ously. The solvent was removed under reduced pressure until the volume was reduced to 1–2 ml, and the mixture was diluted with 10 ml of water. After cooling at 5° for several hours the yellow crystalline solid which separated was filtered off and dried in air, 125 mg (85%), mp 120–121°.

7-Acetoxymethyl-12-methylbenz[*a*]anthracene (XIII). Method A.—A mixture of X (3.0 g), pyridine (30 ml), fused sodium acetate (3 g), and Ac_2O (15 ml), was refluxed for 1 hr and stirred overnight at room temperature. It was poured in ice water (300 ml) and the solid was removed by filtration. Crystallized from benzene–ethanol it formed feather-like crystals (3 g, 84%), mp 145–146°.

Method B.—A mixture of X (0.25 g), Ag_2CO_3 (0.25 g), and Ac_2O (1.5 ml) was refluxed 0.5 hr. After evaporation under reduced pressure, the mixture was diluted with 50 ml of ice water and allowed to stand overnight in the refrigerator. The product was filtered off and crystallized from benzene–methanol, mp 145–146°, 0.15 g (80%) of yellow needles.

7,12-Dihydroxymethylbenz[*a*]anthracene was prepared by the method of Badger and Cook,[14] and **7,12-epidioxy-7,12-dimethylbenz[*a*]anthracene** by the method of Cook and Martin.[15]

Experiments with Rat-Liver Homogenates.—Female Sprague–Dawley rats, age 50 days, were used. Liver homogenates were prepared as described by Boyland and Sims.[6]

A 10% homogenate was prepared in ice-cold 1.15% (w/v) KCl. The homogenate was centrifuged for 20 min at 1475*g* (0°) and the supernatant was diluted with an equal volume of 0.1 *M* sodium phosphate buffer, pH 7.4. To 120 ml of the diluted supernatant was added niacinamide (450 mg), $NADP^+$ (10 mg), glucose 6-phosphate (60 mg), and DMBA (2 mg), dissolved in 1 ml of ethanol. The mixture was incubated 1 hr at 37° under O_2 in a Dubnoff metabolic shaker, then cooled, acidified with 1 *N* HCl to pH 3, and extracted with three 50-ml portions of ether. The ether extract was dried (Na_2SO_4) and evaporated under N_2 to a small volume and chromatographed by tlc. The chromatogram was divided into zones under ultraviolet light. The zones were removed from the plate, and the compounds adsorbed to the silica gel were eluted with ethanol and rechromatographed.

Identification of Metabolites.—Metabolites and their derivatives, prepared by microchemical reactions carried out in parallel with authentic compounds, were identified by their mobility on thin layer chromatograms.

Microchemical Reactions.—Metabolites, purified by thin layer chromatography, were scraped from the thin layer plates and eluted from the silica gel with ethanol.

1. **Acetylation.** The metabolite, dissolved in 0.1 ml of pyridine, was added to an equal volume of Ac_2O and the mixture was heated at 60–70° for 1 hr. The solvent was evaporated with N_2 and the residue was dissolved in benzene and chromatographed (tlc).

2. **Oxidation with CrO_3.**—The sample, dissolved in 0.5 ml of AcOH, was treated with 0.25 ml of CrO_3 (2%) and allowed to stand 1 hr. Water (10 ml) was added and the mixture was extracted with two 5-ml portions of ether, washed ($NaHCO_3$, H_2O), and dried (Na_2SO_4). The product was examined on tlc.

Methylation with Dimethyl Sulfate.—The zone corresponding to 4-hydroxy-DMBA was scraped from the plate and eluted with ethanol. To this ethanolic solution (0.1 ml) was added dimethyl sulfate (0.1 ml) and 20% NaOH (0.1 ml). After standing in the water bath (50°) for 20 min, 0.05 ml of dimethyl sulfate and 0.1 ml of 20% NaOH were added with stirring and the mixture was returned to the bath for 15 min. The mixture was cooled, 20% NaOH (0.5 ml) was added and, after a few minutes, extracted with CH_2Cl_2 (5 ml). The extract was washed with two 0.5-ml portions of water, 1 drop of AcOH was added, and the solution was concentrated under N_2 and examined on tlc.

(14) C. M. Badger and J. W. Cook, *J. Chem. Soc.*, 802 (1939).
(15) J. W. Cook and R. H. Martin, *ibid.*, 1125 (1940).

Derivatives of Fluorene. XXIII.[1] New Thiofluorenes Related to Metabolism of the Carcinogen N-2-Fluorenylacetamide

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Synthesis of N-2-(3-methylthiofluorenyl)acetamide (I) by two routes is described. This compound is identical with one which has been isolated by alkaline degradation of the *in vitro* reaction product of N-acetoxy-N-2-fluorenylacetamide, a highly potent carcinogen, and methionine or methionylglycine or proteins. I is also identical with a compound isolated from rat liver tissue after the rat has been fed N-2-fluorenylacetamide. For comparative studies, N-2-(7-fluoro-3-methylthiofluorenyl)acetamide was prepared and its structure was confirmed by an alternate route. In the initial preparation of this compound, we first used alcoholic sodium methyl sulfide which had been standing for some time, and a series of 3-ethoxyfluorene derivatives resulted instead of the expected 3-methylthiofluorenes. A number of new fluorene derivatives are reported and infrared spectral data are presented and discussed.

N-Hydroxy-N-2-fluorenylacetamide (N-HO-FAA) has been shown by the Millers and their associates[2] to be both a metabolite of the carcinogen N-2-fluorenylacetamide (FAA) and a more potent carcinogen than the latter. In addition, higher levels of hepatic protein and nucleic acid bound derivatives were found after administration of the N-hydroxy compound than after the parent amide or amine.[3] This pointed to the likelihood that N-HO-FAA or a derivative is involved in the binding reaction; indeed, it has now been shown that certain esters of N-HO-FAA react with methionine and its peptides at physiological pHs.[4] N-HO-FAA itself has not been observed to react with proteins or nucleic acids *in vitro*, although N-hydroxyfluoren-2-amine (N-HO-FA) reacts with guanine in nucleic acids at an acid pH.[5] More recently, the Millers, *et al.*,[6,7] have observed a reaction between N-acetoxy-N-2-fluorenylacetamide (N-AcO-FAA) and nucleic acid guanine at pH 7. Certain metabolic esters of N-HO-

(1) (a) Paper XXII: T. L. Fletcher, W. H. Wetzel, and M. J. Namkung, *J. Med. Chem.*, **9**, 593 (1966). (b) Supported in part by a grant (CA-01744) from the National Cancer Institute, National Institutes of Health, and in part by Research Career Development Award 5-K3-CA-14,991 (T. L. F.).

(2) J. W. Cramer, J. A. Miller, and E. C. Miller, *J. Biol. Chem.*, **235**, 885 (1960); E. C. Miller, J. A. Miller, and H. A. Hartmann, *Cancer Res.*, **21**, 815 (1961).

