1-[2-2-Pyridyl)ethyl]-1,2-dibromoindan (VII).—To a stirred solution of 44.2 g. (0.2 mole) of 3-[2-(2-pyridyl)ethyl]indene in 100 ml. of chloroform was added a solution of 32.0 g. (0.2 mole) of bromine in 100 ml. of chloroform during 30 min. at 0–5°. The mixture was stirred for an additional hour, then evaporated to dryness. The brown residue was recrystallized from *n*-butyl alcohol to give 42 g. (55% yield) of light tan crystals, m.p. 204° dec.

Anal. Calcd. for $C_{16}H_{15}Br_2N$ (VII): N, 3.68; Br, 42.0. Found: N, 3.70; Br, 41.2.

1-Anisylidene-3-[2-(2-pyridyl)ethyl]indene (VIII).—Into a mixture of 22.1 g. (0.1 mole) of 3-[2-(2-pyridyl)ethyl]indene, 50 ml. of toluene, and 1.0 g. (0.01 mole) of potassium *t*-butoxide was stirred a solution of 27.2 g. (0.2 mole) of anisaldehyde in 50 ml. of toluene dropwise during 1 hr. at 30–35°. The mixture was then stirred for 2 hr. at 75°, finally neutralized with 1.0 ml. of glacial acetic acid, and filtered. The filtrate was concentrated to 150° (2 mm.) and the brownish residue (48 g.) was recrystallized from 95% ethanol to give 13 g. (38% yield) of a yellow solid, m.p. 88–90°.

Anal. Calcd. for $C_{24}H_{21}NO$ (VIII): N, 4.33. Found: N, 4.10.

3-[2-(4-Pyridyl)ethyl]indene (VI).—To a stirred mixture of 238 g. (2.0 moles) of indene and 2.0 g. (0.018 mole) of potassium *t*-butoxide was added dropwise 110 g. (1.05 moles) of 4-vinylpyridine during 1 hr. at 80–140°. The mixture was stirred for an additional hour at 90–130°, then neutralized with 1.5 ml. of glacial acetic acid, and filtered. The filtrate was concentrated to 162° (pot) at 2 mm. The residue was distilled through a 4-in. Vigreux column to give 133 g. (60% yield) of 3-[2-(4-pyridyl)-ethyl]indene, b.p. 162–165° (2 mm.), a yellow oil which solidified on standing, m.p. 97–101°; after recrystallization from ethyl acetate, large colorless prisms, m.p. 102–103°.

Anal. Calcd. for $C_{16}H_{15}N$: N, 6.33. Found: N, 6.3.

3-Indenepropylamine (If).—A 1-gal. stainless steel, stirring-type autoclave was charged with 338 g. of 3-indenepropionitrile, 500 ml. of benzene, 50 g. of ammonia, 30 g. of nickel-on-kieselguhr catalyst, and a solution of 0.6 g. sodium hydroxide in 30 ml. of 1:1 water–methanol, pressured to 500 p.s.i.g. with hydrogen, and heated to 140° (maximum pressure of 850 p.s.i.g. was reached). The autoclave was repressured with hydrogen to 850 p.s.i.g. whenever the pressure fell to 600 p.s.i.g., until no further pressure drop took place after 2 hr. The autoclave was cooled and vented. The charge was filtered, the cake washed with a little benzene, and the combined filtrates were concentrated to 10° (pot) at 35 mm. The residue was distilled through a 4-in. Vigreux column to give a heart cut of b.p. 146–149° (10 mm.), 273 g. (78% yield) of 3-indenepropylamine, a pale yellow oil.

Anal. Calcd. for $C_{12}H_{15}N$: neut. equiv., 173.0. Found: neut. equiv., 174.1.

1,1-Indenedipropylamine and 1,1,3-Indenetripropylamine.—A 1-gal. stainless steel, stirring-type autoclave was charged with 532 g. of crude polycyanoethylated indene (preparation described before), 500 ml. of benzene, 25 ml. of water, 25 ml. of methanol, 1.0 g. of sodium hydroxide, 142 g. of ammonia, and 50 g. of a stabilized nickel-on-kieselguhr catalyst. The autoclave was pressured to 500 p.s.i.g. with hydrogen and heated to 170°. The autoclave was repressured to 1000-p.s.i.g. total pressure whenever the pressure fell to 600 p.s.i.g. After 2.5 hr. at 172–175° and 1000-p.s.i.g. pressure, no further pressure drop took place. The autoclave was cooled, vented, and discharged. The product was filtered and the filtrate concentrated to 100° (pot) at 9 mm. to give 502 g. of a brown oil. This residue was distilled through a 4-in. Vigreux column to give 55.3 g. of a fraction of b.p. 143–153° (1 mm.) with correct analysis for 1,1-indenedipropylamine.

Anal. Calcd. for $C_{15}H_{22}N_2$: neut. equiv., 115.0. Found: neut. equiv., 116.6.

In addition, there was obtained 253 g. of a fraction of b.p. 220–232° (2 mm.), which corresponded to 1,1,3-indenetripropylamine.

Anal. Calcd. for $C_{18}H_{29}N_3$: neut. equiv. 95.7. Found: neut. equiv., 96.9.

N.m.r. spectra were run at room temperature (22 ± 2°) at 60.00 Mc. on a Varian 4302 DP-60 spectrometer. Line positions were obtained with respect to tetramethylsilane as an internal reference by calibration between side bands of set frequency.[10] Line positions are given in terms of τ-values (chemical shifts in parts per million with respect to tetramethylsilane, tetramethylsilane being set at 10). All samples were run as 10% (by weight) solutions in carbon tetrachloride (except where noted as otherwise in Table I).

Acknowledgment.—The authors wish to thank Dr. J. O'Brochta and Dr. R. B. Carlin for their interest in this work and Mr. H. W. Hampson for his laboratory assistance.

(10) L. M. Jackman, "Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry," Pergamon Press, New York, N. Y., 1959.

Reaction of Indole Derivatives with Thionyl and Sulfuryl Chlorides

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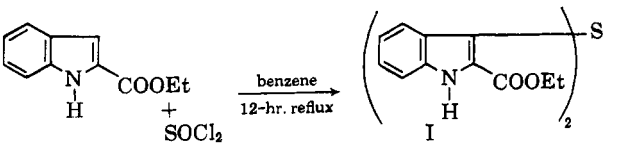
Reaction of 1-methylindole-2-carboxylic acid (II), the corresponding methyl ester V, and of ethyl indole-2-carboxylate with thionyl chloride afforded sulfinyl chlorides III, VI, and XXIII, respectively. Thionyl chloride and N,1-dimethylindole-2-carboxamide (XIX) led to sulfide XX and imide sulfoxide XXI. Sulfinyl chloride VI was converted to several sulfinamides (XI) on treatment with amines. Sulfinamides XI were oxidized with permanganate to sulfonamides XII. Treatment of VI with hydrazine in the cold gave disulfide IV, which was transformed to XXVII on heating with hydrazine. Monosulfide VIII, disulfide IV, and trisulfide X were obtained from the reaction of V with sulfur monochloride. Reaction of 1-methylindole-2-carboxylic acid hydrazide (XXX) with sulfuryl chloride led to the dichloro compound (XXXI), and V with sulfuryl chloride afforded the tetrachloro compound (XXXI) and the hexachloro compound (XXXII).

Kunori[1] has reported recently on the reaction of ethyl indole-2-carboxylate with thionyl chloride and isolation of sulfide I from the reaction mixture. We would like to describe at this time our experiments on the condensation of several indole derivatives with the same reagent.[2]



I

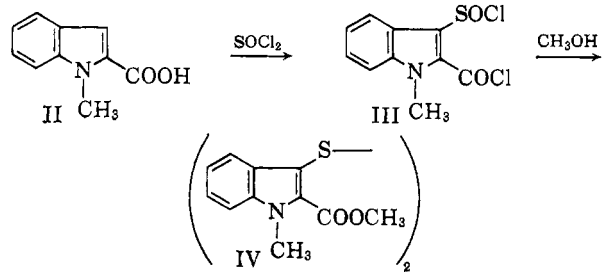
During an attempted preparation of 1-methylindole-2-carbonyl chloride[3] from the corresponding acid (II)

(1) M. Kunori, *Nippon Kagaku Zasshi*, **80**, 407 (1959); *Chem. Abstr.*, **55**, 5457 (1961).

