Reaction of 2-Dimethylaminomethylene-1,3-diones With Dinucleophiles. III. Synthesis of 5-Acylpyrimidines and 7,8-Dihydroquinazolin-5(6*H*)-ones

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The reaction of open-chain and cyclohexane *sym*-2-dimethylaminomethylene-1,3-diones with amidines and guanidine in refluxing ethanol gave, generally in good yields, a series of 5-acylpyrimidines and 7,8-dihydroquinazolin-5(6*H*)-ones, respectively. With formamidine (and in part acetamidine), 2-formylimino-1,3-diones were formed in general, as sole products or mixtures with the corresponding pyrimidines or dihydroquinazolinones.

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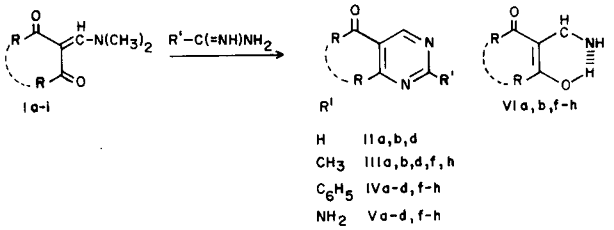
In the preceding papers of the series (1,2) we reported the facile reaction of *sym*-2-dimethylaminomethylene-1,3-diones Ia-i with *N-N* and *N-O* dinucleophiles such as hydrazines and hydroxylamine to give 1,5-disubstituted 4-acylpyrazoles and 5-substituted 4-acylisoxazoles, respectively.

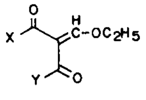
The great significance of pyrimidines (3) and to a lesser extent of quinazolines (4) as naturally occurring and biologically active substances is well known. On the other hand, a survey of the literature revealed the scarcity of methods to obtain substituted 5-acylpyrimidines (5) and 7,8-dihydroquinazolin-5(6*H*)-ones (6), these latter being very attractive for us as synthons for *N,N*-disubstituted α-aminomethyleneketones.

In the case of 5-acylpyrimidines, once more Claisen's 2-ethoxymethylene-1,3-diones VII were useful partners in the reaction with amidines or guanidines to afford the required compounds (7-11), whereas in the case of 7,8-dihydroquinazolin-5(6*H*)-ones the available synthons were 2-phenylaminomethylene-1,3-cyclohexanediones VIII (12,13), 2-hydroxymethylene- and 2-aminomethylene-1,3-cyclohexanedione (13).

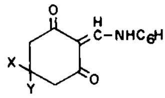
We now wish to report the reaction of synthons I with amidines and guanidine, namely dinucleophiles with *N-C-N* structure, as an useful method to obtain in a sole step substituted 5-acylpyrimidines IIa,b,d, IIIa,b,d, IVa-d, Va-d and 7,8-dihydroquinazolin-5(6*H*)-ones IIIf,h, IVf-h, Vf-h (Table I), whose structures were confirmed by uv, ir and nmr spectral data (Table II).

The reaction was carried out by simply refluxing an ethanol solution of both I and amidine or guanidine. Yields were generally good and in any case better than those reported in the literature, and were fair also in the case of strong steric hindrance (Ic). As other examples of the poor reactivity in the cyclization reactions of cyclopentane derivatives containing O=C(R)-C(R)=CH-NR$_2$ groups [*cf.* 1,2)], Ie did not react, whereas Ii gave IX in one instance, therefore no cyclized product (see Experimental).





VII



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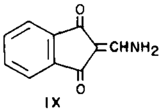
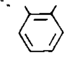


IX

R or R R
a $-CH_3$
b $-CH(CH_3)_2$
c $-C(CH_3)_3$
d $-C_6H_5$
e $-(CH_2)_2-$
f $-(CH_2)_3-$
g $-CH_2-C(CH_3)_2-CH_2-$
h $-CH_2-CH(C_6H_5)-CH_2-$
i

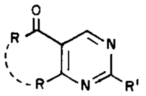


When formamidine (and in part acetamidine) was employed in the above reaction, 2-formylimino-1,3-diones VIa,b,f-h and 2-aminomethylene-1,3-indandione IX (Table III) were formed as sole products or as mixtures with the corresponding 5-acylpyrimidines or 7,8-dihydroquinazolin-5(6*H*)-ones.

