{20}H_{14}O_8$ requires C, 62·8; H, 3·7%); 1 : 2 : 5-*tricarboxylate*, m. p. 212—213°, from benzene (*Found : C, 62·8; H, 3·6%); 1 : 2 : 6-*tricarboxylate*, m. p. 233·5—234·5°, from xylene (*Found : C, 63·0; H, 3·7%); 1 : 2 : 7-*tricarboxylate*, m. p. 204—204·5°, from chloroform–alcohol (*Found : C, 62·6; H, 3·6%). *Tetramethyl anthraquinone*-1 : 2 : 6 : 7-*tetracarboxylate*. (a) The ester obtained from 6 : 7-dimethyl-1 : 2-benzanthraquinone had m. p. 188—190°, from benzene (*Found : C, 60·7; H, 3·7. $C_{22}H_{16}O_{10}$ requires C, 60·0; H, 3·7%). (b) The ester from 6 : 7-*cyclo*penteno-1 : 2-benzanthraquinone had m. p. 193—194°, and did not depress the m. p. of the foregoing ester prepared from the dimethyl compound (*Found : C, 60·7; H, 3·85%). *Tetramethyl anthraquinone*-1 : 2 : 7 : 8-*tetracarboxylate* formed small rosettes of yellow needles, m. p. 237—239°, from xylene (*Found : C, 60·5; H, 3·8%).

4-*Methyl*-1 : 2-*benzanthracene* (compare Fieser and Peters, *loc. cit.*).—1-Benzoyl-2 : 3-dimethylnaphthalene (30 g.) was heated at 415° for 5 hours, and the residue in the flask distilled in a vacuum. The fraction, b. p. 230—280°/10 mm., was crystallised from acetic acid, and the yellow product triturated with cold benzene. A small amount of material remained undissolved which, after recrystallisation from xylene, formed deep orange plates, m. p. 335°, alone or mixed with authentic 2 : 3-benzanthracene. The benzene extract yielded 5 g. of crystalline substance, which was combined with picric acid (5 g.); the *picrate*, recrystallised four times from benzene, had a constant m. p. 149—150° (Found : C, 63·8; H, 4·3. $C_{19}H_{14},C_6H_3O_7N_3$ requires C, 63·7; H, 3·6%). This picrate, when shaken in benzene solution with dilute aqueous sodium carbonate, gave 4-*methyl*-1 : 2-*benzanthracene* (0·4 g.), which crystallised from alcohol in colourless needles, m. p. 124·5—125·5° (Found : C, 94·1; H, 5·7. $C_{19}H_{14}$ requires C, 94·2; H, 5·8%). Oxidation with sodium dichromate in boiling acetic acid gave 4-methyl-1 : 2-benzanthraquinone, m. p. 168—169°, depressed by 1 : 2-benzanthraquinone (Fieser and Peters give m. p. 167°). Attempted conversion of this quinone into trimethyl anthraquinone-1 : 2 : 4-tricarboxylate gave a product, m. p. 171—178°, which was shown by analysis to be very impure. There was insufficient for further purification.

5-*Methyl*-1 : 2-*benzanthracene*.—The dehydration of γ-(3-phenanthryl)butyric acid (Haworth and Mavin, *loc. cit.*) (28 g.) was effected by heating with anhydrous stannic chloride (28 c.c.) at 100° for 1½ hours. After cooling, the clear liquid was decanted, and the solid residue dissolved in acetone, treated with hydrochloric acid, and then extracted with benzene. The

benzene extract was repeatedly washed with hydrochloric acid, then with dilute sodium carbonate solution, concentrated, and treated with alcohol. The 5-keto-5 : 6 : 7 : 8-tetrahydro-1 : 2-benzanthracene which crystallised was sufficiently pure for the next stage. The yield, after making allowance for the acid recovered from the sodium carbonate extract, was 75%.

The finely powdered ketone (3·5 g.) was added gradually to an ice-cold Grignard solution prepared from methyl iodide (1·25 c.c.), magnesium turnings (0·5 g.), and anhydrous ether (20 c.c.). After being kept at room temperature for 2 hours, the mixture was decomposed with ice and ammonium chloride; the resinous carbinol which resulted was heated with selenium (1·5 g.) at 300—320° for 20 hours. The benzene extract of the product was distilled and the solid distillate (b. p. 220°/4 mm.; 2·6 g.) was treated in benzene solution with an equal weight of picric acid. After 2 recrystallisations from benzene, *5-methyl-1 : 2-benzanthracene picrate* formed dark red needles, m. p. 163—163·5° (*Found: N, 8·8. $C_{19}H_{14},C_6H_3O_7N_3$ requires N, 8·9%). The *hydrocarbon*, obtained as colourless leaflets, m. p. 157·5—158·5° (from alcohol) (*Found: C, 94·2; H, 5·8. $C_{19}H_{14}$ requires C, 94·2; H, 5·8%), was oxidised by sodium dichromate in boiling acetic acid to *5-methyl-1 : 2-benzanthraquinone*, long slender orange-yellow needles, m. p. 173·5—174·5° (from acetic acid) (*Found: C, 83·9; H, 4·5. $C_{19}H_{12}O_2$ requires C, 83·8; H, 4·4%).