(3) E. C. Miller, C. W. Cooke, P. D. Lotlikar, and J. A. Miller, *Proc. Am. Assoc. Cancer Res.*, **5**, 45 (1964); F. Marroquin and E. Farber, *Cancer Res.*, **25**, 1262 (1965); R. F. Williard and C. C. Irving, *Federation Proc.*, **23**, 167 (1964).

(4) P. D. Lotlikar, J. D. Scribner, J. A. Miller, and E. C. Miller, *Life Sci.*, **5**, 1263 (1966).

(5) E. Kriek, *Biochem. Biophys. Res. Commun.*, **20**, 793 (1965).

(6) E. C. Miller, U. Juhl, and J. A. Miller, *Science*, **153**, 1125 (1966).

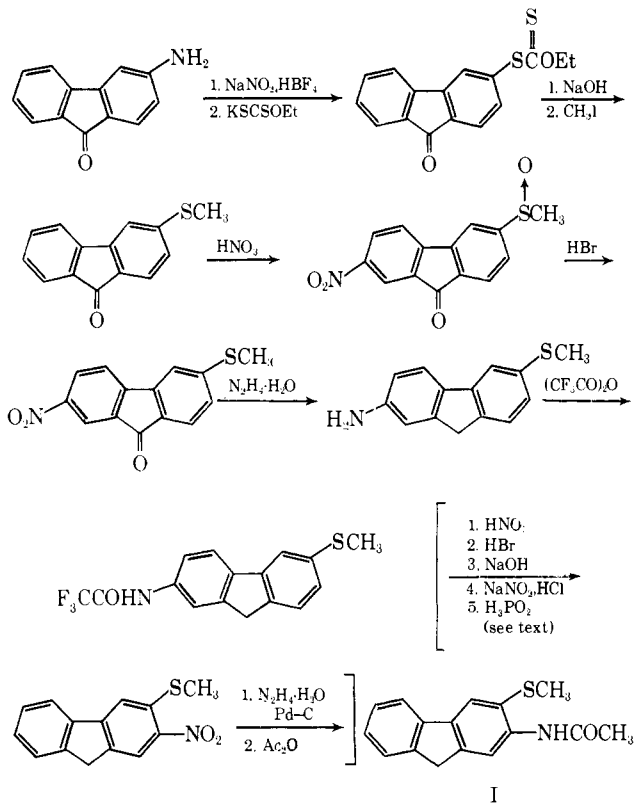
(7) E. Kriek, J. A. Miller, U. Juhl, and E. C. Miller, *Biochemistry*, **6**, 177 (1967).

FAA, therefore, are probable *in vivo* precursors of the much-studied bound derivatives of this carcinogen. Evidence as to the nature of at least a part of the protein-bound material is now available since the reaction product of N-AcO(BzO)-FAA and methionine or methionylglycine, prepared under physiological conditions, breaks down to yield N-2-(3-methylthiofluorenyl)-acetamide (I), identified[4] from spectral data. Likewise, I can be obtained in microgram quantities from alkaline digests of the liver protein of rats fed FAA or N-HO-FAA.[8]

It was felt highly desirable to confirm the proposed structure of I by unambiguous synthesis and also to obtain enough of this compound for additional biological tests.[9] We also wished to prepare N-2-(7-fluoro-3-methylthiofluorenyl)acetamide for comparative studies since N-2-(7-fluorofluorenyl)acetamide, with the principal metabolic ring-hydroxylation site blocked, is a more potent liver carcinogen in the male rat than FAA itself.[10]

Since 9-oxo-3-fluorenamine was readily available,[11] we decided to make 3-methylthio-9-oxofluorene by way of the xanthate, hoping that a mild nitration would give a substantial amount of the 2-nitro derivative. Instead, the initial reaction was oxidation to the sulfoxide; more drastic conditions then led to mononitration. The latter reaction was soon found to have taken place on the 7 position (Scheme I) and subsequent steps were based on our previous finding[12] that the trifluoroacetamido group (7 position) directs nitration to the 2 position.

SCHEME I

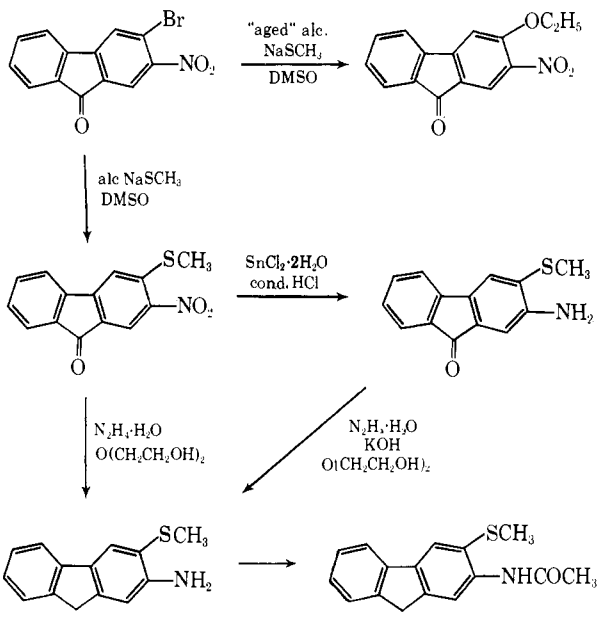


I

After deamination and reduction of the sulfoxide, nitro, and 9-oxo groups, we obtained an extremely small yield of 3-methylthio-2-fluorenamine and its N-acetyl derivative (I) which had the same melting point and infrared spectrum as the compound, mentioned above, obtained by Lotlikar, *et al.*[4] In addition, deamination of the compound obtained by hydrolysis of I (as recovered from the interaction of methionine and N-acetoxy-FAA by Lotlikar, *et al.*[4]) gave authentic 3-methylthiofluorene. The metabolic experiments of De Baun, *et al.*,[8] started with a known 2-substituted fluorene nucleus. This laboratory synthesis began with a known 3-substituted compound. The structure is therefore confirmed.

In addition to the fact that I was obtained in very low yield, several of the intermediates following trifluoroacetylation of 2-amino-6-methylthiofluorene were very difficult to purify. We, therefore, devised the following alternate route (Scheme II).

SCHEME II[a]



I

[a] These same steps were used in the analogous series of compounds with a fluorine atom in the 7 position.

Peracetic acid oxidation of 3-bromo-9-oxo-fluoren-2-amine[13] gave the 2-nitro derivative[14] which was treated with ethanolic sodium thiomethylate in dimethyl sulfoxide to give 3-methylthio-2-nitro-9-oxofluorene. Subsequent reductions to the desired metabolite are described in the Experimental Section.

Synthesis of the 7-fluoro analog of I, by the same steps as shown in Scheme II, appeared at first to go as expected. However, we soon found that we had obtained a series of compounds, with no sulfur and with one more carbon than expected, which proved to be 3-ethoxyfluorenes (Scheme II). We had used the same

(8) J. R. De Baun, E. C. Miller, and J. A. Miller, *Proc. Am. Assoc. Cancer Res.*, **8**, 12 (1967).

(9) Personal communication from J. A. Miller and E. C. Miller. De Baun, *et al.*,[8] find that I is identical, by thin layer and gas–liquid partition chromatography, with the metabolite of FAA released by alkali from the liver protein of rats fed FAA.

