λ_{max}^{MeOH} 283 mμ (ε 16,700). The mass spectrum exhibits mol ions at *m/e* 372, 374, and major fragments at 339 and 97. *Anal.* ($C_{23}H_{29}ClO_2$) C, H.

2',3'α-Tetrahydrofuran-2'-spiro-17-(6,7α-difluoromethylene-4-androsten-3-one) (XI). A soln of the dienone IV (1.00 g, 3.06 mmoles) in 5 ml of redistd triglyme was treated dropwise at 195–200° over a 2-hr period with a soln of 6.0 g of anhyd sodium chlorofluoroacetate in 50 ml of triglyme. The reaction mixt was poured on ice and then was extd with Et_2O. The Et_2O layers were washed with H_2O, then dried (Na_2SO_4) and concd. The crude product was eluted from 100 g of silica gel with C_6H_6 and C_6H_6 with increasing concns of Et_2O up to 5% Et_2O. The cryst material was separated from heptane to give 628 mg (55.3%) of XI: mp 130–132°; [α]D +33.7°; $\lambda_{max}^{CH_3OH}$ 247.5 (ε 14,900). *Anal.* ($C_{23}H_{30}F_2O_2$) C, H, F.

2',3'α-Tetrahydrofuran-2'-spiro-17-(6,7α-difluoromethylene-1,4-androstadien-3-one) (XII). A soln of XI (625 mg, 1.66 mmoles) and DDQ (497 mg, 2.19 mmoles) in 7 ml of C_6H_6 was refluxed for 4 hr. The mixt was cooled to room temp and the hydroquinone largely recovered by filtration. The filtrate was applied directly to a silica gel (6 g) column and partial purification was accomplished by eluting the desired product with 5% Et_2O in C_6H_6 to pure Et_2O. The colored material so obtained was chromatographed on basic alumina (100:1) to give the desired product, 382 mg, eluted with 10% Et_2O in C_6H_6. Recrystn from heptane gave XII: mp 158–159°; [α]D −45°; λ_{max}^{MeOH} 245 mμ (ε 14,800). *Anal.* ($C_{23}H_{28}F_2O_2$) C, H, F.

2',3'α-Tetrahydrofuran-2'-spiro-17-(6,7α-difluoromethylene-1,2α-methylene-4-androsten-3-one) (XIII). A soln of dimethylsulfoxonium methylide was prepd from a suspension of NaH (40 mg of a 55% dispersion in mineral oil) and 220 mg of trimethylsulfoxonium iodide in 2 ml of anhydrous DMSO with vigorous stirring over 60 min. The clear soln was treated with a soln of 100 mg (0.266 mmole) of the diene XII in 2 ml of DMSO at room temp under N_2. After standing 17 hr, H_2O was added and the solid was isolated by filtration. This material was adsorbed on a silica gel column (100:1). The desired product XIII was eluted with increasing concns of Et_2O in C_6H_6 up to 5%. Recrystn from C_6H_{14} afforded 77.8 mg of XIII: mp 156–158°; [α]D +180°; $\lambda_{max}^{CH_3OH}$ 244 mμ (ε 11,500). *Anal.* ($C_{24}H_{30}F_2O_2$) C, H, F.

3'-(6,7α-Difluoromethylene-1,2α-methylene-17β-hydroxy-3-oxo-4-androsten-17α-yl)propionic Acid Lactone (XIV). A soln prepd from 200 mg of the spiroether XIII, 2.8 ml of *tert*-butyl chromate,[16] 0.8 ml of glacial HOAc, and 0.4 ml of Ac_2O in 4.0 ml of CCl_4 was refluxed for 2.5 hr under N_2. The cooled reaction mixt was treated with 4 ml of a satd aqueous soln of oxalic acid. The organic layer was dild with CCl_4 and was sepd from the aqueous layer. The organic layer was washed with H_2O, dried, and concd to an amber oil which ran as a single spot on thin-layer chromatography on silica gel. Chromatography of this material on 20 g of silica gel with increasing concns of EtOAc in C_6H_6 gave, initially, fractions of a dark oil. Continued elution gave the desired product XIV (140 mg) as a clear oil which readily crystd. Recrystn from aqueous CH_3OH afforded a colorless solid: mp 183–185°; [α]D +162.6°; $\lambda_{max}^{CH_3OH}$ 243 mμ (ε 11,600); mol wt 402 (mass spectrum). *Anal.* ($C_{24}H_{28}F_2O_3$) C, H, F.

