Synthesis of Two Novel Bicyclic Systems, Imidazo[1,5-*d*]-*as*-triazine and Imidazo[1,2-*d*]-*as*-triazine

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4-Imidazolecarboxyaldehyde was condensed with methyl dithiocarbazinate and with ethyl carbazate, the resulting hydrazones were subjected to thermolysis in diphenyl ether at 175-240°, to give imidazo[1,5-*d*]-*as*-triazine-4(3*H*)thione and imidazo[1,5-*d*]-*as*-triazin-4(3*H*)one, respectively. A number of 2-, 5-, and 2,5-substituted 4-imidazolecarboxaldehydes were also carried through this scheme. The same sequence of reactions with 2-imidazolecarboxaldehyde gave the novel system imidazo[1,2-*d*]-*as*-triazine-5-(6*H*)thione. Upon treatment with sodium hydride and methyl iodide, imidazo[1,5-*d*]-*as*-triazine-4(3*H*)thione and imidazo[1,2-*d*]-*as*-triazine-5(6*H*)-thione gave 4-methylthioimidazo[1,5-*d*]-*as*-triazine and 5-methylthioimidazo[1,2-*d*]-*as*-triazine, respectively. Displacement of the thiomethyl group was achieved with a selection of amine reagents in both of the above cases.

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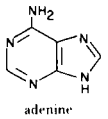
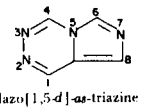
During a study of some bicyclic heterocycles resembling adenine, we became interested in the synthesis of the previously unknown heterocyclic system imidazo-[1,5-*d*]-*as*-triazine.