(10) J. A. Miller, R. B. Sandin, E. C. Miller, and H. P. Rusch, *Cancer Res.*, **15**, 188 (1955).

(11) N. Ishikawa, M. Okazaki, and M. Hayashi, *Yuki Gosei Kagaku Kyokai Shi* **15**, 34 (1958); *Chem. Abstr.*, **52**, 5349 (1958).

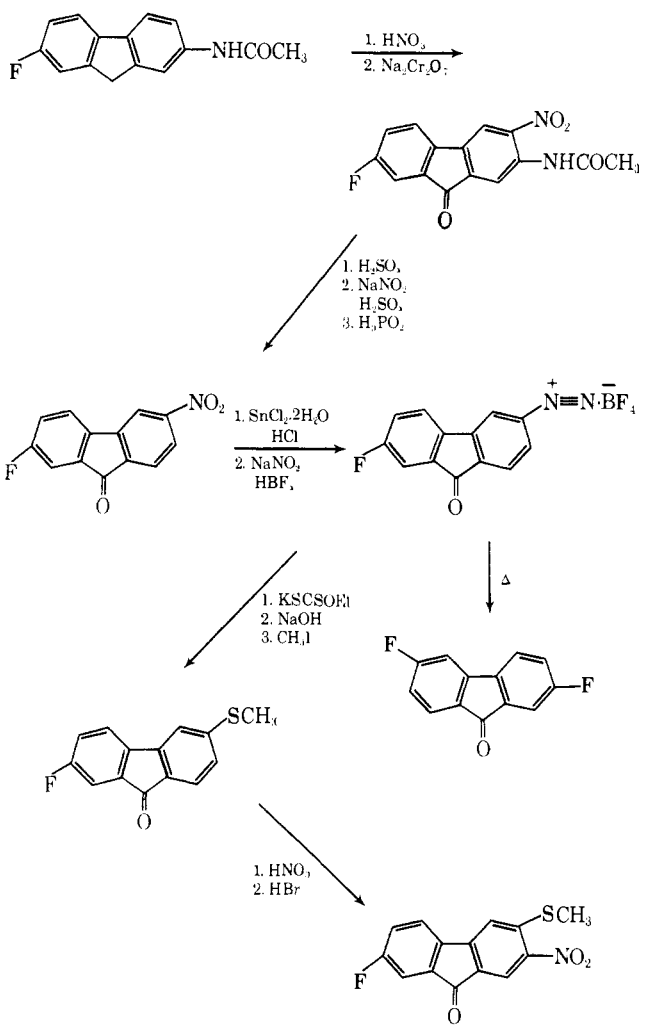
(12) M. J. Namkung and T. L. Fletcher, *J. Org. Chem.*, **25**, 740 (1960).

(13) T. L. Fletcher and H.-L. Pan, *J. Am. Chem. Soc.*, **78**, 4812 (1956); T. L. Fletcher, M. J. Namkung, and H.-L. Pan, *Chem. Ind.* (London), 660 (1957).

(14) K. Suzuki, E. K. Weisburger, and J. H. Weisburger, *J. Org. Chem.*, **26**, 2236 (1961).

ethanolic sodium thiomethylate solution, which had given good results with 3-bromo-2-nitrofluorenone when freshly prepared, but which had "aged" in the refrigerator for several months. Subsequent reaction of this old solution with 3-bromo-2-nitrofluorenone led, likewise, to a good yield of 3-ethoxy-2-nitrofluorenone. Returning to the main road, and using fresh thiomethylate solutions, we obtained the desired 7-fluoro-3-S-methyl derivatives as in Scheme II. Confirmation of the structure of 7-fluoro-3-methylthio-2-nitro-9-oxofluorene, and thus of the final compound, was obtained as shown in Scheme III, in which all of the compounds, except the first one and 2,6-difluoro-9-oxofluorene,[15] are new to the literature. The latter was prepared to confirm the position of the initial nitration shown in Scheme III.

Scheme III



From 3-amino-7-fluorofluorenone, we obtained 3-hydroxy- (and ethoxy-) 7-fluorofluorenone, thus establishing the structure of the substance which had been obtained from aged ethanolic sodium thiomethylate and 3-bromo-7-fluoro-2-nitro-9-oxofluorene.

Relatively little work has been reported on thiofluorenes, and we found no such derivatives with sulfur attached to the 3 position prior to the work cited above.[4]

(15) T. L. Fletcher, M. J. Namkung, W. H. Wetzel, and H.-L. Pan, *J. Org. Chem.*, **25**, 1342 (1960).

Infrared spectral data follow each procedure. Most of the spectra of compounds with a methylthio or sulfoxide group have a weak absorption band at 685–665 cm^{-1}, but this can be no more than a tentative assignment for C–S stretching vibrations. Bands at *ca.* 1325 cm^{-1} are assigned to the C–H symmetric deformation of the S–CH_3 group and have significantly lower wave numbers than are generally assigned to the C–H of OCH_3 and CCH_3 (1370–1380 cm^{-1}).[16] There are three prominent bands, between 1250 and 1036 cm^{-1} (COC and C=S), in the spectra of the two xanthates, agreeing with literature reports.[16-18] There is some confusion, however, over the position of the C=S band, which generally is given as between 1020 and 1070 cm^{-1}, agreeing with our assignment. A band ranging from 1262 to 1143 has also been assigned to C=S, but one we find in that range, at 1250–1247 cm^{-1}, seems more likely to arise as one of the absorption bands of the COC grouping of these xanthates.

Reviewing our work on 2-acetamido-*x*-fluorofluorenes,[19] which were synthesized for an exploration of the carcinogenic mechanism of 2-acetamidofluorene, it is interesting to note that all monofluoro-2-acetamidofluorenes exhibit two Ar–F bands which can be classified as follows: 1- and 8-fluoro at *ca.* 1320 and 1240 cm^{-1}, 7-fluoro at *ca.* 1265 and 1220 cm^{-1}, 3- and 6-fluoro at *ca.* 1300 and 1180 cm^{-1}, 4-fluoro at *ca.* 1280 and 1130 cm^{-1}, and 5-fluoro at *ca.* 1270 and 1230 cm^{-1}.

Experimental Section[20]

Ethyl 9-Oxofluoren-3-yl Xanthate.—The diazonium fluoroborate prepared from 40 g of 9-oxo-3-fluorenamine in 50% aqueous dimethyl sulfoxide (DMSO) was added in portions, with stirring, to a warm (70–80°) solution of 50 g of potassium ethyl xanthate (Eastman, White Label) in 200 ml of water covered with 100 ml of benzene. Rapid decomposition took place with the evolution of gas, after which the benzene layer was separated and the solvent evaporated. The product was dissolved in 150 ml of benzene, chromatographed on alumina, and eluted with benzene. The fast-moving yellow band was collected and the solvent evaporated giving 25 g (41%), mp 180–181°. Recrystallization from benzene gave an analytical sample with unchanged melting point; ν_{max} 1706 (keto C=O), 1250, 1111 (COC), 1036 (C=S),[16] 762 and/or 740 (four adjacent H) cm^{-1}.