References

(1) G. H. Rasmusson, A. Chen, G. F. Reynolds, D. J. Patanelli, A. A. Patchett, and G. E. Arth, 163rd National Meeting of the American Chemical Society, Boston, Mass., April 1972, MEDI 41.
(2) J. A. Cella and R. C. Tweit, *J. Org. Chem.*, **24**, 1109 (1959).
(3) R. F. Spark and J. C. Melby, *Ann. Intern. Med.*, 69, 685 (1968).
(4) S. L. Steelman, J. R. Brooks, E. R. Morgan, and D. J. Patanelli, *Steroids*, **14**, 449 (1969).
(5) G. E. Arth, H. Schwam, L. H. Sarett, and M. Glitzer, *J. Med. Chem.*, 6, 617 (1963).
(6) R. Wiechert, H. Steinbeck, W. Elger, and F. Neumann, *Arznem.-Forsch.*, **17**, 1103 (1967).
(7) E. J. Corey and M. Chaykovsky, *J. Amer. Chem. Soc.*, **84**, 867 (1962).
(8) R. Wiechert, *Angew. Chem.*, 79, 815 (1967).
(9) G. W. Krakower and H. A. Van Dine, *J. Org. Chem.*, 31, 3467 (1966).
(10) C. Beard, B. Berkoz, N. H. Dyson, I. T. Harrison, P. Hodge, L. H. Kirkham, G. S. Lewis, D. Grannini, B. Lewis, J. A. Edwards, and J. H. Fried, *Tetrahedron*, **25**, 1219 (1969), and references cited.
(11) H. Budzikiewicz, C. Djerassi, and D. Williams, "Interpretation of Mass Spectra of Organic Compounds," Holden Day, San Franciso, Calif., 1964, p 54.
(12) G. F. Reynolds, G. Rasmusson, L. Birladeanu, and G. E. Arth, *Tetrahedron Lett.*, 5057 (1970).
(13) J. R. Brooks, R. D. Busch, D. J. Patanelli, and S. L. Steelman, manuscript in preparation.
(14) H. L. Saunders, K. Holden, and J. R. Kerwin, *Steroids*, **3**, 387 (1964); A. Zarate, V. B. Mahesh and R. B. Greenblatt, *J. Clin. Endocrinol.*, 26, 1394 (1966), and references cited.
(15) R. O. Neri, M. D. Monahan, J. G. Meyers, B. A. Alfonso, and I. A. Tabachnick, *Eur. J. Pharmacol.*, 1, 438 (1967).
(16) K. Heusler and A. Wettstein, *Helv. Chim. Acta*, **35**, 284 (1952).

Azaindole Anthelmintic Agents

Michael H. Fisher,* George Schwartzkopf, Jr., and Dale R. Hoff

Merck Sharp and Dohme Research Laboratories, Division of Merck & Co., Inc., Rahway, New Jersey 07065.

Received June 6, 1972

A series of 2-substituted azaindoles, isosteric with analogous anthelmintic benzimidazoles related to thiabendazole, was synthesized. The most promising of these, 2-(4-thiazolyl)-6-azaindole, proved to be effective against the abomasal parasite *Haemonchus contortus* in sheep at 100 mg/kg but lacked the breadth of spectrum of thiabendazole.