adenine



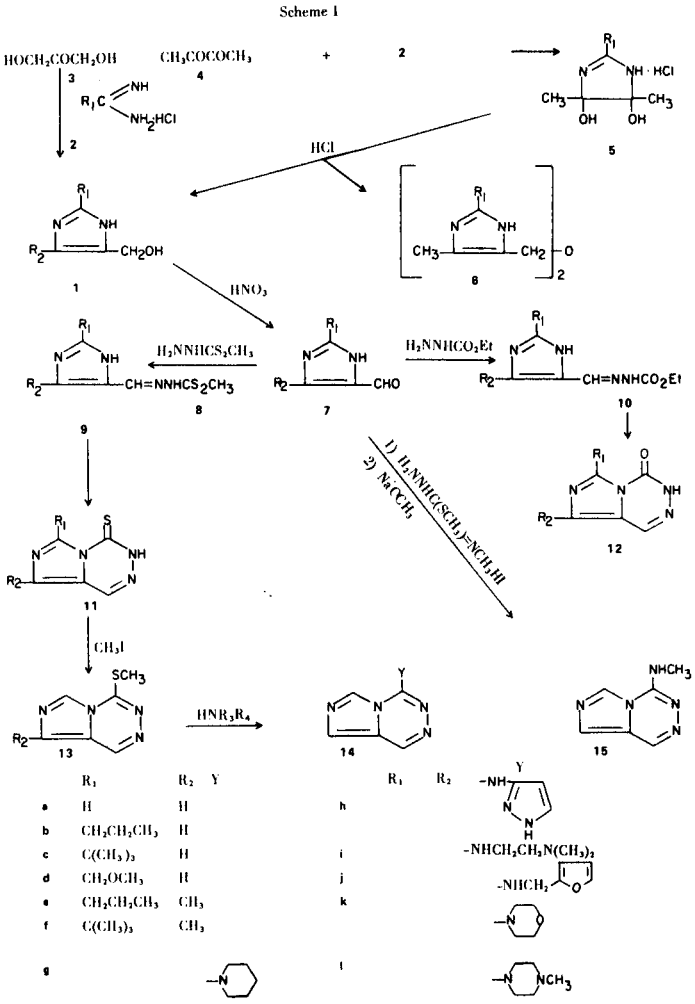
imidazo[1,5-*d*]-*as*-triazine

The synthesis was approached from the imidazole ring, since this would give an unambiguous result, whereas syntheses from the triazine portion could give rise to isomeric products. After some futile attempts to scale up the very tedious and erratic synthesis of 4-hydroxymethylimidazole (**1a**) (1) as reported in the older literature (2), a very simple synthesis for this compound was conveniently published by Dziuron and Schunack (3). Using their method, various amidines (**2**) or imido esters were treated with 1,3-dihydroxy acetone (**3**) in liquid ammonia in a bomb at 60° to give a variety of 2-substituted-4-hydroxymethylimidazoles (**1**) (Scheme I). Disubstituted hydroxymethylimidazoles (**1**) were prepared by a modification of Jacquier's procedure (4), which involved condensing amidines with 2,3-butanedione (**4**) to give glycols **5**. Acid rearrangement of **5** provided **1**.

In the course of the latter procedure, bisimidazolemethyl ethers (**6**) were occasionally isolated as by-products (see Experimental). Oxidation of the imidazole alcohols (**1**) to aldehydes was carried out with hot nitric acid by the method of Pyman (5), or with cold nitric acid by the method of Diels (4b).

One approach to the bicyclic system involved reacting 4-imidazolecarboxaldehyde (**7a**) with hydrazine followed by various reagents to achieve cyclization. However, even

Scheme I



when the aldehydes were treated with large (30x) excesses of hydrazine, azines formed which were of no use synthetically. In another approach based on the work of

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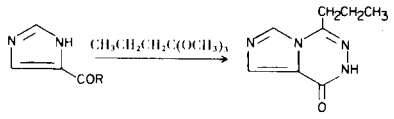
Omar (6), elimination of hydrogen sulfide from various thiosemicarbazones of **7a** with a variety of metal salts was tried, but provided only a trace of bicyclic material. Nevertheless, the fact that the new system was stable and could be identified encouraged further efforts to improve the synthesis. Finally, 4-imidazolecarboxaldehydes **7** were reacted with methyl dithiocarbazinate (**8**) (7) or ethyl carbazate to give **9** or **10**. Heating each carbazone in diphenyl ether furnished the respective bicyclic product **11** and **12** in good yield. On treatment of imidazo[1,5-*d*]-*as*-triazine-4(3*H*)thione (**11a**) with sodium hydride and iodomethane, the thiomethyl derivative **13** was obtained, which underwent displacement with piperidine to give **14**.

Since 4-methylthioimidazo[1,5-*d*]*as*-triazine (**13**) would not react with methylamine in refluxing methanol to give **15** (while liquid ammonia at 120° gave only tars), 4-imidazolecarboxaldehyde (**7a**) was reacted with 3,4-dimethylthiosemicarbazide hydroiodide, neutralized, and cyclized by heating, in one overall operation. The latter procedure unfortunately did not prove to be general.

Scheme 2

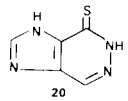


R
16 OH
17 OEt
18 N_2H_3

19

During the oxidation of 4-hydroxymethylimidazole (**1a**), 4-imidazolecarboxylic acid (**16**) also formed. This acid was always easy to isolate (5), which was not the case with substituted imidazolecarboxylic acids. After conversion of **16** to its ester **17**, and then to the hydrazide **18** by known procedures, treatment with trimethyl orthobutyrate gave 4-propylimidazo[1,5-*d*]-*as*-triazin-1-(2*H*)one (**19**), Scheme 2.

The structure of the imidazo[1,5-*d*]-*as*-triazine system was demonstrated by its method of synthesis, by its analyses, nmr spectra and mass spectra. Unless extensive rearrangements are proposed, the only alternative cyclization of **9a** or **10a** would be onto the less reactive 5 position of the imidazole to give **20** or a tautomer thereof.



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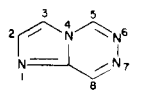
The nmr spectrum of **11a** showed three aromatic C-H protons. Moreover, when a 5-substituted imidazole such as **1e** was carried through the sequence to **11e**, the reaction went smoothly to a product whose ir, uv, and nmr spectra closely resembled **11a**, demonstrating that the same nucleus had formed, rather than **20**.