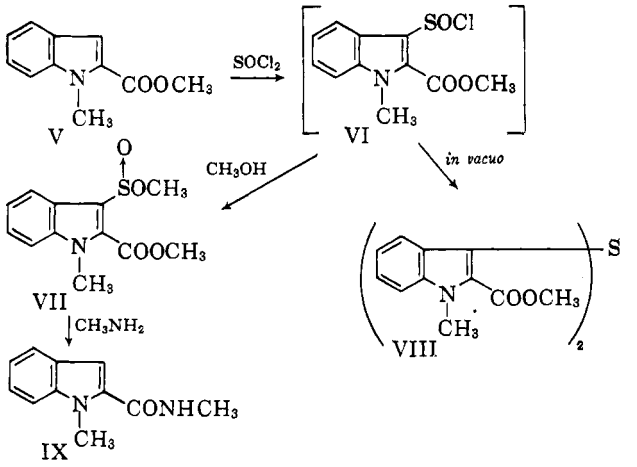
(2) This work was complete prior to the appearance of Kunori's paper[1] in *Chemical Abstracts*.

(3) This acid chloride is best prepared from the acid with phosphorus pentachloride in ether according to J. R. Johnson, R. B. Hasbrouck, J. D. Dutcher, and W. F. Bruce, *J. Am. Chem. Soc.*, **67**, 423 (1945).

and thionyl chloride we observed that under certain conditions (see the Experimental) a sulfur-containing compound was produced for which structure III is proposed.[4a] Treatment of III with methanol brought about a disproportionation[4b] and led to disulfide IV which was identical with an authentic sample.

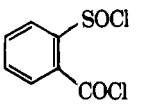


Extension of the thionyl chloride reaction to methyl 1-methylindole-2-carboxylate (V) gave the sulfinyl chloride (VI) in excellent yield. Unlike III, treatment of VI with methanol afforded the dimethyl ester (VII). On the other hand, VI underwent disproportionation *in vacuo* to give the monosulfide VIII which was identical with an authentic sample. The authentic



monosulfide (VIII) and disulfide IV along with trisulfide X were obtained from the reaction of V with sulfur monochloride.[5a] No reaction occurred between the dimethyl ester (V) and methanolic ammonia or dimethylamine. On the other hand, methylamine under the same conditions produced N,1-dimethylindole-2-carboxamide (IX).[5b]

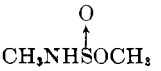
(4)(a) Three structures have been proposed for the product obtained from the reaction of anhydrous chlorine on *o*-thiolbenzoic acid. Recently I. B. Douglass and B. S. Farah [*J. Org. Chem.*, **26**, 351 (1961)] indicated a preference for structure i.

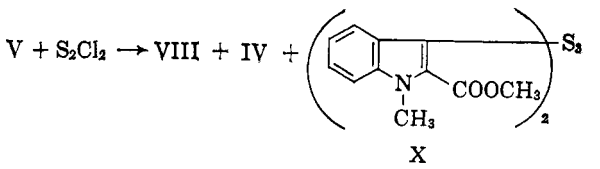


i

(b) *Cf.* F. Muth, "Methoden der Organischen Chemie" (Houben-Weyl), Vol. 9, E. Muller, Ed., Georg Thieme Verlag, Stuttgart, 1955, p. 299.

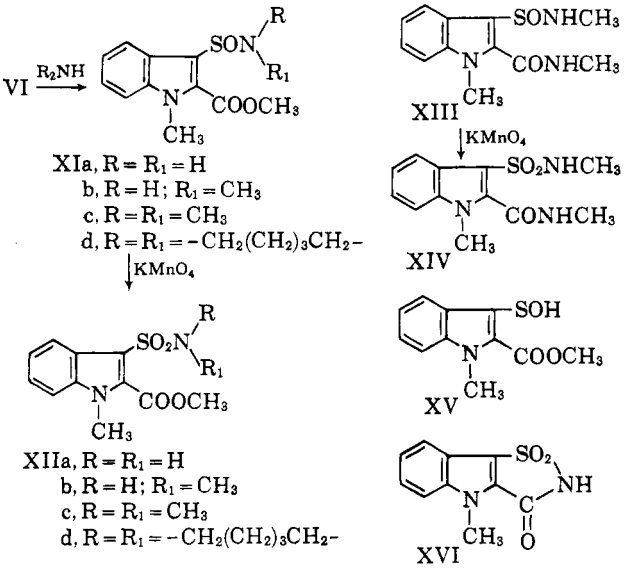
(5)(a) *Cf.* T. Wieland, O. Weiberg, E. Fischer, and G. Horlein, *Ann.*, **587**, 146 (1954); M. Kunori, *Nippon Kagaku Zasshi*, **80**, 409 (1959); *Chem. Abstr.*, **55**, 5458 (1961). (b) The mechanism of this reaction was not investigated. This reaction may proceed either by displacement at the O–CH_3 bond to give dimethylamine and SO_2 as by-products, or by displacement at the C–S bond to give the following.



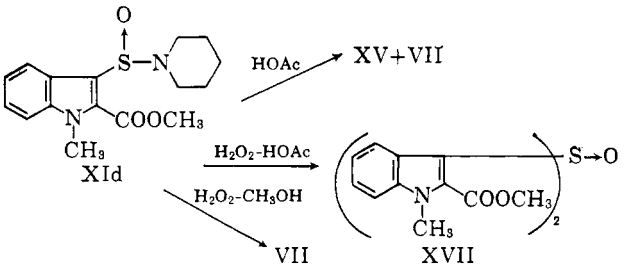


X

Reaction of sulfinyl chloride VI under anhydrous conditions with ammonia, methylamine, dimethylamine, and piperidine afforded sulfinamides XIa, XIb, XIc, and XId, respectively. In the case of methylamine some conversion to the bismethyl amide (XIII) also occurred. Reaction of VI with aqueous dimethylamine afforded 1-methyl-2-carbomethoxyindole-3-sulfenic acid (XV) along with sulfinamide XIc. Sulfenic acid XV also was isolated from an attempted condensation of VI with acetamide in pyridine.

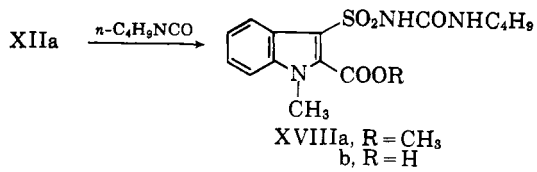


Several additional reactions were carried out with sulfinamide XId. In acetic acid solution XId underwent disproportionation to give sulfenic acid XV and monosulfide VII. Conversion of XId to sulfoxide XVII occurred with hydrogen peroxide in acetic acid, and with hydrogen peroxide in methanol, XId afforded diester VII.

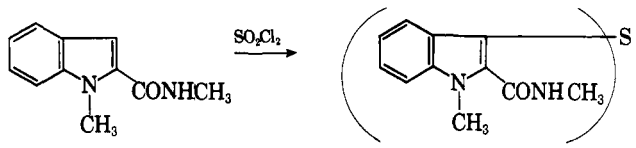


Oxidation of sulfinamides XIa, XIb, XIc, XId, and XIII with potassium permanganate in aqueous acetone afforded sulfonamides XIIa, XIIb, XIIc, XIId, and XIV, respectively. In the case of sulfinamide XIa, imide XVI also was isolated from the oxidation reaction by acidification of the alkaline filtrate.

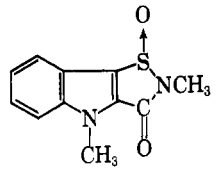
Sulfonamide XIIa reacted with butyl isocyanate to give the urea derivative (XVIIIa), which was hydrolyzed with aqueous base to the corresponding acid (XVIIIb).