2-(4-Thiazolyl)benzimidazole, thiabendazole, reported from these laboratories in 1961,[1] has gained wide acceptance as a safe, broad-spectrum anthelmintic agent. In a continuing attempt to extend this activity to other heterocyclic systems,[2] a series of azaindoles of related structure was synthesized for biological testing.

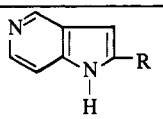
Chemistry. The chemistry of azaindoles has recently been reviewed by Willette.[3] Azaindoles prepared are listed in Tables I, II, and III. Intermediates are shown in Tables IV and V. Synthetic procedures, generalized where possible, are described in the Experimental Section.

2-Phenyl-4-, 5-, 6-, and 7-azaindoles (**16, 1, 9,** and **15**) were prepared by cyclization of the appropriate *o*-benzamidopicolines, using the standard Madelung procedure.[4] However, the strongly basic conditions and high temperatures necessary in this reaction made it unsuitable for the synthesis of azaindoles bearing sensitive substituents. New azaindole syntheses were devised to provide the required compounds.

2-(2-Thiazolyl)-6-azaindole (**14**) was obtained from ethyl 6-azaindole-2-carboxylate (**5**)[5] by a series of straightforward chemical manipulations *via* compounds **6, 7,** and **8.**

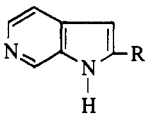
There have been several reports[6] describing the formation of 5-membered heterocycles *via* nitrene intermediates

Table I. 5-Azaindoles



Compd	R	Syn method	% yield	Recrystn solvent	Mp, °C	Formula	Analysis	Anthelmintic act.
1	C_6H_5	A, C	14	H_2O-MeOH	282-283	$C_{13}H_{10}N_2$	C, H, N	200
2	2-FC_6H_4	C	15	H_2O-MeOH	205-208 dec	$C_{13}H_9FN_2$	C, H, N	200
3		C	9.7	H_2O-MeOH	275-279 dec	$C_{11}H_8N_2S$	C, H, N, S	200
4		C	7.4	H_2O-MeOH	248-252 dec	$C_{10}H_7N_3S$	C, H, N	I

Table II. 6-Azaindoles



Compd	R	Syn method	% yield	Recrystn solvent	Mp, °C	Formula	Analysis	Anthelmintic act.
5	$COOC_2H_5$		44	EtOAc	212-214	$C_{10}H_{10}N_2O_2$	C, H, N	I
6	$CONH_2$		97	H_2O	320-330	$C_8H_7N_3O$	C, H, N	I
7	CN		72.4	EtOH	305-310	$C_8H_5N_3$	C, H, N	I
8	$CSNH_2$		65.7	EtOH	>325	$C_8H_7N_3S$	C, H, N, S	I
9	C_6H_5	A	14.2	H_2O-MeOH	223-225	$C_{13}H_{10}N_2$	C, H, N	200
10	2-FC_6H_4	C	22	H_2O-MeOH	201-202	$C_{13}H_9FN_2$	C, H, N, F	I
11	2-$C_{10}H_7$	C	12.4	H_2O-MeOH	263-264	$C_{17}H_{12}N_2$	C, H, N	200
12		C	13.2	H_2O-MeOH	235-236	$C_{11}H_8N_2S$	C, H, N, S	I
13		C	14.1	H_2O-MeOH	247-248	$C_{10}H_7N_3S$	C, H, N, S	50
14			13.2	Sublimed 110° (0.1 mm)	234-235	$C_{10}H_7N_3S$	C, H, N, S	I