Anal. Calcd for $C_{16}H_{12}O_2S_2$: C, 63.97; H, 4.03; S, 21.35. Found: C, 64.07; H, 4.12; S, 21.34.

3-Methylthio-9-oxofluorene.—A mixture of the above xanthate (25 g), 500 ml of ethanol, and 10 g of NaOH was refluxed for 10 min and cooled, and 150 ml of CH_3I was added with stirring, the color changing from dark red to light yellow. The mixture was boiled down to near dryness and the product was extracted with benzene and chromatographed on alumina (benzene). Upon evaporation, a yellow product came out giving 16 g (85%), mp 117–118°. One recrystallization from benzene did not change the melting point; ν_{max} 1698 (keto C=O), 1295 (C–H deforma-

(16) L. J. Bellamy, "The Infrared Spectra of Complex Molecules," 2nd ed, John Wiley and Sons, Inc., New York, N. Y., 1958; particularly K. Nakanishi, "Infrared Absorption Spectroscopy—Practical," Holden-Day, Inc., San Francisco, Calif., 1962, and *Quart. Rept. Sulfur Chem.*, **1**, 189 (1966), which deals entirely with the spectra of organic sulfur compounds (Jan 1961–Dec 1964).

(17) M. L. Shankaranarayana and C. C. Patel, *Can. J. Chem.*, **39**, 1633 (1961).

(18) L. H. Little, G. W. Poling, and J. Leja, *ibid.*, **39**, 745 (1961).

(19) M. J. Namkung, T. L. Fletcher, and W. H. Wetzel, *J. Med. Chem.*, **8**, 551 (1965), is the latest of our five Fluorofluorene papers.

(20) Melting points to 250° were taken on a Fisher-Johns block and are corrected to standards; above 250° they were taken in a capillary on the Hoover apparatus and are not corrected, unless noted. Infrared spectra were run in KBr disks with a Beckman IR-5 (*ca.* 1.5 mg/300 mg of KBr). Band assignments were made with the help of the references listed in ref 16. Analyses were run by Schwarzkopf Laboratories, Woodside, N. Y.

tion of SCH_3), 921 (isolated H), 813 (two adjacent H), 762 or 731 (four adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_{10}OS$: C, 74.30; H, 4.46; S, 14.17. Found: C, 74.56; H, 4.53; S, 14.45.

Methyl 9-Oxofluoren-3-yl Sulfoxide.—To a mixture of 26 ml of AcOH and 13 ml of yellow fuming HNO_3 at room temperature, 13 g of 3-methylthio-9-oxofluorene was added in small portions. An exothermic reaction took place with evolution of reddish brown fumes, and the temperature rose to 50°. The mixture was then cooled and stirred into 200 ml of cold water. Upon trituration, a light yellow precipitate solidified which was filtered off, washed with water, and dried, giving 11 g (79%), mp 148–150°. Recrystallization from benzene gave an analytical sample: mp 149–150°; ν_{max} 1701 (keto C=O), 1297 (C–H deformation of SCH_3), 1041 broad (sulfoxide), 763, *ca.* 740 (four adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_{10}O_2S$: C, 69.41; H, 4.16; S, 13.22. Found: C, 69.36; H, 3.97; S, 13.06.

Methyl 7-Nitro-9-oxofluoren-3-yl Sulfoxide. A. Nitration of Methyl 9-Oxofluoren-3-yl Sulfoxide.—The sulfoxide (1 g) was added to 5 ml of yellow fuming HNO_3 (*d* 1.50) at 10°. The reaction was controlled by holding the temperature under 30°. After 10 min the mixture was stirred into 50 ml of cold water. The yellow precipitate was filtered off and dried giving 1.2 g, mp 197–205°. Recrystallization from benzene (Darco) yielded 0.7 g of the nitro compound, mp 209–210°. Another recrystallization from the same solvent gave an analytical sample with unchanged melting point; ν_{max} 1718 (keto C=O), 1524, 1344 (NO_2), 1055–1038 (sulfoxide) cm^{-1}.

Anal. Calcd for $C_{14}H_9NO_4S$: C, 58.53; H, 3.16; N, 4.88; S, 11.16. Found: C, 58.46; H, 3.15; N, 5.00; S, 11.31.

B. Nitration of 3-Methylthio-9-oxofluorene.—The procedure in A was applied to 3-methylthio-9-oxofluorene yielding the same compound (60%), mp 209–210°.

6-Methylthio-2-nitro-9-oxofluorene.—The nitro sulfoxide (11.3 g) was dissolved in 34 ml of warm glacial acetic acid and cooled to room temperature, and 4.5 ml of 48% HBr was added with stirring. A yellow precipitate came out, which was allowed to stand for 24 hr and then filtered off giving 9.7 g (90%) of the product, mp 215–217°. One recrystallization from AcOH gave an analytical sample: mp 218–219°; ν_{max} 1704 (keto C=O), 1517, 1340 (NO_2), 1340 (C–H deformation of SCH_3) cm^{-1}.

Anal. Calcd for $C_{14}H_9NO_3S$: C, 61.98; H, 3.34; N, 5.16; S, 11.81. Found: C, 61.89; H, 3.28; N, 4.95; S, 12.27.

6-Methylthio-9-oxofluoren-2-amine.—A mixture of 12 g of methyl 7-nitro-9-oxofluoren-3-yl sulfoxide, 70 g of $SnCl_2 \cdot 2H_2O$, 240 ml of concentrated HCl, and 120 ml of ethanol was boiled for 15 min and cooled to room temperature. The yellow precipitate was filtered off and stirred with dilute NH_4OH releasing the deep purple amino compound which was filtered off and washed to obtain 8 g (79%), mp 156–158°. This was dissolved in boiling toluene and filtered. The resulting crystals melted at 157–158°; ν_{max} 1698 (keto C=O), 1314 (C–H deformation of SCH_3), 878 or 866 (isolated H), 832, 820 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_{11}NOS$: C, 69.69; H, 4.59; N, 5.80; S, 13.27. Found: C, 69.74; H, 4.44; N, 5.70; S, 13.16.

N-2-(6-Methylthio-9-oxofluorenyl)acetamide.—Acetylation of the amine and recrystallization from alcohol gave the amide: mp 252–253°; ν_{max} 1695–1672, broad band (keto C=O and amide C=O), 1305 (C–H deformation of SCH_3), 867 (isolated H), 835 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{16}H_{13}NO_2S$: N, 4.95. Found: N, 5.23.

6-Methylthiofluoren-2-amine.—A mixture of 8.2 g of 6-methylthio-2-nitro-9-oxofluorene, 100 ml of diethylene glycol, and 50 ml of 85% hydrazine hydrate was boiled under reflux for 1.5 hr without a condenser until the temperature of the solution rose to 205° and under reflux again for 2.5 hr. The straw-colored mixture was then cooled and poured into 500 ml of water. The white precipitate was filtered off, washed, and dried, giving 6.5 g (95%), mp 105–107°. One recrystallization from alcohol (Darco) gave an analytical sample: mp 107–107.5°; ν_{max} 1445 (CH_2), 1314 (C–H deformation of SCH_3), 849 (isolated H), 819, 801 and (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_{13}NS$: C, 73.98; H, 5.77; N, 6.16; S, 14.08. Found: C, 73.80; H, 6.13; N, 6.27; S, 13.92.