Unlike *N*-monosubstituted and *N,N*-disubstituted 2-aminomethylene-1,3-diones, whose structure was unequivocally ascertained (14), compounds VI appear to be rather chelated enolic forms of 2-formylimino-1,3-diones, as resulted from the uv, ir and nmr spectral data (Table IV). They showed indeed in their nmr spectra two broad signals, which disappeared with deuterium oxide, at δ 6.5-8.5 and 10-10.5, attributable to NH and OH groups, respectively; the uv spectra presented two intense maxima at 247-259 and 280-294 nm, corresponding to two different

Table I

5-Acylpyrimidines IIa,b,d, IIIa,b,d, IVa-d, Va-d and 7,8-Dihydroquinazolin-5(6*H*)-ones IIIf,h, IVf-h, Vf-h



Compound No.	R or R⌒R	R'	Reflux time (hours)	Yield %	Bp °/mm or Mp, °C	Molecular Formula	Analyses % Calcd./Found C	H	N
IIa	$-CH_3$	H	1	28	105/6 (a)	$C_7H_8N_2O$	61.75 61.56	5.92 5.99	20.58 20.70
IIIa	$-CH_3$	CH_3	1	67	70/0.3 (b)	$C_8H_{10}N_2O$			
IVa	$-CH_3$	C_6H_5	1	68	103 (c)	$C_{13}H_{12}N_2O$			
Va	$-CH_3$	NH_2	1	95	229 (d)	$C_7H_9N_3O$			
IIb	$-CH(CH_3)_2$	H	1.5	41	80/0.5	$C_{11}H_{16}N_2O$	68.72 68.41	8.39 8.32	14.57 14.69
IIIb	$-CH(CH_3)_2$	CH_3	1.5	73	80/0.4	$C_{12}H_{18}N_2O$	69.87 69.88	8.80 8.90	13.58 13.60
IVb	$-CH(CH_3)_2$	C_6H_5	1	90	44 (e)	$C_{17}H_{20}N_2O$	76.08 75.89	7.51 7.52	10.44 10.54
Vb	$-CH(CH_3)_2$	NH_2	1.5	100	98 (f)	$C_{11}H_{17}N_3O$	63.74 63.70	8.27 8.27	20.27 20.25
IVc	$-C(CH_3)_3$	C_6H_5	24	45	155/0.6	$C_{19}H_{24}N_2O$	76.99 76.90	8.16 8.16	9.45 9.48
Vc	$-C(CH_3)_3$	NH_2	9	54	139 (f)	$C_{13}H_{21}N_3O$	66.35 66.61	9.00 9.06	17.86 17.80
IId	$-C_6H_5$	H	3	69	163/0.5	$C_{17}H_{12}N_2O$	78.44 78.33	4.65 4.77	10.76 10.52
IIId	$-C_6H_5$	CH_3	3	84	104 (e)	$C_{18}H_{14}N_2O$	78.81 79.00	5.14 5.10	10.21 10.10
IVd	$-C_6H_5$	C_6H_5	3	80	100 (f)	$C_{23}H_{16}N_2O$	82.12 81.91	4.79 4.80	8.33 8.36
Vd	$-C_6H_5$	NH_2	3	97	164 (g)	$C_{17}H_{13}N_3O$	74.16 73.92	4.76 4.72	15.26 15.43
IIIf	$-(CH_2)_3-$	CH_3	1	58	53 (h)	$C_9H_{10}N_2O$	66.65 66.39	6.22 6.47	17.27 17.19
IVf	$-(CH_2)_3-$	C_6H_5	1	61	125 (i)	$C_{14}H_{12}N_2O$	74.99 74.75	5.38 5.14	12.49 12.75
Vf	$-(CH_2)_3-$	NH_2	1.5	84	276 (ℓ)	$C_8H_9N_3O$	58.88 59.06	5.56 5.57	25.75 25.94
IVg	$-CH_2-C(CH_3)_2-CH_2-$	C_6H_5	7	54	124 (e)	$C_{16}H_{16}N_2O$	76.16 76.41	6.39 6.34	11.10 10.92
Vg	$-CH_2-C(CH_3)_2-CH_2-$	NH_2	1	64	235 (m)	$C_{10}H_{13}N_3O$	62.80 62.97	6.85 6.91	21.98 22.12
IIIh	$-CH_2-CHC_6H_5-CH_2-$	CH_3	1.5	63	123 (e)	$C_{15}H_{14}N_2O$	75.60 75.60	5.92 5.90	11.76 11.50
IVh	$-CH_2-CHC_6H_5-CH_2-$	C_6H_5	7	45	133 (e)	$C_{20}H_{16}N_2O$	79.98 79.80	5.37 5.28	9.33 9.51
Vh	$-CH_2-CHC_6H_5-CH_2-$	NH_2	1.5	63	234 (n)	$C_{14}H_{13}N_3O$	70.27 70.27	5.48 5.53	17.56 17.35