Table III. Miscellaneous Azaindoles

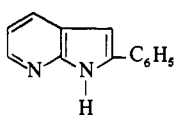
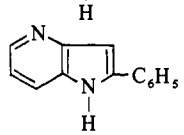
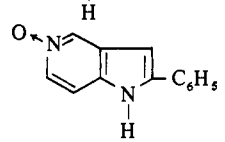
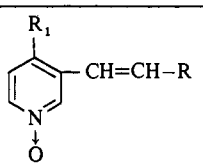
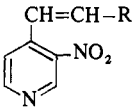
Compd	Structure	Syn method	% yield	Recrystn solvent	Mp, °C	Formula	Analysis	Anthelmintic act.
15		A	5.2	MeOH	204-205	$C_{13}H_{10}N_2$	C, H, N	I
16		A	18.7	H_2O-MeOH	255-256	$C_{13}H_{10}N_2$	C, H, N	I
17			95.2	H_2O-MeOH	271-274	$C_{13}H_{10}N_2O$	C, H, N	I

Table IV. 3-Arylvinylpyridine 1-Oxides

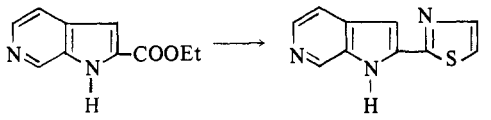


Compd	R	R_1	Syn method	% yield	Recrystn solvent	Mp, °C	Formula	Analysis
18	C_6H_5	$NHNH_2$		59.7	$CHCl_3$-EtOH	188-190	$C_{13}H_{13}N_3O$	C, H, N
19	C_6H_5	N_3		97	Me_2CO	210-215	$C_{13}H_{10}N_4O$	
	(Picrate)				EtOH	219-224	$C_{19}H_{13}N_7O_8$	C, H, N, O
20	2-FC_6H_4	NO_2	B	25.8	MeOH	195-196	$C_{13}H_9FN_2O_3$	C, H, N
21		NO_2	B	59.5	EtOH	200-201	$C_{11}H_8N_2O_3S$	C, H, N
22		NO_2	B	61.2	MeOH	185-187	$C_{10}H_7N_3O_3S$	C, H, N

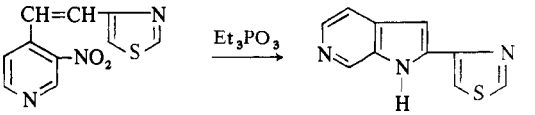
Table V. 4-Arylvinyl-3-nitropyridines



Compd	R	Syn method	% yield	Recrystn solvent	Mp, °C	Formula	Analysis
23	2-FC_6H_4	B	16.5	MeOH	98-99	$C_{13}H_9FN_2O_2$	C, H, N, F
24	2-$C_{10}H_7$	B	30	EtOH	155-156	$C_{17}H_{12}N_2O_2$	C, H, N
25		B	36.4	MeOH	108-109	$C_{11}H_8N_2O_2S$	C, H, N, S
26		B	22.2	H_2O-MeOH	101-102	$C_{10}H_7N_3O_2S$	C, H, N, S

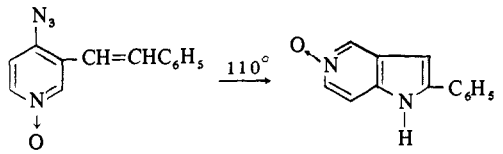


5 14



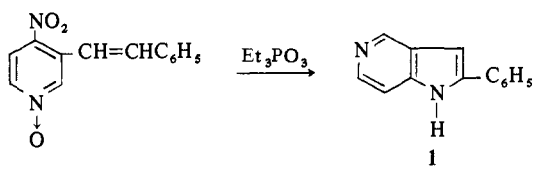
26 13

obtained by the thermal decomposition of aryl azides, and this type of synthesis appeared to be applicable to azaindoles. Accordingly, 4-chloro-3-styrylpyridine 1-oxide[7] was converted with hydrazine into 4-hydrazino-3-styrylpyridine 1-oxide (**18**) which with sodium nitrite gave 4-azido-3-styrylpyridine 1-oxide (**19**). Decomposition of the azide in refluxing toluene gave a good yield of 2-phenyl-5-azaindole 5-oxide (**17**), which was reduced to 2-phenyl-5-azaindole (**1**) by Zn-AcOH.