Acetylation gave **N-2-(6-methylthiofluorenyl)acetamide**, mp 190–191.5°. Recrystallization from alcohol (Darco) raised this to 191–192°; ν_{max} 1667 (amide C=O), 1429 (CH_2), 1305 (C–H deformation of SCH_3), 801 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{16}H_{15}NOS$: N, 5.20. Found: N, 5.12.

N-2-(6-Methylthiofluorenyl)-2′,2′,2′-trifluoroacetamide.—To a stirred solution of 5 g of 6-methylthiofluoren-2-amine in 100 ml of benzene, 4 g of trifluoroacetic anhydride was added dropwise. The precipitate was filtered off and dried giving 6.9 g (99%) of the product, mp 193–194°. Two recrystallizations from alcohol gave an analytical sample, with unchanged melting point; ν_{max} 1730 ($CF_3C{=}O$), 1425 (CH_2), 1304 (C–H deformation of SCH_3), 1165 broad (CF_3), 836 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{16}H_{12}F_3NOS$: C, 59.43; H, 3.74; N, 4.33. Found: C, 59.63; H, 3.97; N, 4.22.

N-2-(3-Methylthiofluorenyl)acetamide.—The steps included between brackets (Scheme I) gave compounds which proved tedious to purify. After obtaining a few milligrams of the desired compound (I), we pursued the alternate route (Scheme II). However, since the reactions in Scheme I actually gave us compound I, the procedures are briefly indicated here. Nitration of 6 g of N-2-(6-methylthiofluorenyl)-2′,2′,2′-trifluoroacetamide in a mixture of concentrated HNO_3 and yellow fuming HNO_3 (*d* 1.49–1.50), followed by reduction of the sulfoxide function with 50% HBr gave **N-2-(6-methylthio-7-nitrofluorofluorenyl)-2′,2′,-2′-trifluoroacetamide**, mp >310°. Hydrolysis in aqueous alcoholic NaOH gave dark red **6-methylthio-7-nitrofluoren-2-amine**, mp >310°.

Anal. Calcd for $C_{14}H_{12}N_2O_2S$: C, 61.75; H, 4.44. Found: C, 61.37; H, 4.44.

Diazotization ($NaNO_2$ and HCl) and deamination (of 0.18 g) in the usual way with H_3PO_2 gave a crude product which was dried and sublimed (230°, 1 mm), giving 21 mg, mp 240–242°, of **3-methylthio-2-nitrofluorene**. This was reduced in a little alcohol with $N_2H_4 \cdot H_2O$ and Pd–C in the usual way.[19] After filtration and evaporation of the solvent, the product was dried in a vacuum and acetylated to obtain a few milligrams of I, mp 162–165°. A mixture with I obtained from the Millers (mp 163–165°) melted at 163–165°, and the infrared spectra were the same.

3-Methylthiofluorene. A. Reduction of 3-Methylthio-9-oxofluorene.—Reduction of 2 g of 3-methylthio-9-oxofluorene in 20 ml of diethylene glycol and 20 ml of 85% hydrazine hydrate, as above, gave 1.3 g (69%), mp 61–64°. Two recrystallizations from methanol raised the melting point to 66–67°; ν_{max} 1443 (CH_2), 1303 (C–H deformation of SCH_3), 858 (isolated H), 800 (two adjacent H), 766, 730, (four adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_{12}S$: C, 79.21; H, 5.70; S, 15.09. Found: C, 79.11; H, 5.91; S, 15.23.

B. Deamination of 3-Methylthiofluoren-2-amine.—To a solution of 100 mg of 3-methylthiofluoren-2-amine[21] in 1 ml of tetrahydrofuran, 3 ml of concentrated HCl was added. The mixture was cooled in an ice–salt bath to −5° and 50 mg of $NaNO_2$ was added. After stirring for 10 min, 10 mg of sulfamic acid was added to destroy excess HNO_2, and the mixture was stirred into 10 ml of cold 50% H_3PO_2. Gas evolved and after 10 min a few crystals of $KMnO_4$ were added. In 1 hr the evolution of gas had ceased and the mixture was refrigerated overnight. The light yellow precipitate was filtered off, washed with water, and dried, giving 50 mg of crude product, mp 58–64°. One recrystallization from methanol (Darco) raised the melting point to 65–67°. The melting point of a mixture of this compound with the one obtained in A was not depressed and the infrared spectra were identical.

3-Bromo-2-nitro-9-oxofluorene.—A mixture of 3-bromo-9-oxo-2-fluorenamine[13] (5.5 g), 40% peracetic acid (70 ml), and AcOH (50 ml) were refluxed with stirring for 15 min then diluted with water. The yellow precipitate was separated (5.8 g), recrystallized from benzene, and then from acetone–methanol, mp 256–257° (lit.[14] 255–257°).

3-Methylthio-2-nitro-9-oxofluorene.—3-Bromo-2-nitro-9-oxofluorene (1.5 g), DMSO (40 ml), and a freshly made solution of $NaSCH_3$ in absolute ethanol (3.5 ml), containing 1 equiv of the sulfide, were stirred together ($CaCl_2$ tube) for 48 hr, heated on a steam bath for 0.5 hr, then diluted with water containing a few milliliters of 6 *N* HCl. The brown precipitate was filtered off, washed with water, and dried giving 1.3 g (96%), mp 288–291° dec. Chromatography on alumina (benzene) gave an analytical sample: mp 311–312° dec; ν_{max} 1700 (keto C=O), 1570, 1320 (NO_2), 675 w (SCH_3) cm^{-1}.

Anal. Calcd for $C_{14}H_9NO_3S$: C, 61.99; H, 3.34; N, 5.16. Found: C, 61.87; H, 3.39; N, 5.39.

(21) Obtained from Dr. J. A. Miller (see ref 4).

3-Methylthio-9-oxofluoren-2-amine.—The above nitro compound was reduced with $SnCl_2 \cdot 2H_2O$ and HCl giving deep purple crystals: mp 184–185°; ν_{max} 1700 (keto C=O), 1300 (C–H deformation of SCH_3), 670 w (SCH_3) cm^{-1}.

Anal. Calcd for $C_{14}H_{11}NOS$: N, 5.80; S, 13.29. Found: N, 5.81; S, 12.89.

3-Methylthiofluoren-2-amine. A.—3-Methylthio-9-oxofluoren-2-amine (2.4 g), 2,2′-oxydiethanol (200 ml), 99–100% hydrazine hydrate (10 ml), and KOH (2 g) were mixed, refluxed with occasional shaking for 1 hr, and diluted with water. The amine (1.9 g, 88%) was recrystallized from methanol–water giving an analytical sample: mp 117–118°; ν_{max} 1307 (C–H deformation of SCH_3), 685 w (SCH_3) cm^{-1}.