(a) A product erroneously described as 5-acetyl-4-methylpyrimidine (17) showed mp above 200° dec. (b) Ref (11) bp 90°/5, yield 62%. (c) From 95% ethanol; ref (7) mp 107°; ref (11) mp 105-107°, yield 66%. (d) From 95% ethanol, in sealed tube; ref (8) mp 227°, yield 80%; ref (11) mp 231°, yield 94%. (e) From diethyl ether. (f) From anhydrous diethyl ether, after chromatography on Florisil (diethyl ether). (g) From ethyl acetate; the product still contained one mole of ethyl acetate (elemental analysis and nmr spectral data) which was eliminated by drying *in vacuo*. (h) From anhydrous diethyl ether, after chromatography on Florisil (chloroform). In ref (13) it was isolated as the phenylhydrazone. (i) From ethyl acetate; ref (13) mp 125-126°. (ℓ) From dioxane; ref (13) mp 296-299°. (m) From 95% ethanol; ref (13) mp 240-241°. (n) From dioxane.

Table II

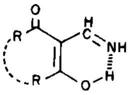
UV, IR and NMR Spectral Data of Compounds IIa,b,d, IIIa,b,d, IVa-d, Va-d, IIIf,h, IVf-h and Vf-h

	UV λ max nm (log ε)	IR, cm^{-1} (Chloroform)	NMR, δ (Deuteriochloroform)
IIa	224 (3.87) 299 (3.25)	1695, 1575, 1535, 1425	2.67 (s, CH$_3$—4), 2.78 (s, CH$_3$CO), 9.03 (s, CH—6), 9.17 (near s, CH—2)
IIIa	232.5 (4.00)	1695, 1580, 1532, 1430	2.66 (s, CH$_3$—4), 2.77 (s, CH$_3$—2 + CH$_3$CO), 8.95 (s, CH—6)
IVa	282.5 (4.36)	1690, 1570, 1525, 1425	2.63 (s, CH$_3$—4), 2.84 (s, CH$_3$CO), 7.35-7.65 (m, 2 H aryl *m* + 1 H aryl *p*), 8.4-8.7 (m, 2 H aryl *o*), 9.04 (near s, CH—6)
Va	271.5 (4.32)	3280, 3110, 1672, 1588, 1530, 1433 (a)	2.45 (s, CH$_3$—4), 2.50 (s, CH$_3$CO), 7.34 (broad s, NH$_2$; disappears with deuterium oxide), 8.78 (s, CH—6) (b)
IIb	219 (3.75) 249 sh (3.37) 282 (2.87)	1695, 1570, 1532, 1437	1.22 [d, J = 6.6, (C*H*$_3$)$_2$CH—4], 1.29 [d, J = 6.6, (C*H*$_3$)$_2$CHCO], 3.28 and 3.33 (2 H, J = 6.6, 2 CHMe$_2$), 8.77 (near s, CH—6), 9.22 (near s, CH—2)
IIIb	228.5 (3.88) 252 sh (3.56) 282 (2.78)	1695, 1582, 1538, 1435	1.20 [d, J = 6.6, (C*H*$_3$)$_2$CH—4], 1.27 [d, J = 6.6, (C*H*$_3$)$_2$CHCO], 2.75 (s, CH$_3$—2), 3.27 and 3.35 (2 h, J = 6.6, 2 CHMe$_2$), 8.69 (s, CH—6)
IVb	277.5 (4.35)	1695, 1567, 1520, 1430	1.23 [d, J = 6.6, (C*H*$_3$)$_2$CH—4], 1.38 [d, J = 6.6, (C*H*$_3$)$_2$CHCO], 3.34 and 3.52 (2 h, J = 6.6, 2 CHMe$_2$), 7.4-7.7 (m, 2 H aryl *m* + 1 H aryl *p*), 8.50-8.75 (m, 2 H aryl *o*), 8.89 (s, CH—6)
Vb	270.5 (4.24)	3530, 3430, 1677, 1605, 1580, 1525, 1415	1.19 [d, J = 6.6, (C*H*$_3$)$_2$CH—4, 1.22 [d, J = 6.6, (C*H*$_3$)$_2$CHCO], 3.45 (2 superimposed H, J = 6.6, 2 CHMe$_2$), 6.12 (broad s, NH$_2$; disappears with deuterium oxide), 8.58 (near s, CH—6)