1-α-Naphthoyl-2 : 3-dimethylnaphthalene.—Anhydrous aluminium chloride (50 g.) was added to an ice-cold mixture of α-naphthoyl chloride (50 g.), 2 : 3-dimethylnaphthalene (50 g.), and carbon disulphide (150 c.c.). After being kept at 0° for 5 hours, the product was decomposed with ice, and the *ketone* isolated in the usual way (31 g., after crystallisation from methyl ethyl ketone). Recrystallisation from benzene gave a yellowish crystalline powder, m. p. 191° (Found: C, 89·1; H, 6·0. $C_{23}H_{18}O$ requires C, 89·0; H, 5·85%).

1-β-Naphthoyl-2 : 3-dimethylnaphthalene (62 g.), similarly prepared from β-naphthoyl chloride (50 g.), formed a colourless crystalline powder (from acetic acid), m. p. 129—130° (Found: C, 89·0; H, 6·0%).

4-Methyl-1 : 2 : 5 : 6-dibenzanthracene was formed when either of the foregoing ketones (30 g.) was heated at 445° for 2 hours, and the residue in the retort distilled at 2—3 mm. The distillate, b. p. 260—300°, was recrystallised from benzene and then had m. p. 172—175° (3·4 g.). This was decolorised with maleic anhydride (compare *Proc. Roy. Soc.*, 1932, *B*, 111, 469) and then treated in benzene with picric acid. Fractional crystallisation from benzene gave the *dipicrate* of *4-methyl-1 : 2 : 5 : 6-dibenzanthracene*, light red needles, m. p. 200—201° (Found: C, 56·0; H, 4·0. $C_{23}H_{16},2C_6H_3O_7N_3$ requires C, 56·0; H, 3·0%). The *hydrocarbon* formed colourless needles, m. p. 184—185°, from benzene (Found: C, 94·6; H, 5·6. $C_{23}H_{16}$ requires C, 94·5; H, 5·5%).

1-α-Naphthoyl-6-methyl-2-naphthaldehyde.—A mixture of 1-α-naphthoyl-2 : 6-dimethylnaphthalene (6 g.) (J., 1931, 492), selenious acid (15 g.), and water (15 c.c.) was heated in a sealed tube at 220° for 5 hours. After removal of a small amount of acidic substance, the product was crystallised from methyl ethyl ketone and then from benzene. The *aldehyde* (1·5 g.) formed a yellowish crystalline powder, m. p. 185—186° (Found: C, 85·3; H, 5·0. $C_{23}H_{16}O_2$ requires C, 85·2; H, 5·0%). Probably it is the methyl group adjacent to the carbonyl group which was oxidised (compare J., 1932, 1476), but this is not proved.

9 : 10-Dihydro-1 : 2 : 5 : 6-dibenzanthracene (I).—A solution of 1 : 2 : 5 : 6-dibenzanthracene (2 g.) in tetralin (300 c.c.) was hydrogenated in the presence of nickel at 205° and 200 lb./sq. in., in a laboratory plant supplied by Technical Research Works, Ltd. The solvent was removed in steam, and the residue treated with picric acid in benzene. The very sparingly soluble 1 : 2 : 5 : 6-dibenzanthracene picrate separated and was collected. The filtrate was freed from picric acid, the solvent removed, and the residue (0·35 g.) recrystallised from *cyclo*hexane and then from acetic acid. *9 : 10-Dihydro-1 : 2 : 5 : 6-dibenzanthracene* formed colourless leaflets, m. p. 196—198° (*Found: C, 94·0; H, 5·6. $C_{22}H_{16}$ requires C, 94·2; H, 5·8%).

1 : 2 : 5 : 6-Dibenz-3 : 4-anthraquinone (III).—(a) A suspension of pure colourless 1 : 2 : 5 : 6-dibenzanthracene (9·5 g.) in acetic acid (200 c.c.) was boiled for 3 hours with sodium dichromate (20 g.). The crude oxidation product (10·1 g.; m. p. 232—240°), consisting chiefly of the 9 : 10-quinone (m. p. 248—250°), was recrystallised from boiling xylene. A small amount of dark red material remained undissolved and was sublimed in a vacuum at 300° and recrystallised from nitrobenzene; it formed dark red, silky needles, m. p. 326—327° (decomp.), which gave a bright blue solution in concentrated sulphuric acid (*Found: C, 84·8; H, 4·0. $C_{22}H_{12}O_2$ requires C, 85·7; H, 3·9%). This *o-quinone* gave an *azine* when its suspension in acetic acid was boiled with *o*-phenylenediamine. The product crystallised from nitrobenzene as a yellow

microcrystalline powder which decomposed above 300° (*Found: N, 8·0. $C_{28}H_{16}N_2$ requires N, 7·4%).