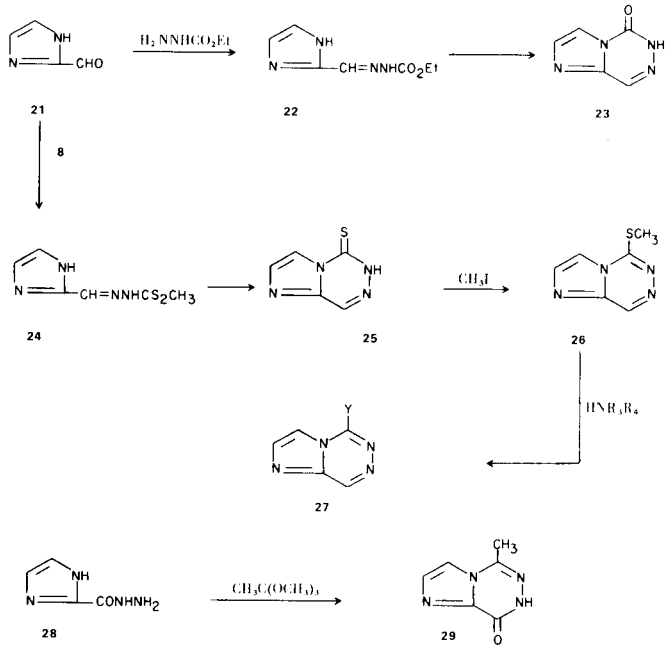
A second bicyclic system was prepared by the above sequence. Although a 6,7-benzo fused form of imidazo-[1,2-*d*]-*as*-triazine has been reported (8) the bicyclic system itself was unknown. Furthermore, the reported synthesis of the tricyclic system, which involved the reaction of 2-benzimidazolecarboxaldehyde with hydrazine



imidazo[1,2-*d*]-*as*-triazine

followed by cyclization with an ortho ester, was not applicable to the synthesis of the bicyclic system. When 2-imidazolecarboxaldehyde (9) was treated with hydrazine only an azine could be isolated, as with **7a** above. Reacting **21** (Scheme 3) with ethyl carbazate gave **22** which on heating in diphenyl ether furnished imidazo[1,2-*d*]-*as*-triazin-5(6*H*)one (**23**). Methyl dithiocarbazinate (**8**) converted **21** to **24** which was cyclized (**25**), S-methylated (**26**), and reacted with various amines to give **27**. Oxygen could be introduced into the 8-position of this system by reacting 2-imidazolecarboxylic acid hydrazide (**28**) with methyl orthoacetate to provide 5-methylimidazo-[1,2-*d*]-*as*-triazin-8(7*H*)one (**29**).

Scheme 3



Y defined in Scheme 1.

EXPERIMENTAL

Melting points were taken on a Mel-Temp apparatus and are uncorrected. The nmr spectra were taken on a Varian model HA 100A, 100 M Hz instrument using tetramethylsilane as an internal standard with all samples being dissolved in DMSO-d_6. Mass spectra were taken in an AEI MS9. Microanalyses were performed by Mr. L. Brancone and staff. Spectra were determined by Mr.

Table 1

Substituted 4-Imidazolecarboxaldehydes Prepared by the Method of **7e**

Compound	Yield %	M.p., °C	Recrystallization Solvent	Molecular Formula	Analysis Calcd. C	H	N	Found C	H	N
7b	59	103.5-105.5	water (a)	$C_7H_{10}N_2O$	60.85	7.30	20.38	61.14	7.43	20.61
7c	17	201-203	2-propanol	$C_8H_{12}N_2O$	63.13	7.95	18.41	63.03	8.22	18.36
7d	59	100-103 (b)	2-propanol (a)	$C_6H_8N_2O_2$	51.42	5.75	19.99	51.74	5.64	20.20
7f	54	196-198	chloroform-petroleum ether (a)	$C_9H_{14}N_2O\cdot\frac{1}{8}H_2O$	64.21	8.46	16.64	64.25	8.54	16.90

(a) Chromatographed on silica gel first.
(b) Recrystallized for analysis, m.p. 103.5-105°.