Extension of the thionyl chloride reaction to N,1-dimethylindole-2-carboxamide (XIX) led to sulfide XX and imide sulfoxide XXI. Thionyl chloride also reacted with ethyl indole-2-carboxylate (XXII)[6] and

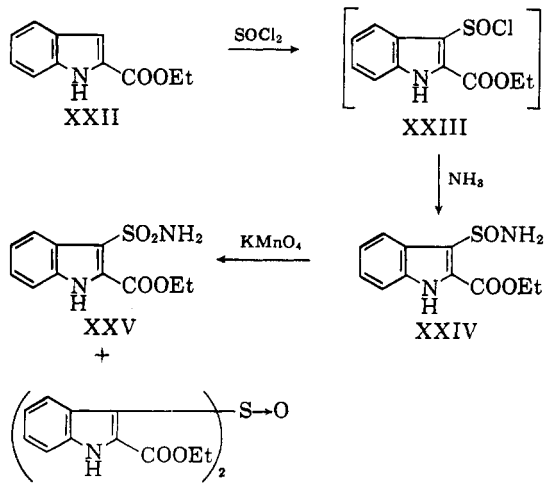


XIX XX



XXI

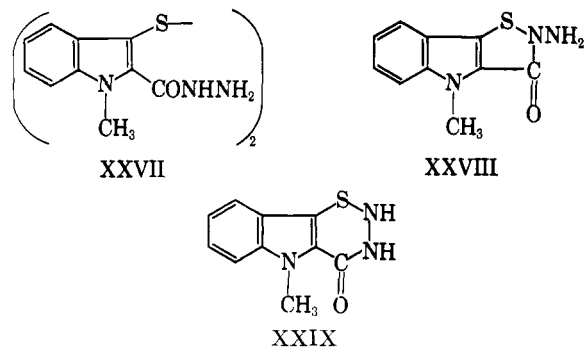
afforded the corresponding sulfinyl chloride XXIII which was converted to sulfinamide XXIV in 87% over-all yield. Oxidation of XXIV with permanganate led to sulfonamide XXV, accompanied by a small quantity of sulfoxide XXVI.



Sulfinyl chloride VI was very smoothly converted with hydrazine in the cold to the disulfide IV in 70% yield. On refluxing with hydrazine hydrate, IV was transformed to a new compound for which structure XXVII is postulated. Compound XXVII formed a bisbenzylidene derivative, a tetraacetyl derivative, and a bisisopropylidene derivative. The n.m.r. spectrum[7] of the tetraacetyl derivative showed $COCH_3$ hydrogens at 127 c.p.s. (area 6), NCH_3 at 230 (area 3), aromatic hydrogen at 415 to 462 (area 4), and NH at 645 (area 0.9). The presence of hydrogen, typical of the NH

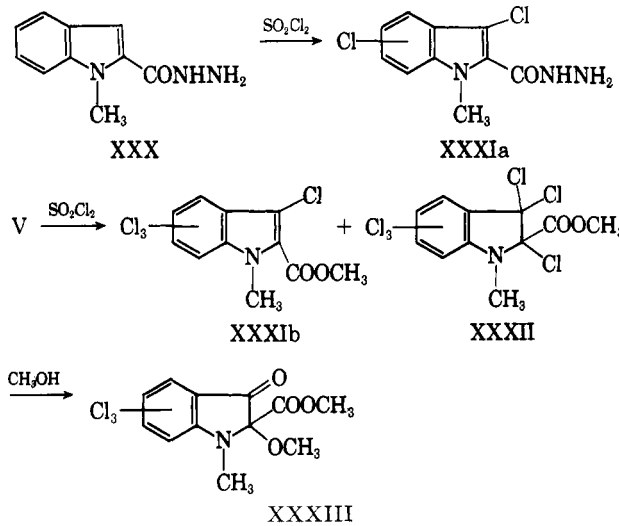
(6) Kunori[1] isolated from this reaction only disproportionation products and not XXIII, since he employed more drastic conditions.

(7) The spectrum was run with a Varian H.R. 60 spectrometer and deuterated dimethyl sulfoxide as solvent. Frequencies are reported in cycles per second downfield from internal tetramethylsilane. We thank Dr. G. Slomp and F. A. MacKellar for the spectrum and its interpretation.



grouping, provides strong support for structure XXVII in preference to the tricyclic structures (XXVIII and XXIX), assuming that no skeletal change occurred during the mild acetylation reaction.

Two reactions were carried out with sulfuryl chloride. Treatment of 1-methylindole-2-carboxylic acid hydrazide (XXX) with sulfuryl chloride afforded the dichloro derivative (XXXIa). Reaction of V with sulfuryl chloride led to a mixture of the tetrachloro compound



(XXXIb) and the hexachloro compound (XXXII). On refluxing with methanol, XXXII afforded the trichloro derivative (XXXIII). The structures of the last three compounds are postulated on the basis of analytical data, and ultraviolet and infrared spectra.

Experimental[8,9]

Condensation of 1-Methylindole-2-carboxylic Acid (II) with Thionyl Chloride.—Thionyl chloride (7 ml.) was added to acid II[10] (m.p. 212–214°, 3.50 g., 0.02 mole). The resulting solid mass was heated on the steam bath for a short time and, since solution did not occur, 25 ml. of benzene was added and the mixture was refluxed for 75 min. The resulting brown solution was evaporated to dryness on the steam bath *in vacuo*; the residue was flushed twice with benzene and crystallized from benzene–Skellysolve B to give 1.85 g., m.p. 141–143°. Two recrystallizations from benzene with considerable loss of material afforded

(8) Melting points were taken in a capillary tube and are uncorrected. Ultraviolet spectra (recorded in mμ) were determined in 95% ethanol using a Cary spectrophotometer Model 14. Infrared spectra (recorded in $cm.^{-1}$) were determined in Nujol using a Perkin-Elmer recording infrared spectrophotometer, Model 21. Skellysolve B is commercial hexane, b.p. 60–70°, made by Skelly Oil Co., Kansas City, Mo.

(9) The author is indebted to Dr. R. W. Rinehart and his associates for microanalyses, to Betty F. Zimmer and Miss L. M. Pschizoda for ultraviolet and infrared spectra, and to Mr. L. G. Laurian for laboratory assistance.

(10) H. R. Snyder and P. L. Cook, *J. Am. Chem. Soc.*, **78**, 969 (1956).

yellow needles of III, m.p. 151–152°. Ultraviolet spectrum (in dimethylacetamide) showed λ_{max} 295 mμ (ε 12,400), sh 312 (10,000), sh 324 (8700), sh 372 (2500). Infrared spectrum showed 1750; 1604 (C=O); 1563, 1487 (C=C) cm.$^{-1}$. This compound decomposes on standing at room temperature.

Anal. Calcd. for $C_{10}H_7Cl_2NO_2S$: C, 43.49; H, 2.56; Cl, 25.68; N, 5.07; S, 11.61. Found: C, 44.15; H, 2.15; Cl, 24.98; N, 5.41; S, 11.93.

Conversion of III with Methanol to IV.—The dichloride (200 mg., m.p. 148–150°) was dissolved in 5 ml. of boiling methanol and allowed to crystallize overnight, to give 47 mg., m.p. 185–187° (fast). Recrystallization from methanol afforded plates, m.p. 183.5–184.5°. Sublimation at 160–170° (0.01 mm.) followed by crystallization from acetone gave disulfide IV, m.p. 191–192°, which was identical (ultraviolet and infrared spectra, mixture melting point) with the product obtained by the reaction of V with sulfur monochloride.

Condensation of Methyl 1-Methylindole-2-carboxylate (V) with Thionyl Chloride.—Thionyl chloride (5 ml.) was added to V[11] (m.p. 96.5–97.5°, 1.89 g., 0.01 mole). Solution occurred, followed by vigorous evolution of gas, and then solidification. The mixture was allowed to stand for 5 min., 15 ml. of anhydrous ether was added, the solid was triturated, filtered, and washed with ether. The infrared spectrum of this yellow product VI showed a strong band at 1745 cm.$^{-1}$. The solid was dried *in vacuo* for 10 min. and amounted to 2.45 g., m.p. 85–88° dec. It was not sufficiently stable for analysis. This reaction could be run using 0.8 mole of the ester.