IVc	268 (4.33)	1688, 1560, 1505, 1428	1.34 [s, (CH$_3$)$_3$C—4], 1.43 [s, (CH$_3$)$_3$CCO], 7.4-7.6 (m, 2 H aryl *m* + 1 H aryl *p*), 8.45-8.60 (m, 2 H aryl *o*), 8.62 (near s, CH—6)
Vc	224 (3.92) 262 (3.84) 294 sh (3.65)	3530, 3430, 1682, 1603, 1575, 1518, 1407	1.29 and 1.31 [2 s, (CH$_3$)$_3$C—4 + (CH$_3$)$_3$CCO], 5.55 (broad s, NH$_2$; disappears with deuterium oxide), 8.21 (near s, CH—6)
IId	258 (4.25) 277 sh (4.08)	1665, 1565, 1528, 1435	7.1-8.0 (m, 2 C$_6$H$_5$), 8.91 (s, CH—6), 9.45 (s, CH—2)
IIId	256.5 (4.26) 277 sh (4.11)	1660, 1565, 1527, 1432	2.90 (s, CH$_3$—2), 7.1-7.8 (m, 10 H aryl), 8.77 (s, CH—6)
IVd	266 (4.53)	1660, 1555, 1518, 1420	7.1-7.9 (m, 2H aryl *m* + 1 H aryl *p* + 2 C$_6$H$_5$), 8.50-8.85 (m, 2H aryl *o*), 8.95 (s, CH—6)
Vd	251 (4.37) 285 sh (4.09)	3540, 3425, 1652, 1568, 1525, 1445	6.30 (mc, NH$_2$; disappears with deuterium oxide), 7.1-7.9 (m, 10 H aryl), 8.55 (near s, CH—6)
IIIf	219 sh (3.76) 233 (3.92) 257 sh (3.64) 266 sh (3.49) 285 (2.75)	1695, 1580, 1555, 1435	2.1-2.5 (m, CH$_2$—7), 2.8 (s, CH$_3$—2), 2.6-2.9 (m, CH$_2$—8), 3.12 (t, J = 6, CH$_2$—6), 9.14 (s, CH—4)
IVf	290 (4.39)	1695, 1572, 1547, 1417	1.9-2.5 (m, CH$_2$—7), 2.72 (near t, J = 6, CH$_2$—8), 3.14 (t, J = 6, CH$_2$—6), 7.35-7.80 (m, 2 H aryl *m* + 1 H aryl *p*), 8.53 (mc, 2 H aryl *o*), 9.27 (s, CH—4)
Vf	274 (4.05)	3280, 3130, 1695, 1670, 1595, 1555, 1435, 1418 (a)	1.70-2.25 (m, CH$_2$—7), 2.51 (near t, J = 6, CH$_2$—8), 2.78 (t, J = 6, CH$_2$—6), 7.52 (broad s, NH$_2$; disappears with deuterium oxide), 8.67 (s, CH—4) (b)
IVg	292 (4.40)	1693, 1568, 1550, 1417	1.15 (s, 2 CH$_3$—7), 2.58 (near s, CH$_2$—8), 3.05 (near s, CH$_2$—6), 7.45-7.70 (m, 2 H aryl *m* + 1 H aryl *p*), 8.45-8.70 (m, 2 H aryl *o*), 9.29 (s, CH—4)
Vg	276 (4.29)	3310, 3160, 1675, 1583, 1553, 1435 (a)	1.01 (s, 2 CH$_3$—7), 2.40 (near s, CH$_2$—8), 2.69 (near s, CH$_2$—6), 7.53 (mc, NH$_2$; disappears with deuterium oxide), 8.65 (near s, CH—4) (b)
IIIh	238 (4.07) 255 sh (3.88) 294 (3.61)	1695, 1580, 1557, 1432	2.5-3.7 (m, CH$_2$—6 + CH$_2$—8 + CH—7), 2.76 (s, CH$_3$—2), 7.33 (mc, C$_6$H$_5$—7), 9.17 (near s, CH—4)
IVh	294 (4.41)	1692, 1570, 1545, 1417	2.8-3.7 (m, CH$_2$—6 + CH$_2$—8 + CH—7), 7.28 (mc, C$_6$H$_5$—7), 7.35-7.60 (m, 2 H aryl *m* + 1 H aryl *p*), 8.47 (mc, 2 H aryl *o*), 9.24 (s, CH—4)
Vh	276.5 (4.28)	3330, 3180, 1675, 1645, 1570, 1533, 1435 (a)	2.4-3.7 (m, CH$_2$—6 + CH$_2$—8 + CH—7), 7.30 (mc, C$_6$H$_5$—7), 7.56 (broad s, NH$_2$; disappears with deuterium oxide), 8.68 (s, CH—4) (b)