Table 2

Heterocyclic-Carboxaldehyde Carbazones
(Method of **9a**)

Compound	Yield %	M.p., °C (a)	Recrystallization Solvent	Molecular Formula	Analysis Calcd. C	H	N	S	Found C	H	C	S
9a (b)	96	198 dec. 258-261	methanol	$C_6H_8N_4S_2$	35.98	4.03	27.98	32.02	35.88	4.13	27.60	32.25
9b	96	95-104 (c)	chloroform	$C_9H_{14}N_4S_2\cdot 1/2\ H_2O$	43.00	6.01	22.29	25.51	43.30	5.78	22.46	25.68
9d	95	150-154 dec.	methanol	$C_8H_{12}N_4OS_2$	39.32	4.95	22.93	26.25	39.31	4.82	22.93	26.05
9e	87	175-179 dec.	ethyl acetate	$C_{10}H_{16}N_4S_2$	46.84	6.29	21.85	25.01	46.79	6.56	21.53	24.86
9f	100	174-176	ethyl acetate-petroleum ether	$C_{11}H_{18}N_4S_2$	48.85	6.71	20.72	23.72	48.85	6.40	20.51	23.80
10a (b)	98	213-216 dec.	methanol	$C_7H_{10}N_4O_2$	46.15	5.52	30.76		45.96	5.68	30.76	
10b	94	180-182		$C_{10}H_{16}N_4O_2$	53.55	7.19	24.99		53.40	7.58	25.15	
10c	89	194-197	ethyl acetate-petroleum ether	$C_{11}H_{18}N_4O_2$	55.44	7.61	23.52		55.55	7.76	23.65	
10d	94	186-190 dec.	ethanol	$C_9H_{14}N_4O_3$	47.78	6.24	24.77		47.52	5.87	24.60	
10e	88	184-188	2-propanol	$C_{11}H_{18}N_4O_2$	55.44	7.61	23.52		55.37	7.68	23.77	
10f	82	226-228.5 dec.	ethanol	$C_{12}H_{20}N_4O_2$	57.11	7.99	22.21		56.90	7.95	21.93	
22 (c)	92	229-231		$C_7H_{10}N_4O_2$	46.15	5.52	30.76		46.23	5.55	30.63	
24 (c)	61	174-176	ethanol	$C_6H_8N_4S_2$	35.98	4.02	27.98	32.02	35.72	4.04	27.77	31.96

(a) Melting points in these compounds are of limited significance since the products are mixtures of *syn* and *anti* isomers. On recrystallization, a separation of isomers was often observed as determined by nmr. In addition, almost all of the compounds cyclized on melting and the cyclized product exhibited a second melting point.
(b) Starting material 4-imidazolecarboxaldehyde (3a, then 5).
(c) Starting material 2-imidazolecarboxaldehyde (9).

Table 3
Bicyclic-Heterocycles
(Method of **11a**)