Anal. Calcd for $C_{14}H_{13}NS$: C, 73.97; H, 5.76; N, 6.16; S, 14.11. Found: C, 73.82; H, 5.68; N, 5.95; S, 13.97.

B.—3-Methylthio-2-nitro-9-oxofluorene (1.4 g), 2,2′-oxydiethanol (100 ml), and 99–100% hydrazine hydrate (10 ml) were refluxed for 30 hr. The condenser was then removed and heating was continued until the temperature of the reaction mixture reached 210°. The mixture was then cooled and diluted with water, and the white crystals were filtered off giving 0.1 g (9%), mp 115–117°.

N-2-(3-Methylthiofluorenyl)acetamide.—The above amine (A or B) was acetylated giving the amide (I): mp 164.5–165.5°; ν_{max} 1665 (amide C=O), 765, 730 (four adjacent H), 680 w (SCH_3) cm^{-1}.

Anal. Calcd for $C_{16}H_{13}NOS$: C, 71.34; H, 5.61; N, 5.20; S, 11.90. Found: C, 71.57; H, 5.79; N, 5.48; S, 11.45.

3-Bromo-7-fluoro-2-nitro-9-oxofluorene.—3-Bromo-7-fluoro-9-oxofluoren-2-amine[22] (12.5 g) was added in small portions to rapidly stirred 40% peracetic acid (250 ml) over a period of 40 min. The suspension was then gently refluxed with continuous stirring for 0.5 hr and cooled. After water dilution, the product was isolated as yellow crystals, 9.7–11.3 g (70–83%), mp 212–213.5°. Chromatography through alumina (benzene) gave an analytical sample: mp 214–215°; ν_{max} 1720 (keto C=O), 1530, 1340 (NO_2), 1270, 1240 (ArF) cm^{-1}.

Anal. Calcd for $C_{13}H_5BrFNO_3$: C, 48.48; H, 1.56; N, 4.35. Found: C, 48.62; H, 1.48; N, 4.38.

3-Ethoxy-7-fluoro-2-nitro-9-oxofluorene.—3-Bromo-7-fluoro-2-nitro-9-oxofluorene (6.6 g) was mixed with DMSO (150 ml) and a solution of aged sodium methyl sulfide in absolute ethanol (13 ml, containing 1.3 g of the sulfide). This solution had been prepared and used, and the remainder had been stored in a glass-stoppered bottle in a refrigerator for 6 months prior to this use. The reaction mixture was stirred for 5.5 days then heated on a steam bath for 1 hr, diluted with water, and acidified with HCl. The solid (5.7 g) was separated and chromatographed through alumina (benzene) giving 2.5 g; mp 178.5–179.5°; ν_{max} 1720 (keto C=O), 1520, 1340 (NO_2), 1275–1250 (Ar ether, ArF), 1224 (ArF) cm^{-1}.

Anal. Calcd for $C_{15}H_{10}FNO_4$: C, 62.72; H, 3.51; N, 4.88. Found: C, 62.48; H, 3.72; N, 5.00.

3-Ethoxy-7-fluoro-9-oxofluoren-2-amine.—The above nitro compound was reduced with $SnCl_2 \cdot 2H_2O$ and HCl in the usual manner giving lustrous purple blades (benzene–ligroin): mp 180–181°; ν_{max} 1700 (keto C=O), 1280, 1265 (Ar ether, ArF), 1210 (ArF) cm^{-1}.

Anal. Calcd for $C_{15}H_{12}FNO_2$: C, 70.03; H, 4.70; F, 7.39; N, 5.44. Found: C, 69.91; H, 4.55; F, 7.11; N, 5.08.

3-Ethoxy-7-fluorofluoren-2-amine.—A mixture of 3-ethoxy-7-fluoro-9-oxofluoren-2-amine (0.2 g), 2,2′-oxydiethanol (25 ml), 99–100% hydrazine hydrate (2 ml), and KOH (0.3 g) was refluxed for 0.5 hr and diluted with water. The product was isolated and recrystallized from methanol–water giving 0.15 g; mp 139–139.5°; ν_{max} 1295, 1240 (Ar ether, ArF), 1215 (ArF) cm^{-1}.

Anal. Calcd for $C_{15}H_{14}FNO$: F, 7.81; N, 5.76. Found: F, 7.91; N, 5.73.

Acetylation of 0.2 g gave 0.2 g of **N-2-(3-ethoxy-7-fluorofluorenyl)acetamide**: mp 192–193°; ν_{max} 1280, 1235 (Ar ether, ArF), 1188 (ArF) cm^{-1}.

Anal. Calcd for $C_{17}H_{16}FNO_2$: C, 71.56; H, 5.65; N, 4.91. Found: C, 71.23; H, 5.77; N, 4.78.

3-Ethoxy-7-fluoro-9-oxofluorene.—3-Ethoxy-7-fluoro-9-oxofluoren-2-amine (0.2 g) was diazotized in 4 *N* HCl (15 ml) with $NaNO_2$ (0.1 g) at 0–5°. Cold 50% H_3PO_2 (20 ml) was slowly stirred into the mixture. After warming to room temperature, the mixture was diluted with water and the product was isolated and purified by chromatography on alumina (benzene) giving 0.15 g; mp 125.5–126°; ν_{max} 1700 (keto C=O), 1267, 1220 (Ar ether, ArF), 1215 (ArF), 876 (isolated H), 829 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{15}H_{11}FO_2$: C, 74.37; H, 4.58. Found: C, 74.00; H, 4.55.

7-Fluoro-3-hydroxy-9-oxofluorene.—A solution of 10.65 g of 7-fluoro-9-oxofluoren-3-amine, made by way of N-2-(7-fluorofluorenyl)acetamide as described below (see Scheme III), in 100 ml of hot AcOH was cooled in an ice bath to 15° and a nitrosyl sulfate solution (made by addition of 4 g of $NaNO_2$ in small portions to 30 ml of concentrated H_2SO_4) was added with stirring at such a rate that the temperature of the mixture was held below 35°. This was stirred for 2 hr and then poured into 400 ml of water and heated to 90° for 30 min. When the temperature reached 85°, reaction commenced (gas) and a yellow precipitate formed. After cooling, the precipitate was filtered off, washed, and dried, giving 9.2 g (92%), mp 265–270°. Sublimation followed by recrystallization from alcohol gave 6.7 g, mp 280–281°. An analytical sample was prepared by one more recrystallization from alcohol (unchanged melting point): ν_{max} 1689 (keto C=O), 1377 (ArOH), 1269 (ArF), 1220–1211 (ArOH, ArF), 886 (isolated H), 826, 813 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{13}H_7FO_2$: C, 72.90; H, 3.29; F, 8.87. Found: C, 72.89; H, 3.17; F, 9.17.

3-Ethoxy-7-fluoro-9-oxofluorene.—Treatment of the foregoing compound with ethyl sulfate in alkaline solution yielded 97%, mp 124–126°. Recrystallization from alcohol gave an analytical sample, mp 125–125.5°. Admixture with the compound obtained from 2-nitro-3-bromo-7-fluoro-9-oxofluorene and aged $NaSCH_3$ in alcohol did not depress the melting point. The infrared spectra of the two compounds were identical.