19 17

Cadogan and his associates[8] have extensively studied the deoxygenation of aryl nitro and nitroso compounds with triethyl phosphite and the utility of this reaction for the preparation of carbazoles, indoles, indazoles, and triazoles. The successful conversion of **19** to **17** and the ready availability of suitable nitropyridines prompted us to study the application of similar reductive cyclizations to azaindole synthesis. The conversion of 4-nitro-3-styrylpyridine 1-oxide[9] to 2-phenyl-5-azaindole (**1**) was used to establish the best reaction conditions, which were refluxing with 6 moles of triethyl phosphite in dry benzene under nitrogen for 7 days. 1-Deoxygenation occurred during the reaction. Compounds **2**, **3**, and **4** were obtained similarly.

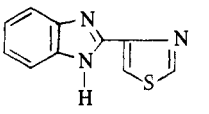


1

The 6-azaindoles **10**, **11**, **12**, and **13** were synthesized by similar reductive cyclization of 3-nitro-4-(2-arylvinyl)pyridines. The 3-nitro-4-(2-arylvinyl)pyridine and **4**-nitro-3-(2-arylvinyl)pyridine 1-oxide intermediates were prepared by base-catalyzed condensation of the appropriate aldehydes with either 3-nitro-4-picoline or 4-nitro-3-picoline 1-oxide.

Biological Activity. Biological results are shown in Tables I, II, and III. The column showing anthelmintic activity indicates the lowest oral dose in mg/kg which demonstrated activity against trichostrongyles in a laboratory animal model assay† or inactivity (I) at 200 mg/kg. The most potent compound (**13**) was tested against a braod range of parasites in sheep. At a single oral dose of 100 mg/kg it was effective against *Haemonchus contortus* but essentially inactive against all other parasites present.

Structure-Activity Relationships. Preliminary anthelmintic testing of 2-phenyl-4-, 5-, 6-, and 7-azaindoles showed that 2-phenyl-4- and 7-azaindoles (**16**, **15**), were inactive, whereas 2-phenyl-5- and 6-azaindoles (**1**, **9**) were active at 200 mg/kg. These compounds can be viewed as analogs of thiabendazole in which one of the benzimidazole nitrogen atoms has been moved into the aromatic ring. Should structure-activity relationships similar to benzimidazoles hold, the highest activity would be expected with



thiabendazole

16 1

15 9

azaindoles in which the 2-substituent was *o*-fluorophenyl, 2-naphthyl, 2-thienyl, 2-thiazolyl, and 4-thiazolyl. Accordingly, a selection of 5- and 6-azaindoles bearing these substituents in the 2 position was evaluated for anthelmintic activity. Structure-activity correlations between the benzimidazole and azaindole series were at best only partially successful. In the 5-azaindole series, the 2-phenyl (**1**), 2-*o*-

†A modification of the method described by Lynch and Nelson.[10]

Table VI

Compd	pK_a CH_3OH-H_2O	$K_D = \frac{[pH\ 7.2\ buffer]}{[oleyl\ alcohol]}$	Anthelmintic act.
Thiabendazole	4.58	0.03	A12.5
1	7.5	0.40	A200
3	7.6		A200
4	7.5	0.54	I
9	7.5	0.05	A200
10	7.1		I
11		0.2	A200
12	7.3	0.11	I
13	7.3	0.08	A50
14	6.5	0.09	I
15		1.0	I
16	6.4	1.0	I

fluorophenyl (2), and 2-(2-thienyl) (3) derivatives were active whereas 2-(4-thiazolyl)-5-azaindole (4) was surprisingly inactive. In the 6-azaindole series the 2-phenyl (9), 2-(2-naphthyl) (11), and 2-(4-thiazolyl) (13) derivatives were active, whereas the 2-*o*-fluorophenyl (10), 2-(2-thienyl) (12), and 2-(2-thiazolyl) (14) derivatives were inactive.