Compound	Yield %	M.p., °C	Recrystallization Solvent	Molecular Formula	Calcd. C	Calcd. H	Calcd. N	Calcd. S	Analysis Found C	Found H	Found N	Found S
11a	93	266-269	methanol wash	$C_5H_4N_4S$	39.47	2.65	36.82	21.07	39.50	2.78	37.05	20.96
11b	79	201.5-203.5 (a)	2-propanol-ethanol	$C_8H_{10}N_4S$	49.46	5.19	28.84	16.51	49.78	5.30	28.96	16.68
11d	68	219.5-223	DMF	$C_7H_8N_4OS$	42.84	4.11	28.55	16.34	42.97	4.33	28.70	16.38
11e	79	183-186	ethyl acetate	$C_9H_{12}N_4S$	51.90	5.81	26.90	15.40	51.66	5.60	26.83	15.24
12a	89	286.5-288.5	DMF	$C_5H_4N_4O$	44.12	2.96	41.17		43.83	3.10	41.06	
12b	82	159-162.5	ethyl acetate	$C_8H_{10}N_4O$	53.92	5.66	31.45		54.08	5.71	31.84	
12c	26	186-188	methanol	$C_9H_{12}N_4O$	56.23	6.29	29.15		56.02	6.22	29.29	
12d	77	200-205	ethanol-methanol	$C_7H_8N_4O_2 \cdot 1/8C_2H_5OH$	46.83	4.74	30.13		46.55	4.68	30.11	
12e	92	129.5-131.5 (b)	benzene	$C_9H_{12}N_4O$	56.23	6.29	29.15		55.85	5.88	28.90	
12f	81	198-200	2-propanol	$C_{10}H_{14}N_4O$	58.23	6.84	27.17		58.18	6.67	27.25	
25	73	238-240	ethanol-methanol	$C_5H_4N_4S$	39.46	2.65	36.82	21.07	39.50	2.62	36.73	20.99

(a) Sublimed for analysis, m.p. 205-206.5°.
(b) A dimorphic form, m.p. 122.5-123°, also exists.

W. Fulmor and staff. Interpretation of nmr spectra was made by Mr. G. Morton and mass spectra by Dr. R. T. Hargreaves. All starting materials not referenced were commercially available.

2-Propyl-4-hydroxymethylimidazole (**1b**).

A mixture of 180 g. (2.00 mole) of 1,3-dihydroxyacetone dimer, 245 g. (2.00 mole) of butyramidine hydrochloride and 1 l. of liquid ammonia were warmed to 60° for 5 hours in a bomb. After evaporation of the mixture to dryness in a hood, the residue was stirred with 600 ml. of 2-propanol. An insoluble precipitate (ammonium chloride) was filtered off and the filtrate concentrated under vacuum. Upon adding 600 ml. of 50% saturated aqueous sodium carbonate, the mixture was extracted with 3 x 500 ml. portions of tetrahydrofuran. The combined organic layers were washed with 330 ml. of saturated aqueous sodium carbonate. Next the organic layer was dried over sodium sulfate (anhydrous) and evaporated to dryness. The residue was boiled with 1.75 l. of acetone, treated with charcoal and cooled to give 190.2 g. of solid, m.p. 91-97°. Two more recrystallizations from acetone gave 156.7 g. (58%) of product, m.p. 95-101°.

Anal. Calcd. for $C_7H_{12}N_2O$: C, 59.97; H, 8.63; N, 19.99. Found: C, 60.12; H, 8.79; N, 20.12.

2-*t*-Butyl-4-hydroxymethylimidazole (**1c**).

This compound was prepared from *t*-butyl amidine hydrochloride (12) by the method of **1b** in 68% yield, m.p. 212-221° from 2-propanol.

Anal. Calcd. for $C_8H_{14}N_2O$: C, 62.30; H, 9.15; N, 18.17. Found: C, 62.43; H, 9.26; N, 18.44.

2-Methoxymethyl-4-hydroxymethylimidazole (**1d**).

This compound was prepared from ethyl 2-methoxyacetimidate hydrochloride (13) using the method of **1b** in 51% yield as an oil. The picrate of **1d** had m.p. 177.5-178.5° from 50% aqueous ethanol.

Anal. Calcd. for $C_{12}H_{13}N_5O_9$ (picrate): C, 38.82; H, 3.58; N, 18.87. Found: C, 38.82; H, 3.73; N, 18.97.

5-Methyl-2-propyl-4-hydroxymethylimidazole (**1e**) and 4,5-Dimethyl-2-propyl-2-imidazoline-4,5-diol Hydrochloride (**5e**).

n-Butyramidine (245 g., 2.00 mole) was dissolved in 100 ml. of water, then 172 g. (2.00 mole) of freshly distilled 2,3-butanedione was added. The mixture was stirred, becoming exothermic and giving a solution which rapidly crystallized. After cooling overnight, the precipitate was collected, washed twice with 600 ml. of acetone to give 215.1 g. (52%) of white, crystalline glycol, m.p. 110-116° dec. These glycols could not always be isolated; in which case one volume of hydrochloric acid was added, the solution heated for 4 hours and then worked up as below.