Methyl 1-Methyl-2-carbomethoxyindole-3-sulfinate (VII).—A suspension of VI (0.5 g.) in 15 ml. of methanol was refluxed until solution resulted (*ca.* 5 min.). It was evaporated to a small volume and allowed to crystallize to colorless prisms, 0.45 g. (64%), m.p. 104–110° dec., discolors at 80°. Recrystallization from methanol afforded VII melting at 108–110° dec., discolors at 93°. Ultraviolet spectrum showed λ_{max} 215 mμ (ε 25,600), 237 (24,000), 304 (15,500). Infrared spectrum showed 1715 (C=O); 1603, 1564, 1490 (C=C); 1240, 1120, 1110, 1100 (C–O/S→O) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{13}NO_4S$: C, 53.92; H, 4.90; N, 5.24; S, 12.00; OCH_3, 23.22. Found: C, 53.79; H, 4.52; N, 5.21; S, 12.13; OCH_3, 22.40.

This compound was stable for a period of only a few days, but could be kept indefinitely *in vacuo*.

Disproportionation of VII *in Vacuo*.—The sulfinyl chloride (VII, 1.4 g.) was left *in vacuo* at room temperature overnight. The resulting oily mixture was boiled with 20 ml. of methanol and the solution was evaporated to *ca.* 5 ml. and allowed to crystallize; needles (380 mg.), m.p. 147–150°. Recrystallization from methanol raised the melting point to 152–152.5°. This material was identical (ultraviolet and infrared spectra, mixture melting point) with the monosulfide VIII obtained from the reaction of V with sulfur monochloride.

Reaction of V with Sulfur Monochloride.—Sulfur monochloride (13.5 g., 0.1 mole) was added during 20 min. to a solution of V (38 g., 0.2 mole) in 250 ml. of benzene with stirring under nitrogen and cooling so that the temperature was below 5°. The mixture was stirred for 3 hr. The suspension was filtered and the solid was washed with benzene to give 7.3 g. of A, m.p. 157–161°. The filtrate was diluted with 1 l. of petroleum ether (b.p. 30–60°) and cooled in ice for 0.5 hr. It was filtered and the solid washed with petroleum ether to give 11 g. of B, m.p. 127–160°. The filtrate was evaporated to dryness and the residue was crystallized from 100 ml. of benzene and 100 ml. of petroleum ether to give 18.5 g., m.p. 128–141°. Recrystallization from acetone afforded 3 g. of trisulfide X, m.p. 155–157°, and filtrate C. The analytical sample melted at 158.5–159.5° (from acetone). Ultraviolet spectrum showed λ_{max} 222 mμ (ε 38,100), sh 276 (17,000), 299 (21,200), sh 344 (9300). Infrared spectrum showed 1705 (C=O); 1615, 1575, 1490 (C=C); 1235 (C–O) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{20}N_2O_4S_3$: C, 55.91; H, 4.27; N, 5.93; S, 20.36; OCH_3, 13.13. Found: C, 55.85; H, 4.05; N, 5.84; S, 20.28; OCH_3, 13.66.

Solid A was crystallized from 300 ml. of acetone to give 2.71 g. of disulfide IV as yellow rods, m.p. 199–200°, unchanged on further purification. Ultraviolet spectrum showed λ_{max} 216 mμ (ε 41,000), 234 (33,200), 279 (21,200), 302 (22,200), sh 356 (5850). Infrared spectrum showed 3050, 3020 (=CH); 1708 (C=O); 1610, 1573, 1488 (C=C); 1255 (C–O) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{20}N_2O_4S_2$: C, 59.98; H, 4.58; N, 6.36; S, 14.56; OCH_3, 14.09. Found: C, 60.11; H, 4.41; N, 6.47; S, 14.71; OCH_3, 13.07.

Solid B was crystallized from acetone as before and afforded 2.53 g. of disulfide IV, m.p. 198–199.5° (identified by mixture melting point determination). The filtrate from the acetone crystallization of solid B was concentrated to about one-half volume and allowed to crystallize to give 2.3 g. of monosulfide VIII, m.p. 149.5–150.5°. Recrystallization from benzene–petroleum ether raised the melting point to 150.5–152°. Ultraviolet spectrum showed λ_{max} 237 mμ (ε 41,250), 299.5 (24,000), 352 (9650). Infrared spectrum showed 1705 (C=O); 1610, 1492 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{20}N_2O_4S$: C, 64.69; H, 4.94; N, 6.86; S, 7.85; OCH_3, 15.20. Found: C, 65.00; H, 4.76; N, 6.74; S, 7.82; OCH_3, 14.03.

Filtrate C was evaporated to dryness to give 13.7 g. of solid. It was dissolved in minimum of benzene and chromatographed on Woelm neutral alumina (411 g.). Elution with 0.5% methanol–benzene (4800 ml.) gave 10.13 g. which was allowed to crystallize from 25 ml. of benzene. A mixture resulted which was separated mechanically to give 0.3 g. of colorless rods of monosulfide VIII, m.p. 150.5–152°, and 1.2 g. of yellow prisms of disulfide IV, m.p. 190–195°, raised on recrystallization from acetone to 197–200°. The benzene filtrate was diluted with 10 ml. of petroleum–ether (b.p. 30–60°) to give an additional 3.1 g. of monosulfide VIII, m.p. 149–152°.

Reaction of VII with Amines. A. With Methylamine.—Sulfinate VII (4.0 g., 0.015 mole) was dissolved in 150 ml. of methanol and methylamine was added until 32 g. was absorbed. The solution was allowed to stand for 70 hr. It was then evaporated to dryness to give a colorless crystalline product melting at 108–111°. It was dissolved in ether, filtered from a small amount of a brown amorphous solid, and allowed to crystallize to give 2.2 g., m.p. 110–112°. The second crop amounted to 0.55 g., m.p. 109–111°. The ultraviolet [λ_{max} 217 mμ (ε 29,350), 291 (16,150)] and infrared spectra were identical with those of authentic N,1-dimethylindole-2-carboxamide[11] and the mixture melting point showed no depression.

B. With Anhydrous Ammonia.—The reaction was run as under A using 13 g. of ammonia. The solution was evaporated to dryness to give recovered starting material in quantitative yield, m.p. 95–97° (polymorph of the previously encountered form as shown by infrared spectra in chloroform and mixture melting point).

C. With Dimethylamine.—The reaction was run as under A using 50 g. of dimethylamine. The solid residue was crystallized from methanol and afforded 2.84 g. of recovered starting material.

Methyl 1-Methyl-3-(aminosulfinyl)indole-2-carboxylate (XIa).—Sulfinyl chloride VI (prepared from 0.2 mole of V) was added during 3 min. to a solution of 150 ml. of liquid ammonia in 300 ml. of ether with stirring and cooling in a Dry Ice bath. The suspension was then stirred for an additional 5 min. and the Dry Ice bath was replaced with tap water to evaporate the ammonia. Ether was then evaporated *in vacuo*, 200 ml. of water was added, and the solid was filtered and washed well with three 100-ml. portions of water. Crystallization from 100 ml. of methanol and 100 ml. of water afforded 47.5 g. (94.5%), m.p. 111–116.5° unchanged on further recrystallization. Ultraviolet spectrum showed λ_{max} 216 mμ (ε 24,000), 234 (24,000), 301 (14,600). Infrared spectrum showed 3580, 3340, 3200 (NH/OH); 1698 (C=O); 1635, 1565, 1500 (C=C); 1250 (C–O) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{12}N_2O_3S \cdot 1/4H_2O$: C, 51.44; H, 4.73; N, 11.17; S, 12.49; OCH_3, 12.08. Found: C, 51.27; H, 4.47; N, 11.43; S, 13.01; OCH_3, 11.36.

Methyl 1-Methyl-3-sulfamoylindole-2-carboxylate (XIIa) and XVI.—A solution of potassium permanganate[12] (5.25 g., 0.0332 mole) in 110 ml. of water (in all the other experiments the amount of water was reduced to half this volume) was added during 15 min. with stirring to a solution of sulfinamide XIa (12.6 g., 0.05 mole) in 500 ml. of purified acetone (boiled with potassium permanganate, dried over potassium carbonate, and distilled) keeping the temperature at 22–25° by occasional cooling. The mixture was then stirred for 1.5 hr. A saturated solution of

(11) Prepared according to reference quoted in ref. 3.