In an attempt to better understand these puzzling deviations in structure-activity, the pK_a values and distribution coefficients were measured and compared with activity for several of the compounds (Table VI). Unfortunately, no obvious correlation could be discerned.

Experimental Section‡

Method A. **2-Phenyl-4-azaindole (16).** To a solution of 1.4 g (0.06 g-atom) of Na in 30 ml of EtOH was added 1.372 g (0.006 mole) of 3-benzamido-2-picoline. The resulting solution was evaporated to dryness and then heated for 15 min at 310–320° under nitrogen. Ice water was added to the cooled mixture, and the solid residue was collected, dried, and sublimed at 200° (0.1 mm). The sublimate crystallized from H_2O–MeOH, 0.3 g (18.7%); mp 255–256°. *Anal.* ($C_{13}H_{10}N_2$) C, H, N.

2-Carbamoyl-6-azaindole (6). A suspension of 3.86 g of ethyl 6-azaindole-2-carboxylate[5] in 30 ml of MeOH and 30 ml of liquid NH_3 was heated for 8 hr at 100°. Evaporation yielded the product which was crystallized from H_2O, 3.175 g (97%); mp 320–330° dec. *Anal.* ($C_8H_7N_3O$) C, H, N.

2-Cyano-6-azaindole (7). A suspension of 2.81 g of 6 in 20 ml of $POCl_3$ was refluxed for 5 min. The cooled solution was poured onto NH_3–ice, and the precipitate was collected. Crystallization from EtOH gave 1.808 g (72.4%), mp 305–310°. *Anal.* ($C_8H_5N_3$) C, H, N.

2-Thiocarbamoyl-6-azaindole (8). H_2S was passed into a solution of 1.608 g of 7 in 25 ml of pyridine and 2.5 ml of triethylamine for 1 hr. The solution was allowed to stand at room temperature for 1 hr and then diluted with 125 ml of H_2O. The product separated after standing at 0°, 1.307 g (65.7%), mp >325°. Crystallization from EtOH gave no change in mp. *Anal.* ($C_8H_7N_3S$) C, H, N, S.

2-(2-Thiazolyl)-6-azaindole (14). A solution of 0.1 g (0.0006 mole) of 8 and 0.5 ml (0.0026 mole) of 40% $ClCH_2CHO$–H_2O in 2 ml of EtOH was heated to dryness on a steam bath. The residue was dissolved in 2 ml of H_2O and heated on a steam bath for 2 hr. Neutralization with $NaHCO_3$ precipitated a small amount of gum which was filtered off. The filtrate deposited the product, 15 mg (13.2%), mp 226–227°. Sublimation at 110° (0.1 mm) raised the mp to 234–235°. *Anal.* ($C_{10}H_7N_3S$) C, H, N, S.

4-Hydrazino-3-styrylpyridine 1-Oxide (18). A mixture of 5 g of 4-chloro-3-styrylpyridine 1-oxide[7] (0.022 mole) and 6.9 ml of 95% NH_2NH_2 (0.22 mole) in 50 ml of MeOH was refluxed for 3 hr. The product separated on cooling. Crystallization from $CHCl_3$–EtOH gave 2.93 g (59.7%), mp 188–190°. *Anal.* ($C_{13}H_{13}N_3O$) C, H, N.

4-Azido-3-styrylpyridine 1-Oxide (19). A solution of 1.7 g of $NaNO_2$ (0.025 mole) in 20 ml of H_2O was added dropwise to a stirred solution of 5.4 g (0.024 mole) of 18 in 100 ml of 10% HCl at 10°. The mixture was stirred for 1 hr at room temperature, then basified with 10% Na_2CO_3 and extracted with $CHCl_3$. The extract was dried with Na_2CO_3 and evaporated, and the product was crystallized from Me_2CO, 5.5 g (97%), mp 210–215°. The picrate crystallized from EtOH, mp 219–224°. *Anal.* ($C_{19}H_{13}N_7O_8$) C, H, N, O.