Anal. Calcd. for $C_8H_{17}ClN_2O_2$: C, 46.04; H, 8.21; Cl, 16.99; N, 13.43. Found: C, 46.17; H, 8.57; Cl, 17.24; N, 13.85.

A portion (214.1 g., 1.026 mole) of the glycol **5e** was stirred with 740 ml. of 6*N* hydrochloric acid at 90° for 4 hours giving a clear solution which was neutralized with potassium bicarbonate and concentrated in vacuum. The residue was extracted several times with ethanol and the combined extracts reconcentrated to an oil, 190.4 g., theory-158.3 g. An nmr indicated the oil was 9:1 product to 5,5′-(oxydimethylene)bis[4-methyl-2-propylimidazole] (**6e**).

In an earlier experiment, after extensive purification, a 6% yield of solid **1e** had been obtained which had m.p. 134-136° (acetone).

Anal. Calcd. for $C_8H_{14}N_2O$: C, 62.30; H, 9.15; N, 18.77.

Table 4

Substituted Amino-Bicyclic Heterocycles
(Method of **14g**)

Compound	Yield %	M.p., °C	Recrystallization Solvent	Molecular Formula	Analysis Calcd. C	Calcd. H	Calcd. N	Found C	Found H	Found N
14g	60	126.5-128	2-propanol (a)	$C_{10}H_{13}N_5$	59.09	6.45	34.46	58.79	6.43	34.22
14h	64	271-274 (b)	ethanol-DMF	$C_8H_7N_7$	47.76	3.51	48.74	47.80	3.69	48.53
14i	78	172-177	2-propanol	$C_9H_{14}N_6$	52.41	6.84	40.75	52.48	6.90	41.06
14j	83	262-266.5	ethanol (c)	$C_{10}H_9N_5O$	55.81	4.22	32.54	55.89	4.50	32.52
27k	36	191-193	benzene	$C_9H_{11}N_5O$	52.67	5.40	34.13	52.68	5.44	34.45
27j	42	214-216	methanol	$C_{10}H_9N_5O$	55.81	4.22	32.54	55.52	4.28	32.63
27l	30	176-178	benzene	$C_{10}H_{14}N_6$	55.03	6.47	38.51	54.77	6.52	38.11

(a) Chromatographed on silica gel first.
(b) Analytical m.p. 274-276.5°.
(c) Triturated with boiling ethanol.

Found: C, 62.08; H, 9.32; N, 18.42.

2-*t*-Butyl-4-hydroxymethyl-5-methylimidazole (**1f**).

This compound was prepared from *t*-butyl amidine hydrochloride by the method of **1e** giving a 30% yield of **1f** after recrystallization from 2-propanol, m.p. 195.5-196.5°.

Anal. Calcd. for $C_9H_{16}N_2O$: C, 64.25; H, 9.59; N, 16.65. Found: C, 64.42; H, 9.53; N, 16.63.

5-Methyl-2-propylimidazole-4-carboxaldehyde (**7e**) and 5,5'-(Oxydimethylene)bis[4-methyl-2-propylimidazole] (**6e**).

The 190.4 g. (1.026 mole) of crude, oily 5-methyl-2-propyl-4-hydroxymethylimidazole (**1e**) was oxidized with 144.3 ml. of concentrated nitric acid in two batches. In each batch, the acid and alcohol were mixed and gently heated on a steam bath in a 2 l. beaker until brown fumes started to come off. The heat was immediately turned off and a vigorous exothermic reaction ensued with a profuse evolution of brown gas. When the reaction had subsided, heat was reapplied until the brown fumes ceased. After cooling, the reaction was neutralized with aqueous concentrated sodium carbonate, then concentrated in vacuum. The residue was chromatographed on a silica gel column to give a major fraction, 62.1 g., of crystals and two minor fractions. Recrystallization of the major fraction from 2-butanone gave 51.99 g. (32% conversion over two steps) of product **7e**, m.p. 126-129°. A sample was recrystallized from acetone for analysis, m.p. 130.5-131.5°.