(12) This experiment will serve as the general procedure for oxidation of sulfinamides with potassium permanganate.

sodium sulfite (3 ml.) was added (in all the other experiments reaction times were longer and addition of reducing agent was omitted), the mixture was filtered, and the precipitate washed with acetone. The filtrate was evaporated *in vacuo* at 35°, the resulting aqueous suspension was filtered, and the resulting XIIa was washed with water to yield 8.3 g. (62%), m.p. 167–170°. Recrystallization from methanol afforded plates, m.p. 168.5–170°. Ultraviolet spectrum showed λ_{max} 210 mμ (ε 31,750), sh 234 (14,000), 297 (12,600). Infrared spectrum showed 3370, 3280 (NH); 3090, 3060, 3020 (=CH); 1710, 1700 (C=O); 1615, 1607, 1600, 1550, 1520 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{12}N_2O_4S$: C, 49.24; H, 4.51; N, 10.44; S, 11.95. Found: C, 49.11; H, 4.51; N, 10.36; S, 12.11.

The aqueous filtrate was cooled in ice, acidified with concentrated hydrochloric acid, and the mixture was extracted with ether. The extracts were washed with saturated salt solution, dried through sodium sulfate, and evaporated to give 3.1 g. of crude 4-methyl-4*H*-isothiazolo[4,5-*b*]indol-3(2*H*)-one 1,1-dioxide (XVI), m.p. 200–220°. Crystallization from acetone–water afforded 1.7 g. (14.4%), m.p. 265–267° dec. One further recrystallization gave needles, m.p. 278–279° dec., discolors at 240°. Ultraviolet spectrum showed λ_{max} 229 mμ (ε 27,900), sh 252 (4600), 262 (3350), 305 (10,000). Infrared spectrum showed 3220 (NH); 1745 (C=O); 1540, 1505, 1485 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{10}H_8N_2O_3S$: C, 50.83; H, 3.41; N, 11.86; S, 13.57. Found: C, 50.73; H, 2.98; N, 11.50; S, 13.47 (no methoxyl).

Methyl 1-Methyl-3-(methylaminosulfinyl)indole-2-carboxylate (XIb) and 1-Methyl-3-(methylaminosulfinyl)indole-2-methylcarboxamide (XIII).—Sulfinyl chloride, VI (prepared from 0.2 mole of V) was added during 5 min. to a solution of methylamine (173 ml.) in 660 ml. of ether with stirring and cooling at −9°. The temperature rose to 5° during the addition and the mixture was maintained at this temperature for 15 min. It was then evaporated to dryness *in vacuo*, 125 ml. of water was added, and the solid was filtered and washed with water. It was crystallized from ethyl acetate to give 23.5 g. (44% yield) of XIII as clusters of colorless prisms, m.p. 165–168°, raised to 171–172° on recrystallization from methanol. Ultraviolet spectrum howed λ_{max} 217 mμ (ε 30,500), sh 225 (28,600), 291 (16,400). Infrared spectrum showed 3250 (NH); 3100, 3050 (=CH); 1660, 1653 (amide I); 1570 (amide II); 1610, 1500 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{15}N_3O_2S$: C, 54.32; H, 5.70; N, 15.83; S, 12.08. Found: C, 54.52; H, 5.79; N, 15.32; S, 11.97 (no methoxyl).

The ethyl acetate filtrate was allowed to stand overnight to give 8.72 g. (16%) of XIb as prisms, m.p. 137–138°, unchanged on recrystallization from ethyl acetate. Ultraviolet spectrum showed λ_{max} 216 mμ (ε 23,650), 234 (26,050), 302 (15,050), sh 328 (6100), sh 336 (4200). Infrared spectrum showed 3280, 3240 (NH); 1712 (C=O); 1610, 1570, 1505 (C=C); 1250 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{14}N_2O_3S$: C, 54.12; H, 5.30; N, 10.52; S, 12.04; OCH_3, 11.65. Found: C, 54.16; H, 5.19; N, 10.32; S, 11.82; OCH_3, 10.85.

Methyl 1-Methyl-3-(methylsulfamoyl)indole-2-carboxylate (XIIb).—Sulfinamide XIb (8.72 g., 0.033 mole) was oxidized[12] during 17.5 hr. The resulting solid melted at 119–120°. Crystallization from benzene–petroleum ether (b.p. 30–60°) gave 5.1 g. (55%), m.p. 121–122°. This product was a polymorph of XIIb obtained from a similar experiment (as determined by infrared in Nujol and in chloroform solution) and which melted at 114.5–115.5°. Ultraviolet spectrum showed λ_{max} 211 mμ (ε 33,100), sh 236 (10,350), 291 (10,950). Infrared spectrum showed 3320 (NH); 1695 (C=O); 1650, 1610, 1565, 1505 (C=C); 1265 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{14}N_2O_4S$: C, 51.05; H, 5.00; N, 9.92; S, 11.36; OCH_3, 10.99. Found: C, 51.47; H, 4.98; N, 9.72; S, 11.53; OCH_3, 10.65.

1-Methyl-3-(methylaminosulfinyl)indole-2-methylcarboxamide (XIV).—Sulfinamide XIII (11.3 g., 0.043 mole) was oxidized[12] during 4 hr. The resulting solid was crystallized from 35 ml. of methanol and afforded 7.7 g. (64%), m.p. 186–187°, unchanged on recrystallization. Ultraviolet spectrum showed λ_{max} 215 mμ (ε 40,850), 282 (10,900). Infrared spectrum showed 3330, 3170 (NH); 1660 (amide I); 1575 (amide II); 1500 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{15}N_3O_3S$: C, 51.23; H, 5.37; N, 14.94; S, 11.40. Found: C, 51.19; H, 5.09; N, 14.93; S, 11.97 (no methoxyl).

Preparation of Methyl 1-Methyl-3-(dimethylaminosulfinyl)indole-2-carboxylate (XIc). A. With Anhydrous Dimethylamine.—Sulfinyl chloride VI (prepared from 0.2 mole of V) was added during 5 min. to a solution of dimethylamine (180 g.) in 660 ml. of ether with stirring and cooling at 3°. The mixture was then stirred for 15 min. and evaporated *in vacuo*. Water (150 ml.) was added and the solid XIc was filtered, washed with water, and crystallized from methanol to give 46.5 g. (83%), m.p. 132–134°, raised to 134–135° on recrystallization. Ultraviolet spectrum showed λ_{max} 215 mμ (ε 24,000), 235 (26,150), 303 (15,300), sh 324, sh 326 (4,700). Infrared spectrum showed 3070 (=CH); 1720 (C=O); 1610, 1567, 1495 (C=C); 1240 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{13}H_{16}N_2O_3S$: C, 55.69; H, 5.75; N, 9.99; S, 11.44; OCH_3, 11.06. Found: C, 55.71; H, 5.80; N, 9.60; S, 11.20; OCH_3, 10.65.

B. With Aqueous Dimethylamine.—Sulfinyl chloride VI (prepared from 0.03 mole of V) was added to a solution of dimethylamine (6.8 ml. of 40% aqueous solution, 0.06 mole) and 50 ml. of ether with stirring and ice cooling. The mixture was stirred in the cold for 2 hr. It was then filtered and the yellow solid (m.p. 95–147°) crystallized from acetone–water to give 2.4 g., m.p. 193–194° dec., unchanged on recrystallization. This compound was identical with sulfenic acid XV obtained below (mixture melting point and infrared spectrum).

The aqueous acetone filtrate was evaporated to get rid of acetone and the solid (2.37 g., m.p. 128–130°) was crystallized from benzene–petroleum ether (b.p. 30–60°); m.p. 132–133°. This compound was identical with XIc (C, H, N, S, OCH_3 analyses, ultraviolet and infrared spectra).

Methyl 1-Methyl-3-(dimethylsulfamoyl)indole-2-carboxylate (XIIc).—Sulfinamide XIc (33.37 g., 0.119 mole) was oxidized[12] during 23 hr. The residue was extracted with four 200-ml. portions of benzene, the extract was washed with saturated salt solution, dried over sodium sulfate, and evaporated. The residue (25 g.) was dissolved in benzene and chromatographed on 750 g. of acid-washed alumina. Elution with four 400-ml. portions of benzene gave 1.91 g. (m.p. range 60–69°) which could not be crystallized. Further elution with fourteen 400-ml. portions of benzene gave a total of 5.09 g. which was crystallized from benzene–petroleum ether (b.p. 30–60°) to give 2.4 g., m.p. 113–115°, raised to 114–115.5° on recrystallization. Ultraviolet spectrum showed λ_{max} 211 mμ (ε 36,000), 286 (10,700). Infrared spectrum showed 1745 (C=O); 1520 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{13}H_{16}N_2O_4S$: C, 52.68; H, 5.44; N, 9.45; S, 10.82; OCH_3, 10.47. Found: C, 53.01; H, 5.28; N, 9.68; S, 10.87; OCH_3, 10.58.