2-Phenyl-5-azaindole 5-Oxide (17). A solution of 1.31 g of 19 in 260 ml of toluene was refluxed for 18 hr. After cooling, the product was filtered off and recrystallized from H_2O–MeOH, 1.1 g (95.2%), mp 271–274°. *Anal.* ($C_{13}H_{10}N_2O$) C, H, N. Deoxygenation with Zn–AcOH gave 2-phenyl-5-azaindole, mp 282–283°.

Method B. **3-Nitro-4-[2-(2-thienyl)vinyl]pyridine (25).** A solution of 5.6 g (0.05 mole) of 2-thiophenecarboxaldehyde, 6.7 g (0.048 mole) of 3-nitro-4-picoline, and 2 ml of piperidine in 25 ml of MeOH was refluxed for 6 hr and cooled, and the product was filtered off and crystallized from MeOH, 4.1 g (36.4%), mp 108–109°. *Anal.* ($C_{11}H_8N_2O_2S$) C, H, N, S.

Method C. **2-(4-Thiazolyl)-6-azaindole (13).** A mixture of 16.5 g (0.071 mole) of 25 and 82.5 ml (0.5 mole) of Et_3PO_3 in 1 l. of dry C_6H_6 was refluxed for 7 days under N_2. The solvent was evaporated, and the residue was stirred for 10 min with 800 ml of H_2O to decompose the excess of Et_3PO_3. The mixture was acidified with AcOH and stirred for 5 min, and unreacted starting material was extracted with $CHCl_3$. The aqueous portion was basified with $NaHCO_3$ and evaporated to dryness, the inorganic salts were dissolved out with a little water, and the product remaining was crystallized from H_2O–MeOH, 2.1 g (14.1%), mp 247–248°. *Anal.* ($C_{10}H_7N_3S$) C, H, N, S.

‡Where analyses are indicated only by symbols of the elements, analytical results obtained for those elements were within ±0.4% of the theoretical values. Melting points were taken on a Thomas-Hoover Uni-Melt apparatus and are uncorrected.

Acknowledgments. The anthelmintic results reported were obtained by Drs. W. C. Campbell and J. R. Egerton and the staff of the Parasitology Department, Merck Sharp and Dohme Research Laboratories. Microanalyses were determined by Mr. R. N. Boos.

References

(1) H. D. Brown, A. R. Matzuk, I. R. Ilves, L. H. Peterson, S. A. Harris, L. H. Sarett, J. R. Egerton, J. J. Yakstis, W. C. Campbell, and A. C. Cuckler, *J. Amer. Chem. Soc.*, 83, 1764 (1961).
(2) Michael H. Fisher and Aino Lusi, *J. Med. Chem.*, 15, 982 (1972).
(3) R. E. Willette, *Advan. Heterocycl. Chem.*, 9, 27 (1968).
(4) W. Madelung, *Chem. Ber.*, 45, 1128 (1912).
(5) Michael H. Fisher and Alexander R. Matzuk, *J. Heterocycl. Chem.*, 6, 775 (1969).
(6) (a) G. Smolinsky, *J. Amer. Chem. Soc.*, 82, 4717 (1960); (b) G. Smolinsky, *J. Org. Chem.*, 26, 4108 (1961); (c) G. Smolinsky and B. I. Feuer, *ibid.*, 29, 3097 (1964); (d) J. H. Hall and D. R. Kamm, *ibid.*, 30, 2092 (1965); (e) L. Krbechek and H. Takimoto, *ibid.*, 29, 3630 (1964).
(7) E. C. Taylor and A. J. Crovetti, *ibid.*, 25, 850 (1960).
(8) J. I. G. Cadogan, *Quart. Rev., Chem. Soc.*, 22, 222 (1968).
(9) D. Jerschel and H. E. Heck, *Justus Liebigs Ann. Chem.*, 613, 171 (1958).
(10) John E. Lynch and Barbara Nelson, *J. Parasitol.*, 45, 659 (1959).