Anal. Calcd for $C_{15}H_{11}FO_2$: C, 74.37; H, 4.58; F, 7.84. Found: C, 74.47; H, 4.55; F, 8.12.

7-Fluoro-3-methylthio-2-nitro-9-oxofluorene.—3-Bromo-7-fluoro-2-nitro-9-oxofluorene (6.4 g) was suspended in 150 ml of DMSO, and a freshly prepared solution of $NaSCH_3$ in absolute ethanol (14 ml, containing 1.4 g of the sulfide) was added dropwise over a period of 75 min. The reaction mixture was stirred for 2 hr and poured into an excess of dilute HCl. The product was separated and recrystallized from benzene giving 4.2 g (73%); mp 279–280° (cor);[22] ν_{max} 1710 (keto C=O), 1508, 1325 (NO_2), 1282 (C–H deformation of SCH_3), 1275, 1232 (ArF), 835 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_8FNO_3S$: F, 6.57; S, 11.08. Found: F, 6.52; S, 11.01.

7-Fluoro-3-methylthio-9-oxofluoren-2-amine.—7-Fluoro-3-methylthio-2-nitro-9-oxofluorene (2.8 g) was reduced in a boiling mixture of $SnCl_2 \cdot 2H_2O$ (20 g), concentrated HCl (80 ml), and ethanol (40 ml). The amine, 2.3 g (92%), melted at 173.5–174.5°; ν_{max} 1700 (keto C=O), 1265, 1217 (ArF) cm^{-1}.

Anal. Calcd for $C_{14}H_{10}FNOS$: N, 5.40. Found: N, 5.30.

N-Acetyl derivative had mp 253–253.5°; ν_{max} 1700 (keto C=O), 1265, 1205 (ArF) cm^{-1}.

Anal. Calcd for $C_{16}H_{12}FNO_2S$: C, 63.77; H, 4.01; N, 4.65. Found: C, 63.96; H, 4.09; N, 4.54.

7-Fluoro-3-methylthio-9-oxofluorene.—7-Fluoro-3-methylthio-9-oxofluoren-2-amine was deaminated with 50% H_3PO_2 as described earlier giving a product melting at 144–145.5°. Comparison with the products described below (two methods starting with 7-fluorofluoren-3-amine) showed that they were identical (melting point, mixture melting point, and infrared spectra).

7-Fluoro-3-methylthiofluoren-2-amine.—7-Fluoro-3-methylthio-9-oxofluoren-2-amine (0.5 g) was mixed with 2,2′-oxydiethanol (40 ml), 99–100% hydrazine hydrate (2 ml), and KOH (0.5 g), refluxed for 0.5 hr, and worked up as usual. Recrystallization from methanol–water gave 0.3 g, mp 107.5–110.5°. Further recrystallization from the same solvent gave an analytical sample: mp 109.5–110.5°; ν_{max} 1272, 1240 (ArF) cm^{-1}.

Anal. Calcd for $C_{14}H_{12}FNS$: C, 68.54; H, 4.93; N, 5.71; S, 13.07. Found: C, 68.28; H, 4.85; N, 5.54; S, 12.76.

N-2-(7-Fluoro-3-methylthiofluorenyl)acetamide.—The acetylated amine melted at 209–210°; ν_{max} 1665 (amide C=O), 1279, 1240 (ArF) cm^{-1}.

Anal. Calcd for $C_{16}H_{12}FNOS$: C, 66.88; H, 4.91; F, 6.61; N, 4.87; S, 11.16. Found: C, 66.73; H, 4.67; F, 6.26; N, 4.91; S, 10.93.

(22) H.-L. Pan and T. L. Fletcher, *J. Med. Chem.*, **7**, 31 (1964).

N-2-(7-Fluoro-3-nitrofluorenyl)acetamide.—To a mixture of 9.3 g of N-2-(7-fluorofluorenyl)acetamide and 70 ml of AcOH at 40° in a beaker, 3 ml of HNO_3 (d 1.42) was added. All the solids dissolved as the temperature rose to 53°, and a yellow precipitate came out. After cooling and filtration, the precipitate was washed with 20 ml of acetic acid and with water and dried, giving 9.1 g (80%) of the crude product, mp 225–228°. Crystallization from toluene gave an analytical sample: mp 227–228°; ν_{max} 1689 (amide C=O), 1577, 1333 (NO_2), 1439 (CH_2), 1266–1250, 1247 (ArF) cm^{-1}.

Anal. Calcd for $C_{15}H_{11}FN_2O_3$: N, 9.79. Found: N, 10.00.

N-2-(7-Fluoro-3-nitro-9-oxofluorenyl)acetamide.—To a hot solution of 8.6 g of the foregoing compound in 200 ml of AcOH, 25 g of $Na_2Cr_2O_7 \cdot 2H_2O$ was added. The mixture was boiled for 30 min with stirring and cooled. The bright red precipitate was filtered off, washed with water, and dried, giving 8 g (89%) of the product, mp 310–313°. Recrystallization from *o*-dichlorobenzene raised the melting point to 311–313°; ν_{max} 1718–1705 (keto C=O, amide C=O), 1497, 1330 (NO_2), 1272, 1235 (ArF) cm^{-1}.

Anal. Calcd for $C_{15}H_9FN_2O_4$: N, 9.33. Found: N, 9.47.

7-Fluoro-3-nitro-9-oxofluorene.—A mixture of 7 g of the foregoing compound and 35 ml of concentrated H_2SO_4 was heated on a steam bath for 1 hr and cooled to room temperature, and a nitrosyl sulfate solution, prepared by stirring 3 g of $NaNO_2$ in small portions into 20 ml of concentrated H_2SO_4, was added. After standing for 4 hr, this was stirred with 50 g of cracked ice. Upon addition of 30 ml of 50% H_3PO_2, there was vigorous evolution of gas. After 2 hr the precipitate was filtered off, washed, dried, and sublimed (240°, 1 mm), giving 4.2 g (74%) of the product, mp 228–229°. Recrystallization from toluene gave mp 228.5–229°; ν_{max} 1712 (keto C=O), 1524, 1348 (NO_2), 1274, 1230 (ArF), 826 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{13}H_6FNO_3$: C, 64.20; H, 2.48; F, 7.81; N, 5.76. Found: C, 64.35; H, 2.50; F, 7.51; N, 5.92.

7-Fluoro-9-oxofluoren-3-amine.—The foregoing compound was reduced with $SnCl_2 \cdot 2H_2O$ and HCl and worked up in the usual way to obtain 3.2 g (91%), mp 169–170°. Recrystallization from alcohol did not raise the melting point; ν_{max} 1689 (keto C=O), 1267, 1218 (ArF), 878 (isolated H), 815 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{13}H_8FNO$: C, 72.23; H, 3.78; N, 6.57. Found: C, 72.03; H, 3.51; N, 6.66.