(a) In potassium bromide. (b) In DMSO-d$_6$.

Table III

2-Formylimino-1,3-diones VIa,b,f-h and Compound IX



Formula Number	R or $\overset{\frown}{R\quad R}$	Reflux time (hours)	Yield %	Mp °C	Molecular Formula	Analyses % Calcd./Found C	H	N
VIa	$-CH_3$	1	20	146 (a)	$C_6H_9NO_2$			
VIb	$-CH(CH_3)_2$	1.5	49	80 (b)	$C_{10}H_{17}NO_2$	65.54	9.35	7.64
						65.80	9.35	7.65
VIf	$-(CH_2)_3-$	1.5	71 (f)	110 (c)	$C_7H_9NO_2$	60.42	6.52	10.07
						60.59	6.51	10.09
VIg	$-CH_2-C(CH_3)_2-CH_2-$	1	75 (g)	135 (d)	$C_9H_{13}NO_2$	64.65	7.84	8.38
						64.68	7.68	8.24
VIh	$-CH_2-CH(C_6H_5)-CH_2-$	1.5	90 (h)	160 (d)	$C_{13}H_{13}NO_2$	72.54	6.09	6.51
						72.78	6.03	6.43
IX		3	70	225 (e)	$C_{10}H_7NO_2$	69.36	4.07	8.09
						69.29	4.08	8.08

(a) From ethyl acetate, ref (18,19) mp 144°; ref (20), mp 145-146°, ref (21) mp 142-144°. (b) From diethyl ether. (c) From ethyl acetate, ref (22) mp 110-111°. (d) From ethyl acetate. (e) From 95% ethanol, ref (23) mp 210°. (f) Yield 20% in the reaction with acetamidine, see Experimental. (g) Same yield in the reaction with acetamidine. (h) Yield 10% in the reaction with acetamidine.