Anal. Calcd. for $C_8H_{12}N_2O$: C, 63.13; H, 7.95; N,18.41. Found: C, 62.77; H, 7.68; N, 18.42.

One of the minor fractions after recrystallization from acetone:2-propanol gave 16.0 g. (10%) of recovered starting material **1e**, m.p. 134-137.5°. The second minor fraction, after recrystallization from 2-propanol, consisted of 8.57 g., m.p. 195.5-199.5°, of the compound **6e**, detected by nmr in the starting material.

Anal. Calcd. for $C_{16}H_{26}N_4O$: C, 66.17; H, 9.02; N, 19.29. Found: C, 66.05; H, 9.12; N, 19.34.

Imidazole-4-carboxaldehyde Methyl Dithiocarbazone (**9a**).

After dissolving 17.78 g. (0.186 mole) of imidazole-4-carboxaldehyde (**7a**) (5) in 200 ml. of hot ethanol, a hot solution of 24.4 g. (0.20 mole) of methyl dithiocarbazinate (**8**) (7) in 50 ml. of ethanol was added. A precipitate formed rapidly and the mixture was heated and stirred for ~10 minutes more until it bumped too much to control. Cooling to 0° and collecting the precipitate gave 35.6 g. (96%) of yellow crystals, m.p. 198° dec. resolidified 259-261°. A sample was recrystallized for analysis, m.p. 254-257° dec. Analysis is shown in Table 2.

Imidazo[1,5-*d*]-*as*-triazine-4(3*H*)thione (**11a**).

A suspension of 164.5 g. (0.8225 mole) of imidazole-4-carboxaldehyde methyldithiocarbazone (**9a**) in 1.2 l. of diphenyl ether was heated and stirred at 175° until the methyl mercaptan evolution subsided (20 minutes). The precipitate obtained on cooling to room temperature was collected and washed with petroleum ether and acetone leaving 127.1 g., m.p. 265-268°. As the product was very insoluble in most solvents, it was boiled with 1.2 l. of methanol and filtered hot to give 110.9 g. of tan crystals, m.p. 271-273°. The filtrate gave an additional 5.15 g. (93%) of product, m.p. 266-269°, on partial evaporation; nmr: CH-1 (1H) δ 8.82 (s), NH-3 (1H) 14.0 (s), CH-6 (1H) 8.88 (s), CH-8 (1H) 7.88 (s). Analysis is shown in Table 3.

4-Methylthioimidazo[1,5-*d*]-*as*-triazine (**13**).

To a stirred suspension of 76.0 g. (0.50 mole) of imidazo-[1,5-*d*]-*as*-triazine-4(3*H*)thione (**11a**), in 385 ml. of methanol, under nitrogen, was added a freshly prepared solution of 11.5 g. (0.50 g. at.) of sodium in 155 ml. of methanol. The thione had partially dissolved when a new precipitate appeared. After the addition of base was completed, 31.2 ml. (71 g., 0.50 mole) of methyl iodide was added with vigorous stirring. A midly exothermic reaction occurred giving a black solution. After 0.5 hour, the solution was cooled to 0°. Collecting the precipitated product gave 60.0 g. (72%) of solid, m.p. 186-189°. A sample was recrystallized from methanol for analysis, m.p. 186-190°; nmr: CH-1 (1H) δ 8.59 (s), CH-6 (1H) 9.25 (s), CH-8 (1H) 7.88 (s), CH_3 (3H) 2.83 (s).

Anal. Calcd. for $C_6H_6N_4S$: C, 43.36; H, 3.64; N, 33.71; S, 19.29; Found: C, 43.06; H, 3.69; N, 33.64; S, 19.47.