Methyl 1-Methyl-3-(piperidinosulfinyl)indole-2-carboxylate (XId).—Sulfinyl chloride, VI (prepared from 0.1 mole of V) was added during 3 min. to a solution of piperidine (17 g., 0.2 mole) in 150 ml. of ether with stirring and cooling at 2°. The mixture was then stirred in an ice bath for 2 hr. and evaporated to dryness. Water (50 ml.) was added and the solid was filtered and washed with water, m.p. 102–104°. Crystallization from methanol–water afforded 25.8 g. (78%) of product which had the same melting point. Ultraviolet spectrum showed λ_{max} 215 mμ (ε 24,750), 234.5 (26,650), 303 (14,900), sh 324 (7600), sh 336 (4600). Infrared spectrum showed 1715 (C=O); 1505 C=C; 1245 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{16}H_{20}N_2O_3S$: C, 59.97; H, 6.29; N, 8.75; S, 10.00; OCH_3, 9.68. Found: C, 59.83; H, 6.15; N, 8.45; S, 10.04; OCH_3, 9.32.

Methyl 1-Methyl-3-(piperidinosulfonyl)indole-2-carboxylate (XIId).—Sulfinamide XId (3.2 g., 0.01 mole) was oxidized[12] during 15.5 hr. The resulting oily mixture was extracted with three 50-ml. portions of ether, the extract was washed with saturated salt solution and evaporated to give 3.2 g. of an oil. Crystallization from methanol–water afforded 1.3 g. (39%), m.p. 111–113°, raised to 113.5–115° on recrystallization. Ultraviolet spectrum showed λ_{max} 287 mμ (ε 10,600). Infrared spectrum showed 1765, 1755 (C=O); 1515 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{16}H_{20}N_2O_4S$: C, 57.12; H, 5.99; N, 8.33; S, 9.53; OCH_3, 9.22. Found: C, 57.69; H, 6.12; N, 8.38; S, 9.59; OCH_3, 9.02.

About 30% of the starting material could be recovered from the original aqueous methanolic filtrate.

Reaction of N,1-Dimethylindole-2-carboxamide (XIX) with Thionyl Chloride.—Thionyl chloride (50 ml.) was added all at once to amide XIX[11] (18.8 g., 0.1 mole). The resulting brown solution was allowed to stand for 5 min. Anhydrous ether (750 ml.) was added and the solution was allowed to crystallize during 30 min. It was then filtered, the solid was washed with ether and crystallized from methanol to give 3.05 g. of sulfide XX, m.p. 237–238°. Recrystallization afforded colorless needles, m.p. 239–240.5°. Ultraviolet spectrum showed λ_{max} 230 mμ (ε 49,200), 294 (20,200), sh 328 (8900). Infrared spectrum showed 3400, 3200 (NH); 1655 (amide I); 1530 (amide II) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{22}N_4O_2S$: C, 65.00; H, 5.46; N, 13.77; S, 7.89. Found: C, 64.74; H, 5.29; N, 13.90; S, 7.57 (no methoxyl).

The ether filtrate was allowed to stand overnight and afforded 10.2 g. of yellow solid, m.p. 180–190°. Crystallization from methanol gave colorless needles of imide XXI (and imide filtrate), 5.7 g., m.p. 194–195° dec., discolors at 150°. Since previous experience has shown that this material decomposes on recrystallization from methanol, it was analyzed without further purification. Ultraviolet spectrum showed λ_{max} 213 mμ (ε 37,300), 233 (23,200), 262 (3600), 305 (8300). Infrared spectrum showed 1705 (C=O); 1540, 1500, 1485 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{10}N_2SO_2$: C, 56.39; H, 4.30; N, 11.96; S, 13.69. Found: C, 56.82; H, 4.60; N, 12.15; S, 13.88 (no methoxyl).

The imide filtrate referred to above was concentrated and allowed to crystallize to give 1.85 g. of impure solid, which on crystallization from methanol afforded an additional 1.2 g. of sulfide XX, m.p. 238–239°.

1-Methyl-2-carbomethoxyindole-3-sulfenic Acid (XV).—Sulfinyl chloride VI (prepared from 0.01 mole of ester V) was added during 3 min. to a solution of acetamide (0.591 g., 0.01 mole) in 10 ml. of pyridine. The suspension was stirred for 1 hr., cooled in ice, and acidified with a solution of 12 ml. of concentrated hydrochloric acid in 30 ml. of water. The yellow solid was filtered and washed with water to yield 1.75 g., m.p. 110–113° dec. Crystallization from methanol afforded 0.3 g. of small plates, m.p. 194–195° (purple melt), unchanged on recrystallization. Ultraviolet spectrum showed λ_{max} 213 mμ (ε 24,900), sh 236 (12,700), 296.5 (9850). Infrared spectrum showed 1712 (C=O); 1611, 1575, 1495 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{11}NO_3S$: C, 55.68; H, 4.67; N, 5.90; S, 13.51; OCH_3, 13.08. Found: C, 56.11; H, 4.17; N, 5.86; S, 13.44; OCH_3, 12.28 (no acetyl).

The methanolic filtrate was evaporated to a small volume and afforded 1.25 g. of impure VII, which on one recrystallization from methanol afforded pure VII (identified by ultraviolet and infrared spectra).

Transformations of XId. A. Treatment with Acetic Acid.—Sulfinamide XId (1.6 g., 0.005 mole) was suspended in 5 ml. of acetic acid. Immediately a yellow color developed in the supernatant. The suspension was warmed for a few seconds to achieve solution. After 2 hr., crystallization was induced by scratching. Four hours later the solid was filtered, washed with dilute acetic acid, then with water to give 0.3 g., m.p. 140–143°, discolors at 125°. Crystallization from acetone afforded 85 mg. of sulfenic acid XV, m.p. 185–186° dec. It was identical with the compound obtained previously (by C, H, N, S analyses, ultraviolet and infrared spectra).

The acetone filtrate was diluted with methanol and concentrated to give a solid, which on fractional crystallization from methanol afforded needles, m.p. 149–150°. This product was identical with monosulfide VIII obtained previously (by C, H, N, S analyses, ultraviolet and infrared spectra).

B. Treatment with H_2O_2 in Acetic Acid.—Sulfinamide XId (3.2 g., 0.01 mole) was dissolved in 10 ml. of acetic acid. Hydrogen peroxide (2.3 g. of 30% solution, 0.02 mole) was added during 2 min. A yellow solution resulted and there was a considerable rise in temperature. It was allowed to stand for 1 hr. Water (50 ml.) was added and the resulting suspension was filtered to give a yellow solid, 1.1 g., m.p. 109° dec. Fractional crystallization from methanol afforded 0.8 g. of XVII as colorless plates, m.p. 124–124.5° dec. Ultraviolet spectrum showed λ_{max} 215 mμ (ε 43,800), 233 (42,400), 299 (25,600), sh 328 (13,500), sh 344 (8700). Infrared spectrum showed 1720, 1705 (C=O); 1610, 1500 (C=C); 1255 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{20}N_2O_5S$: C, 62.25; H, 4.75; N, 6.60; S, 7.55; OCH_3, 14.62. Found: C, 62.34; H, 4.58; N, 6.72; S, 7.69; OCH_3, 14.29.

C. Treatment with H_2O_2 in Methanol.—Hydrogen peroxide (0.55 g. of 30% solution, 0.0055 mole) was added to a solution of sulfinamide XId (1.6 g., 0.005 mole) in 5 ml. of methanol. The resulting pale yellow solution was allowed to stand for 19 hr. Water (20 ml.) was added, and the resulting oily solid was isolated by decantation and washing with water. It was then triturated with 2 ml. of cold methanol to give 0.4 g. of a compound, m.p. 107–109°, which was identical with VII (C, H, N, S, OCH_3 analyses, ultraviolet and infrared spectra).