Compounds VIg and IX have been prepared by reaction of ammonia with 2-hydroxymethylene-5,5-dimethylcyclohexane-1,3-dione and 2-ethoxymethylene-1,3-indandione, respectively (24,25).

Table IV

UV, IR and NMR Spectral Data of Compounds VIa,b,f-h and IX

	UV λ max nm (log ε)	IR, cm⁻¹ (Chloroform)	NMR, δ (Deuteriochloroform)
VIa	250.5 (4.14) 280 (4.15)	3340, 3220, 1620, 1505, 1400 (a)	2.28 (s, CH_3), 2.50 (s, CH_3), 6.58 (broad s, NH; disappears with deuterium oxide), 7.65-8.25 (m, CH=N; becomes a near s at δ 7.92 with deuterium oxide), 10.25 (broad s, OH; disappears with deuterium oxide)
VIb	259 (4.12) 280 (4.16)	3490, 3250 broad, 1632, 1468, 1393	1.07 [d, J = 6.6, $(CH_3)_2CHC=C$], 1.13 [d, J = 6.6 $(CH_3)_2CHCO$], 3.06 and 3.66 (2 h, J = 6.6, 2 $CHMe_2$), 6.5-7.3 (m, NH; disappears with deuterium oxide), 7.75-8.25 (m, CH=N; becomes a near s at δ 7.92 with deuterium oxide), 10.20 (broad s, OH; disappears with deuterium oxide)
VIf	247 (4.15) 294 (4.09)	3480, 3320, broad, 1674, 1604, 1472, 1412	1.75-2.25 (m, CH_2-5), 2.3-2.9 (m, CH_2-4 + CH_2-6), 8.26 (mc, CH=N; becomes a near s at δ 8.23 with deuterium oxide), 7.8-8.8 (m, NH; disappears with deuterium oxide), 10.60 (broad s, OH; disappears with deuterium oxide)
VIg	248 (4.16) 293 (4.15)	3485, 3320 broad, 1670, 1605, 1475, 1414	1.08 (s, 2 CH_3-5), 2.41 (mc, CH_2-4 + CH_2-6), 8.20 (mc, CH=N; becomes a near s at δ 8.20 with deuterium oxide), 7.90-8.55 (m, NH; disappears with deuterium oxide), 10.47 (broad s, OH; disappears with deuterium oxide)
VIh	248.5 (4.17) 294 (4.19)	3475, 3300 broad, 1667, 1602, 1472, 1408	2.69 and 2.80 (2 mc, CH_2-4 + CH_2-6), 3.1-3.6 (m, $CH-5$), 7.28 (mc, C_6H_5), 8.10 (mc, NH; disappears with deuterium oxide), 8.34 (mc, CH=N), 10.55 (broad s, OH; disappears with deuterium oxide)
IX	235 (4.43) 248 sh (4.22) 281 sh (4.21) 290 (4.44) 313 sh (4.28) 322.5 (4.34)	3340, 3230, 3170, 1695, 1640, 1548, 1422 (a)	7.73 (mc, 4 H aryl + =CH), 9.12 (broad s, NH_2; disappears with deuterium oxide) (b)

(a) In potassium bromide. (b) In DMSO-d_6.

conjugated chromophores, whereas the ir spectra, near the NH stretching at 3340 or 3480-3490 cm^{-1}, showed a broad absorption in the 3300-3200 cm^{-1} region, typical of a chelated hydroxy group. On the other hand, the reaction product of Ii with formamidine, showing a sole broad signal at δ 8.6-9.4, is best formulated as 2-aminomethylene-1,3-indandione IX. The formation of VI and IX is attributable to the heat decomposition of the amidine into the corresponding nitrile and ammonia (15) and to a subsequent transamination of the latter with the dimethylamino group of I. This decomposition is very marked in the case of formamidine, therefore formation of VI and IX was the sole reaction possible in some instances. Such transaminations are known in other cases (16), and we obtained VIa in high yield by treating with ammonia an ethanol solution of Ia.