5-Methylthioimidazo[1,2-*d*]-*as*-triazine (**26**).

This compound was prepared from imidazo[1,2-*d*]-*as*-triazine-5(6*H*)thione (**25**) by the method of **13** to give a 44% yield of **26**, m.p. 147-149°, from ethanol-methanol.

Anal. Calcd. for $C_6H_6N_4S$: C, 43.36; H, 3.64; N, 33.71; S, 19.29. Found: C, 43.71; H, 3.71; N, 33.34; S, 19.04.

4-*N*-Piperidinylimidazo[1,5-*d*]-*as*-triazine (**14g**).

A mixture of 8.30 g. (0.050 mole) of 4-methylthioimidazo-[1,5-*d*]-*as*-triazine, (**13**) and 25 ml. of piperidine was stirred and refluxed for 1.5 hours. The reaction was permitted to evaporate overnight and the residue chromatographed on a silica gel column. Recrystallization from chloroform-petroleum ether and again from 2-propanol gave 6.15 g. (60%) of product, m.p. 126.5-128°; nmr: CH-1 (1H) δ 8.53 (s), CH-6 (1H) 9.06 (s), CH-8 (1H) 7.80 (s), CH_2NCH_2(4H) 3.46 (m), $CH_2CH_2CH_2$ (6H) 1.72 (m). Analysis is shown in Table 4.

4-Methylaminoimidazo[1,5-*d*]-*as*-triazine (**15**).

A mixture of 0.96 g. (0.010 mole) of imidazole-4-carboxaldehyde (**7a**) 2.47 g. (0.10 mole) of 3,4-dimethylthiosemicarbazide hydroiodide (14) in 30 ml. of ethanol was stirred and refluxed for 0.5 hour. The reaction mixture was concentrated in vacuum and the residue dissolved in 40 ml. of methanol containing 0.54 g. (0.010 mole) of sodium methoxide. After reconcentrating the clear solution in vacuum, approximately 75 ml. of diphenyl ether was added. Upon heating at 240-260° methyl mercaptan was evolved. When the evolution had subsided (∿ 15 minutes), the mixture was cooled to room temperature giving a solid which was collected and washed with petroleum ether. Recrystallization from 25 ml. of water gave 0.60 g. (40%) of product, m.p. 261-266°, M^+ at m/e 149.

Anal. Calcd. for $C_6H_7N_5 \cdot 1/4H_2O$: C, 46.90; H, 4.92; N, 45.58. Found. C, 46.86; H, 4.65; N, 45.78.

4-Propylimidazo[1,5-*d*]-*as*-triazin-1(2*H*)one (**19**).

To a solution of 3.8 g. (0.03 mole) of 4-imidazolecarboxylic acid hydrazide (**18**) (15) in 150 ml. ethanol was added 30 ml. of trimethyl orthobutyrate (16) and the reaction mixture refluxed overnight. Evaporation of the mixture gave a white solid which was triturated with pet. ether and collected. To this intermediate was added 100 ml. diphenyl ether and the reaction heated for 15 minutes at 240-250°. After cooling to room temperature, petroleum ether was added and the precipitate collected, washed twice with hot petroleum ether, yielding 4.5 g. (84%) of white solid, m.p. 116-117°.

Anal. Calcd. for $C_8H_{10}N_4O$: C, 53.92; H, 5.66; N, 31.45. Found: C, 53.57; H, 5.65; N, 31.40.

5-Methylimidazo[1,2-*d*]-*as*-triazin-8(7*H*)one (**29**).

Prepared from 2-imidazolecarboxylic acid hydrazide (**28**) (17) and ethyl orthoacetate by the method of **19**. Upon recrystallization from methanol, a 51% yield, m.p. 332-335°, was obtained.

Anal. Calcd. for $C_6H_6N_4O$: C, 48.00; H, 4.03; N, 37.32. Found: C, 48.18; H, 4.20; N, 37.61.

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(1) For purposes of simplicity, the tautomerism of imidazole is ignored.

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