Treatment of VI with Anhydrous Hydrazine.—Sulfinyl chloride VI (prepared from 0.8 mole of V) was added over a period of 2 hr. to a stirred solution of anhydrous hydrazine (Matheson 95+%, 51.3 g., 1.6 moles) in 4 l. of ether while cooling at 5°. The mixture was then evaporated to dryness *in vacuo* and 500 ml. of water was added. The solid was filtered and washed with water. It was crystallized from 4 l. of benzene overnight. The yellow prisms were filtered and washed with methanol to give 99 g., m.p. 199–201°, unchanged on recrystallization. The second crop amounted to 22 g. of the same melting point (yield, 70%). This compound was identical with disulfide IV obtained before (mixture melting point, ultraviolet and infrared spectra).

Conversion of Disulfide IV to XXVII with Hydrazine Hydrate.—A mixture of disulfide IV (27.5 g., 0.0625 mole) and 125 ml. of hydrazine hydrate was refluxed in an oil bath (140°) with stirring for 1 hr. It was allowed to stand overnight and evaporated to dryness on the steam bath *in vacuo*. Methanol (200 ml.) was added to the resulting yellow oil and the solution was stirred for 4 hr., during which time precipitation occurred. The suspension was filtered to give 18.4 g., m.p. 236.5–238°, unchanged on crystallization from dimethylformamide. The second crop (2.48 g., same melting point) was collected after standing overnight. Air was then bubbled through the filtrate for 6 hr. and the third crop was obtained (1.15 g.) of the same melting point. Total yield of XXII was 80%. Ultraviolet spectrum showed λ_{max} 219 mμ (ε 46,600), 280 (20,300), 296 (19,200), sh 344 (6600). Infrared spectrum showed 3320, 3300, 3180 (NH); 1670, 1645, 1625 (C=O); 1525, 1505 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{20}H_{20}N_6O_2S_2$: C, 54.54; H, 4.58; N, 19.08; S, 14.56. Found: C, 54.72; H, 4.10; N, 18.67; S, 14.56.

Bisbenzylidene Derivative of XXVII.—Benzaldehyde (0.53 g., 5 mmoles) was added to a warm solution of XXVII (1.05 g., 2.4 mmoles) in 15 ml. of dimethylformamide. The solution was heated on the steam bath for 2 hr. It was then evaporated to dryness *in vacuo* and the residue was triturated with hot methanol, to give 1.2 g., m.p. 220–225° (fast). Crystallization from dimethylformamide–methanol afforded yellow prisms, m.p. 222–223°. Ultraviolet spectrum showed λ_{max} 214 mμ (ε 61,000), 303 (56,500), sh 324 (46,700), sh 376 (7450). Infrared spectrum showed 3215 (vw), 3270 (vw) (NH/OH); 1690 (C=O); 1610, 1530, 1580, 1520, 1485 (C=C/C=N); 1225, 1125 (C—N); 750, 730, 690 (aromatic) cm.$^{-1}$.

Anal. Calcd. for $C_{34}H_{28}N_6O_2S_2$: C, 66.21; H, 4.58; N, 13.62; S, 10.40. Found: C, 66.34; H, 4.60; N, 13.47; S, 10.19.

Tetraacetyl Derivative of XXVII.—Acetic anhydride (5 ml.) was added dropwise during about 5 min. to a hot solution of XXVII (1.05 g., 2.4 mmoles) in 15 ml. of pyridine and the solution was allowed to stand at room temperature. Water (25 ml.) was added and the mixture was heated on the steam bath for a few minutes until a clear solution resulted. Further addition of water (25 ml.) caused the separation of an oil which solidified. Crystallization from acetic acid afforded 0.75 g. of yellow needles, m.p. 240–241°. Ultraviolet spectrum showed λ_{max} 211.5 mμ (ε 52,300), 278 (20,000), 291 (19,700), sh 348 (7600). Infrared spectrum showed 3340 (vs) (NH); 1735, 1695 (C=O); 1500 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{28}H_{28}N_6O_6S_2$: C, 55.26; H, 4.64; N, 13.81; S, 10.54. Found: C, 55.46; H, 4.61; N, 13.44; S, 10.79.

Bisisopropylidene Derivative of XXVII.—A mixture of XXVII (15 g., 0.034 mole) and 3 l. of acetone was refluxed for 2.5 hr. The resulting solution was evaporated to about 400 ml. and allowed to cool. The solid amounted to 17.82 g., m.p. 218–220° (quantitative yield). Recrystallization from benzene afforded prisms, m.p. 219–220°. Ultraviolet spectrum showed λ_{max} 219 mμ (ε 46,500), 295 (37,000), sh 320 (32,800), sh 372 (6000).

Infrared spectrum showed 3280 (m) (NH); 3040 (=CH); 1700 (C=O); 1615, 1525 (C=C/C=N); 1225, 1130, 1015 (C—N) 800, 760, 750 (aromatic) cm.$^{-1}$.

Anal. Calcd. for $C_{26}H_{28}N_6O_2S_2$: C, 59.99; H, 5.42; N, 16.15; S, 12.32. Found: C, 60.18; H, 5.38; N, 15.94; S, 12.37.

1-Methyl-2-carbomethoxy-3-[(butylcarbamoyl)sulfamoyl]-indole (XVIIIa).—Triethylamine[13] (94 ml.), followed by butyl isocyanate (19.8 g., 0.2 mole) was added to a suspension of XIIa (53.7 g., 0.2 mole) in 50 ml. of dimethylformamide. The mixture was stirred for 22 hr. Two clear layers resulted, water (350 ml.) was added, and the mixture was stirred for 30 min. when a small amount of solid appeared. The mixture was extracted with ether (100 ml.), and the clear aqueous layer was acidified with 5% hydrochloric acid with cooling. The resulting oil solidified after a few minutes. The product was filtered and washed with water. It was crystallized from methanol to give 46.75 g. (63%) in three crops, m.p. range 190–193.5°. Recrystallization afforded rods, m.p. 191–192°. Ultraviolet spectrum showed λ_{max} 210 mμ (ε 32,400); sh 236, 292 (10,900). Infrared spectrum showed 3380 (NH); 1730 (ester C=O); 1680 (amide I); 1550 (amide II); 1515 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{16}H_{21}N_3O_5S$: C, 52.31; H, 5.76; N, 11.44; S, 8.73; OCH_3, 8.45. Found: C, 52.41; H, 5.44; N, 11.60; S, 8.96; OCH_3, 8.11.

1-Methyl-3-[(butylcarbamoyl)sulfamoyl]indole-2-carboxylic Acid (XVIIIb).—A solution of XVIIIa (36.6 g., 0.1 mole) in aqueous sodium hydroxide (200 ml. of 1 *N* diluted to 700 ml.) was heated on the steam bath for 2 hr. It was then cooled in ice and acidified with 35 ml. of concentrated hydrochloric acid. The resulting solid was filtered and washed with water. It was crystallized from acetone–water to give 27 g. (77%), m.p. 194° (effervescent), unchanged on recrystallization. Ultraviolet spectrum showed λ_{max} 212 mμ (ε 33,950), sh 222 (29,450), sh 282 (10,050), 286 (10,650), sh 300 (5900). Infrared spectrum showed 3400, 3190, 2540 (OH/NH); 1712 (acid C=O); 1650 (amide I); 1550, 1510 (amide II) cm.$^{-1}$.

Anal. Calcd. for $C_{15}H_{19}N_3O_5S$: C, 50.99; H, 5.42; N, 11.89; S, 9.08; neut. equiv., 176.7. Found: C, 51.00; H, 5.06; N, 11.60; S, 9.04; neut. equiv., 175.0.