N-3-(7-Fluoro-9-oxofluorenyl)acetamide.—The acetyl derivative, recrystallized from alcohol, melted at 259–260°; ν_{max} 1695 (keto C=O), 1681 (amide C=O), 1269, 1215 (ArF), 883 (isolated H), 820 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{15}H_{10}FNO_2$: C, 70.58; H, 3.95; N, 5.49. Found: C, 70.79; H, 3.85; N, 5.64.

2,6-Difluorofluorenone.—7-Fluoro-9-oxofluoren-3-amine, diazotized with 50% HBF_4 and $NaNO_2$ in the presence of DMSO in the usual way,[19] gave a diazonium salt, dec pt 160°. Decomposition in boiling *o*-dichlorobenzene yielded 70% of 2,6-difluorofluorenone. Sublimation (170°, 1 mm) gave the pure compound, mp 184–185°. A mixture with the authentic compound[15] melted without depression.

7-Fluoro-3-methylthio-9-oxofluorene. A.—Diazotization of 6-methylthio-9-oxofluoren-2-amine with 50% HBF_4 and $NaNO_2$ in the presence of DMSO[19] in the usual way gave the diazonium fluoroborate, dec pt 160°. Upon decomposition of the above salt in boiling *o*-dichlorobenzene, followed by chromatography on alumina and elution with benzene, the product (mp 143.5–145°) was obtained in 65% yield. Crystallization from alcohol followed by sublimation at 145° (1 mm) gave an analytical sample: mp 146–146.5°; ν_{max} 1700 (keto C=O), 1294 (C–H deformation of SCH_3), 1263, 1224 (ArF), 864 (isolated H), 822 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{14}H_9FOS$: C, 68.84; H, 3.71. Found: C, 69.04; H, 3.73.

B.—The diazonium salt prepared from 10.65 g of 7-fluoro-9-oxofluoren-3-amine, as described for the synthesis of 7-fluoro-3-hydroxy-9-oxofluorene, was added to a solution of 30 g of potassium ethyl xanthate in 400 ml of water with stirring, and the mixture was heated to 90° for 20 min. Reaction commenced at 70° (gas). The precipitate was filtered off and dissolved in 40 ml of benzene and, after drying (Na_2SO_4), the solution was percolated through alumina (benzene). The first (yellow) band was collected and the solvent evaporated giving 3.7 g (23%) of the xanthate, mp 175–177°. Two recrystallizations from alcohol raised the melting point to 176–177°; ν_{max} 1704 (keto C=O), 1259, 1233 (ArF), 1247, 1111 (COC), 1038 (C=S),[16] 877 (isolated H), 838 (two adjacent H) cm^{-1}.

Anal. Calcd for $C_{16}H_{11}FO_2S_2$: C, 60.36; H, 3.48; S, 20.14. Found: C, 60.49; H, 3.45; S, 19.98.

A mixture of 1.4 g of the above xanthate, 20 ml of ethanol, and 1.5 g of NaOH was refluxed for 10 min and cooled, and 15 ml of CH_3I was added. After boiling for 10 min, a white precipitate of inorganic material was filtered off and the filtrate was evaporated to near dryness. Benzene (10 ml) was added and the solution was chromatographed on alumina. A rapidly descending yellow band was collected and the solvent evaporated, giving 0.95 g (88%), mp 145–146°. One recrystallization from alcohol raised the melting point to 146–146.5°. A mixture of this compound with the one prepared in A melted without depression and the infrared spectra were identical.

Methyl 7-Fluoro-2-nitro-9-oxofluoren-3-yl Sulfoxide.—To 10 ml of yellow fuming HNO_3 (d 1.50) in a beaker, 2 g of 2-fluoro-6-methylthio-9-oxofluorene was added in small portions. The temperature rose to 40°. The resulting solution was cooled to 20° and 40 g of crushed ice was added. An oily gum formed which solidified upon trituration. This was filtered off, washed with water, and dried giving 1.5 g (60%), mp 207–217°. Two recrystallizations from toluene (Darco) raised the melting point to 218–219°; ν_{max} 1724 (keto C=O), 1524, 1333 (NO_2), 1269, 1235 (ArF), 1055 (S=O).

Anal. Calcd for $C_{14}H_8FNO_4S$: C, 55.08; H, 2.64; N, 4.59. Found: C, 55.10; H, 2.49; N, 4.71.

7-Fluoro-3-methylthio-2-nitro-9-oxofluorene.—To a warm (40°) solution of 1.3 g of the sulfoxide in 40 ml of glacial acetic acid 10 ml of 48% HBr was added with stirring. After 2 hr the mixture was poured into 100 ml of water. The yellow precipitate was filtered off, washed, and dried, giving 1 g (81%) of crude product, mp 273–275°. Sublimation (265°, 1 mm) followed by recrystallization from toluene gave an analytical sample, mp 279–280° (cor).[20] This proved to be identical with the compound made from the corresponding 3-bromo derivative by reaction with $NaSCH_3$ (mixture melting point, infrared spectra).

Anal. Calcd for $C_{14}H_8FNO_3S$: C, 58.12; H, 2.79; N, 4.84: F, 6.57; S, 11.08. Found: C, 57.89; H, 2.76; N, 4.86; F, 6.82; S, 11.32.

3-Ethoxy-2-nitro-9-oxofluorene.—3-Bromo-2-nitro-9-oxofluorene (3.1 g), "aged" ethanolic $NaSCH_3$ (10%, 6.5 ml), and DMSO (75 ml) were mixed and stirred at room temperature for 5.5 days then heated on a steam bath for 1 hr. Upon addition of dilute HCl, there was obtained 2.8 g of the product which was purified by chromatography on alumina (benzene) giving 1.6 g (60%); mp 235–235.5°; ν_{max} 1700 (keto C=O), 1515, 1330 (NO_2), 1250 (Ar ether), 762, 732 (four adjacent H) cm^{-1}.

Anal. Calcd for $C_{15}H_{11}NO_4$: C, 66.91; H, 4.12; N, 5.20. Found: C, 66.82; H, 4.04; N, 5.43.

3-Ethoxy-9-oxofluoren-2-amine.—The above nitro compound was reduced with $SnCl_2 \cdot 2H_2O$ in concentrated HCl. The amine melted at 153–154°; ν_{max} 1690 (keto C=O), 1215 (Ar ether) cm^{-1}.

Anal. Calcd for $C_{15}H_{13}NO_2$: N, 5.85. Found: N, 6.07.

3-Ethoxyfluoren-2-amine.—The 9-oxo derivative was reduced by refluxing it for 0.5 hr with 99–100% hydrazine hydrate and KOH in 2,2′-oxydiethanol. The product melted at 111–112°; ν_{max} 1205 cm^{-1} (Ar ether).

Anal. Calcd for $C_{15}H_{15}NO$: N, 6.22. Found: N, 6.18.

N-Acetyl derivative had mp 168.5–169.5°; ν_{max} 1240 cm^{-1} (Ar ether).

Anal. Calcd for $C_{17}H_{17}NO_2$: C, 76.38; H, 6.41. Found: C, 76.31; H, 6.15.

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