In conclusion, this seems to be another useful way to employ synthons I in the synthesis of functionalized heterocycles such as pyrimidines and quinazolines.

EXPERIMENTAL

The uv spectra were measured in 95% ethanol with a Hitachi-Perkin-Elmer Model EPS-3T spectrophotometer. The ir spectra were taken on a Perkin-Elmer Model 398 spectrophotometer; the nmr spectra were recorded on a Perkin-Elmer Model R-12 instrument (60 MHz, TMS as internal standard, J in Hz). Melting points were determined with a Fisher-Johns apparatus.

General Procedure for 5-Acylpyrimidines IIa,b,d, IIIa,b,d, IVa-d, Va-d and 7,8-Dihydroquinazolin-5(6*H*)-ones IIIf,h, IVf-h, Vf-h.

To a solution of sodium ethoxide in ethanol, prepared from sodium (0.23 g, 10 mmoles) and anhydrous ethanol (25 ml), guanidine or amidine acetate (10 mmoles) was added at room temperature, followed by a solution of I (10 mmoles) in anhydrous ethanol (30-40 ml). In the case of benzamidine, the reaction was carried out by adding 85% benzamidine (1.41 g, 10 mmoles) to a solution of I (10 mmoles) in anhydrous ethanol (30-40 ml). The solution was refluxed for a certain time (see Table I), evaporated under reduced pressure and the residue was treated with water (150 ml). In the case of Va-d,f,h a crystalline precipitate separated, which was filtered and recrystallized. In all other cases, the resulting mixture was salted out with sodium chloride and extracted thoroughly with diethyl ether (IIa,b,d and IIIa,b,d) or chloroform (IIIf,h). The extracts were dried (sodium sulfate) and evaporated to give a residue which was purified by recrystallization from a suitable solvent or by distillation *in vacuo*.

Reactions of Ie were attempted only with benzamidine (reflux time 2 hours); we were unable to isolate any reaction product and starting compounds were recovered in 50-55% yield.

Reactions of Ii were attempted with formamidine, acetamidine, guanidine and benzamidine (reflux times 1.5-3 hours). With the exception of the reaction with formamidine, where compound IX was isolated in 70% yield (see later), in the case of acetamidine and guanidine a yellow solid, mp above 320°, was isolated by salting out the water solution obtained after the reaction. This solid was very soluble in water and did not contain nitrogen, therefore it was not further investigated. In the case of benzamidine, only intractable decomposition tars were obtained.

2-Formylimino-1,3-diones VIa,b,f-h and 2-Aminomethylene-1,3-indandione (IX).

When formamidine acetate was used in the above reaction, 2-formylimino-1,3-diones VIf-h and 2-aminomethylene derivative IX were formed as the sole products with cyclic synthons If-i (Tables III and IV). Compound IX separated from water, whereas compounds VIf,h were extracted with chloroform and VIg with diethyl ether.

The same reaction with open-chain synthons Ia,b (not attempted with Ic) gave mixtures of VIa, IIa and VIb, IIb, respectively. Anomalous results were also observed in the reaction of acetamidine acetate with If-h, where If,h afforded mixtures of VIf, IIIf and VIh, IIIh, respectively, whereas Ig gave only VIg (see Table III).

Separation of compounds from the above mixtures was reached as follows. When the reaction mixture was formed of a solid and a liquid (VIa, IIa and VIb, IIb), the latter was distilled *in vacuo* and the former was recrystallized from a suitable solvent; when both components were solid, separation was achieved by fractional crystallization (VIh, IIIh) or by chromatography on Florisil (chloroform) followed by recrystallization (VIf, IIIf).

Transamination with Ammonia of Ia to VIa.

An ice-cold solution of Ia (3.0 g, 19 mmoles) in anhydrous ethanol (100 ml) was saturated with gaseous ammonia for 0.5 hours. The solution was concentrated under reduced pressure and the precipitate (2.2 g, 91%) was recrystallized from ethyl acetate, mp 146°.

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