Ethyl 3-(aminosulfinyl)indole-2-carboxylate (XXIV).—Thionyl chloride (5 ml.) was added all at once to ethyl indole-2-carboxylate (XXII,[14] 1.89 g., 0.01 mole). The resulting yellow solution solidified within 5 min. and was allowed to stand for 1 hr. Anhydrous ether (15 ml.) was added, the suspension was broken up, filtered, and the yellow sulfinyl chloride (XXIII) washed three times with ether. It was added during 1 min. to a solution of liquid ammonia (25 ml.) in 50 ml. of ether while cooling in a Dry Ice bath. Tap water bath was then used to evaporate the ammonia. The suspension was evaporated to dryness *in vacuo*, water was added, and the solid was filtered and washed with water to yield 2.2 g. (87%), m.p. 174–175°. Crystallization from dimethylformamide (just warm)–ether afforded needles, m.p. 169–170° dec., discolors at 150°. Ultraviolet spectrum showed λ_{max} 301 mμ (15,750). Infrared spectrum showed 3340, 3240, 3120 (NH); 3060, 3020 (=CH); 1690 (C=O) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{12}N_2O_3$: C, 52.36; H, 4.80; N, 11.11; S, 12.71. Found: C, 51.76; H, 5.09; N, 11.15; S, 12.74.

Ethyl 2-Sulfamoylindole-2-carboxylate (XXV).—Sulfinamide XXIV (1.45 g., 5.8 mmoles) was oxidized[12] during 3.75 hr. Water (20 ml.) was added, and the yellow precipitate was filtered (aqueous filtrate) and washed with water to yield 1.1 g., m.p. 180–187°. Crystallization from aqueous ethanol afforded 0.7 g. of XXV (46%), m.p. 205–209°, raised to 209–211° on recrystallization. Ultraviolet spectrum showed λ_{max} 233 mμ (ε 16,300), 302 (17,300). Infrared spectrum showed 3320, 3240 (NH); 3020 (=CH); 1708 (C=O); 1620, 1575, 1548, 1528, 1500 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{12}N_2O_4S$: C, 49.24; H, 4.51; N, 10.44; S, 11.95. Found: C, 49.39; H, 4.51; N, 9.93; S, 11.97.

The aqueous filtrate was extracted with ether (discarded the ether) and acidified with concentrated hydrochloric acid. The mixture was extracted with ether and the ether extracts dried over sodium sulfate and evaporated to dryness to give an orange oil. Trituration with acetone afforded a colorless solid, which on recrystallization from acetone formed prisms of XXVI (8 mg.), m.p. 178° dec. Ultraviolet spectrum showed λ_{max} 214 mμ (ε 47,800), 232 (41,000), 301 (28,700), sh 335 (9600). Infrared spectrum showed 3320, 3060 (NH); 1715, 1700 (C=O); 1575, 1515 (C=C) cm.$^{-1}$.

Anal. Calcd. for $C_{22}H_{20}N_2O_5S$: C, 62.26; H, 4.75; N, 6.60; S, 7.56. Found: C, 62.08; H, 4.50; N, 6.10; S, 7.61.

1-Methylindole-2-carboxylic Acid Hydrazide (XXX).—Hydrazine hydrate (30 g., 0.6 mole) was added during 3 min. to a refluxing solution of V (37.8 g., 0.2 mole), and the resulting solution was refluxed 8 hr. It was allowed to crystallize overnight, to yield 22.7 g., m.p. 159–160°. The second crop amounted to 9.8 g., m.p. 156–158° (86%). Recrystallization from methanol afforded colorless needles, m.p. 159.5–160.5°. Ultraviolet spectrum showed λ_{max} 217.5 mμ (ε 27,950), sh 234 (17,500), 293 (15,950). Infrared spectrum showed 3290 (vs), 3200, 3180 (NH); 3070, 3050, 3020 (=CH); 1660, 1615 (C=O); 1600 sh, 1565, 1510 sh (C=C); 1535 (amide II); 817, 806, 746, 735 (ring) cm.$^{-1}$.

Anal. Calcd. for $C_{10}H_{11}N_3O$: C, 63.47; H, 5.86; N, 22.21. Found: C, 63.32; H, 5.72; N, 21.67.

3,X-Dichloro-1-methylindole-2-carboxylic Acid Hydrazide (XXXIa).—A hot solution of XXX (1.89 g., 0.01 mole) in 50 ml. of methylene chloride was allowed to cool to room temperature with stirring whereupon partial crystallization occurred. A solution of sulfuryl chloride (1.5 g., 0.011 mole) in 10 ml. of methylene chloride was added dropwise during 15 min., and the suspension was stirred at room temperature for 5 hr. and then allowed to stand overnight. It was filtered and the solid washed with ether to give 1.0 g. of small plates, m.p. 230–235° dec. (effervescent, discolors at 210°), unchanged on crystallization from methanol–ether. Ultraviolet spectrum shows λ_{max} 223 mμ (ε 27,600), 292.5 (13,900). Infrared spectrum showed 3200, 2640 (NH); 1665 (C=O) cm.$^{-1}$.

Anal. Calcd. for $C_{10}H_9Cl_2N_3O$: C, 46.53; H, 3.52; Cl, 27.47; N, 16.28. Found: C, 46.26; H, 3.89; Cl, 27.15; N, 16.60.

Reaction of V with Sulfuryl Chloride.—Sulfuryl chloride (50 ml., 0.616 mole) was added all at once to 18.9 g. (0.1 mole) of V. Vigorous evolution of gas ensued. After 1 hr. the brown oil began to crystallize. Fifty milliliters of petroleum ether (b.p. 30–60°) was added, the resulting solid was filtered and washed with cold petroleum ether to give 7.5 g., m.p. 124–130°. A sample of this tetrachloromethyl ester (XXXIb) was crystallized from methanol to colorless silky needles, m.p. 139–140°. Ultraviolet spectrum showed λ_{max} 216 mμ (ε 19,500), 245 (31,700), sh 298 (11,000), 307 (13,200), sh 328 (6500), sh 344 (4200). Infrared spectrum showed 1725 (C=O); 1515, 1505 (C=C); 1255, 1240 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_{17}Cl_4NO_2$: C, 40.40; H, 2.16; Cl, 43.37; N, 4.28; OCH_3, 9.49. Found: C, 40.28; H, 2.07; Cl, 44.40; N, 4.03; OCH_3, 9.77.

The original filtrate was evaporated to dryness *in vacuo* at room temperature. The residue was dissolved in 15 ml. of petroleum ether and allowed to stand overnight. The resulting hard solid was broken up and filtered to give 16.6 g., m.p. 105–110° (softening at 80°). It was crystallized from 15 ml. of benzene and 100 ml. of petroleum ether to give 3.5 g. of XXXII, m.p. 132–133°. Ultraviolet spectrum (in isooctane) showed λ_{max} 232 mμ (ε 26,700), 274 (6150), 304 (2150), 333 (2600). Infrared spectrum showed 1765 (C=O); 1610, 1565 (C=C); 1235 (C—O) cm.$^{-1}$.

Anal. Calcd. for $C_{11}H_7Cl_6NO_2$: C, 33.20; H, 1.77; Cl, 53.47; N, 3.52; OCH_3, 7.80. Found: C, 33.50; H, 2.09; Cl, 53.54; N, 3.16; OCH_3, 7.55.

The hexachloro compound (XXXII) after standing for 2 months in a closed brown bottle became yellow and the odor of hydrogen chloride was detected. The solid (3.35 g.) was refluxed with 100 ml. of methanol for 15 min. The yellow solution was evaporated to dryness and the resulting solid was dissolved in 10 ml. of ether. After standing overnight in the refrigerator, 0.48 g. of yellow solid was obtained, m.p. 160–167° (fast). Recrystallization from acetone–methanol afforded yellow plates of XXXIII, m.p. 172–174°. Ultraviolet spectrum showed λ_{max} 256 mμ (ε 31,200), sh 276 (7800). Infrared spectrum showed 1770, 1725 (C=O) cm.$^{-1}$.

Anal. Calcd. for $C_{12}H_{10}NCl_3O_4$: C, 42.56; H, 2.98; Cl, 31.42; N, 4.14; OCH_3, 18.33. Found: C, 43.01; H, 3.43; Cl, 31.37; N, 4.14; OCH_3, 19.19.

(13) *Cf.* procedure described by G. F. Holland, D. A. Jaeger, R. L. Wagner, C. D. Laubach, W. M. McLamore, and S. Y. P'an, *J. Med. Pharm. Chem.*, **3**, 99 (1961).

(14) Available from Aldrich Chemical Co., Milwaukee, Wis.