(b) Oxidation of 9 : 10-dihydro-1 : 2 : 5 : 6-dibenzanthracene with sodium dichromate in boiling acetic acid gave a mixture of 1 : 2 : 5 : 6-dibenz-9 : 10-anthraquinone and 1 : 2 : 5 : 6-dibenz-3 : 4-anthraquinone, identified by comparison with authentic samples. The proportion of *o*-quinone (10% and more) was appreciably greater than that arising from the oxidation of 1 : 2 : 5 : 6-dibenzanthracene.

3 : 4 : 5 : 6-*Dibenzphenanthrene* (VI).—The crude mixture of acids (32 g.) resulting from the Pschorr reaction with di-α-*o*-aminobenzylidene-*p*-phenylenediacetic acid (Weitzenböck and Klinger, *loc. cit.*) was extracted for 3 hours with boiling alcohol (1 l.). The insoluble residue (8 g.) was dissolved in *N*-sodium hydroxide solution (50 c.c.) and the crystals which separated were twice recrystallised from water. This procedure resulted in removal of coloured impurities, but examination of the oxidation products showed that the crystalline material was a mixture of sodium salts. The high solubility of this mixture precluded further attempts at separation. For oxidation, a suspension in acetic acid (0·4 g. in 20 c.c.) was boiled for 3½ hours with sodium dichromate (2·5 g.). After cooling, the dark red solid in suspension (0·15 g.) was collected and recrystallised from nitrobenzene (100 c.c.). 3 : 4 : 5 : 6-*Dibenzphenanthra*-1 : 2 : 7 : 8-*diquinone* (V) formed dark red needles, m. p. above 360°, which gave an emerald-green solution in concentrated sulphuric acid (*Found: C, 77·5; H, 3·1. $C_{22}H_{10}O_4$ requires C, 78·1; H, 3·0%). Its *diazine*, formed from *o*-phenylenediamine, crystallised in microscopic yellow needles, m. p. above 360°, and gave a magenta solution in sulphuric acid. This compound was too sparingly soluble to be recrystallised and was washed with boiling benzene (*Found: N, 10·7. $C_{34}H_{18}N_4$ requires N, 11·7%).

The acetic acid liquors from the oxidation were diluted with water and the precipitate was collected and extracted with dilute sodium carbonate solution. Acidification of the filtrate gave a gelatinous precipitate of 1 : 2 : 5 : 6-*dibenzanthraquinone*-4 : 8-*dicarboxylic acid*, which became crystalline in boiling acetic acid, and was washed with alcohol and ether (*Found: C, 72·0; H, 3·2. $C_{24}H_{12}O_6$ requires C, 72·7; H, 3·1%). This acid, m. p. above 360°, gave the Liebermann anthraquinol reaction. Analytically pure samples of these oxidation products could not be obtained on account of their very sparing solubility.

The original alcoholic extract of the crude mixture of acids was concentrated, and the material which separated was extracted with a little boiling acetic acid. The insoluble product (6·7 g.) was somewhat dark in colour but had been freed from much resinous matter. Oxidation showed that this fraction contained very little of the dibenzanthracene acid. 6 G. were heated at 380° in an atmosphere of carbon dioxide until gas evolution had ceased, and the residue was sublimed in a vacuum. The sublimate was extracted with alkali and recrystallised from acetic acid; it then had m. p. 168—174°. For removal of a trace of dibenzanthracene, the substance (1·75 g.) was treated with picric acid (2 g.) in benzene (25 c.c.). After the dibenzanthracene picrate had been collected, the 3 : 4 : 5 : 6-*dibenzphenanthrene* (VI), which gave no crystalline picrate, was recovered from the filtrate and was crystallised from *cyclo*hexane and then from alcohol. It formed colourless needles, m. p. 177—178° (*Found: C, 95·0; H, 5·2%; *M*, Rast method, 301, 315. $C_{22}H_{14}$ requires C, 94·9; H, 5·1%; *M*, 278).

Oxidation of 3 : 4 : 5 : 6-dibenzphenanthrene with sodium dichromate in acetic acid gave a resinous product, which did not crystallise and was treated with *o*-phenylenediamine. The solid product, which gave no Liebermann reaction and hence was free from 1 : 2 : 5 : 6-dibenzanthraquinone, was crystallised from ethyl acetate and from benzene. The yellow powder (indefinite m. p. 226—246°) could not be separated into its components (*Found: C, 88·0; H, 4·5; N, 7·4. Calc. for azine of monoquinone: C, 88·4; H, 4·2; N, 7·4%).

The analyses marked with an asterisk were microanalyses by Dr. A. Schoeller.

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