150. Sydnones as Masked Hydrazines for Heterocycle Formation: Reactions of 3-(2-Substituted Phenyl)sydnones with HCl

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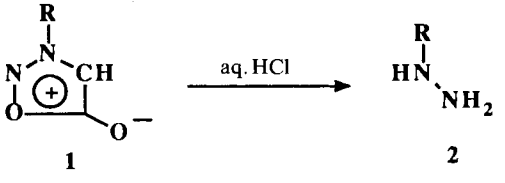
In general, reaction of 3-(2-substituted phenyl)sydnones with HCl gives products derived from cleavage of the sydnone ring to the corresponding hydrazine and subsequent cyclization to the side chain. In one case, 3-(2-aminophenyl)sydnone (**43**), the product obtained, 1-amino-1*H*-benzimidazole (**47**), apparently results from nucleophilic interception by the side chain prior to complete cleavage of the sydnone ring.

Introduction. – Sydnones **1** are known to cleave to hydrazines **2** with HCl [1] (*Scheme 1*). However, while intramolecular cyclization of *ortho*-substituted arylhydrazines is well known [2], to the best of our knowledge, the use of the sydnone ring as a 'masked' hydrazine for heterocycle formation has not been reported. Accordingly, it appeared of value to explore the utility of *ortho*-substituted arylsydnones for heterocycle formation.

Scheme 1



1 **2**

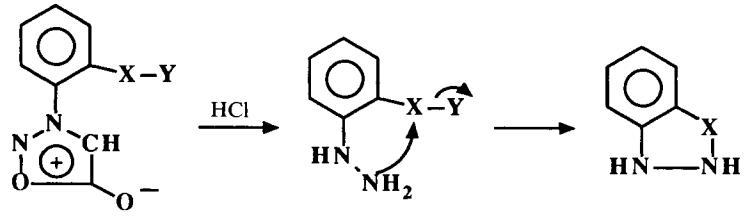
In this regard, the advantage is that sydnones are 'shelf-stable' precursors to often unstable hydrazines and, thus, the latter could be revealed when desired. Two possibilities were considered; *viz.* where the side chain is electrophilic (initial hydrazine formation should be followed by cyclization) (*Scheme 2, Path a*) or where it is nucleophilic (interception of an intermediate iminium ion **3** or *N*-formyl species **4** by the side chain should be possible; *Scheme 2, Path b*).

In addition, the possibility of nucleophilic interception of an intermediate iminium ion by the side chain (*Scheme 2, Path b*) rested solely on the proposed [1] intermediacy of iminium ion **3** during the acid-catalyzed cleavage of sydnones and had not been explored previously as a route to novel heterocycles.

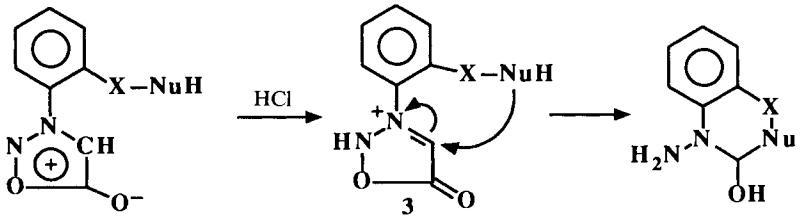
Results and Discussion. – To examine the possibility of the reactions shown in *Scheme 2*, it was decided to explore the utility of aldoxime **5** and benzoyl oxime **6** (*Scheme 3*). The aldoxime **5** was prepared in five steps from methyl anthranilate, as reported previously

Scheme 2

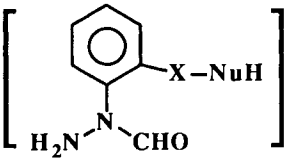
Path a: with an electrophilic side chain



Path b: with a nucleophilic side chain



or *via*



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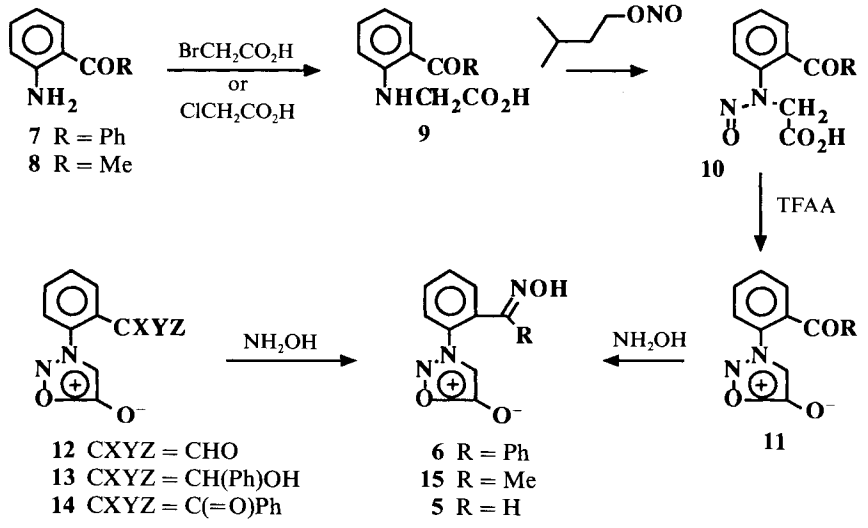
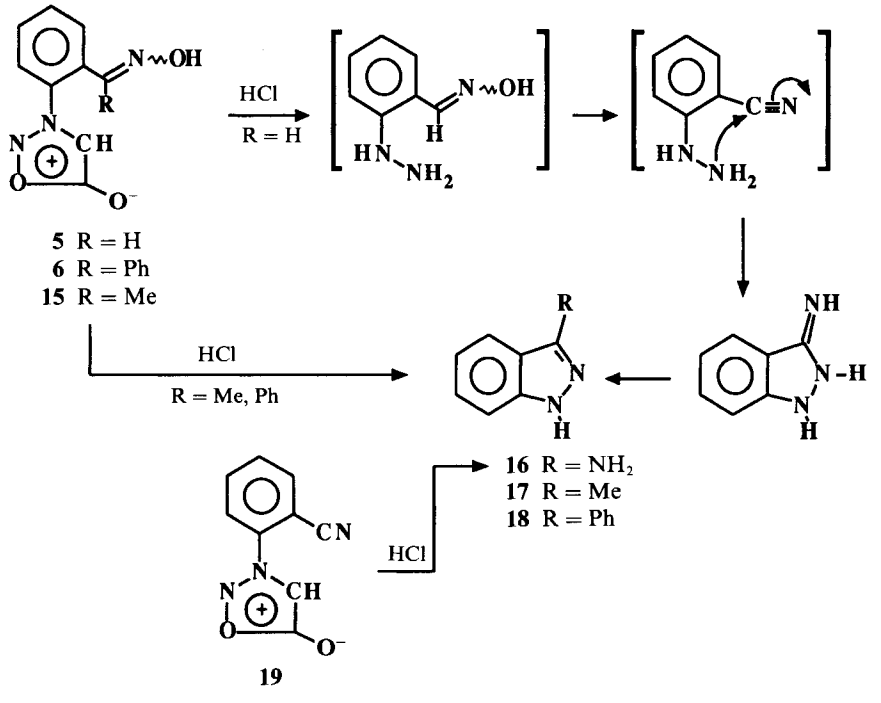
Scheme 3



[3]. The logical route to **6** was to use the standard sydnone build-up from commercially available *o*-aminobenzophenone (**7**); *viz.* reaction with $BrCH_2COOH$ to form the *N*-arylglycine [4], *N*-nitrosation with nitrous acid [5] or isoamyl nitrite [6], subsequent cyclization to the sydnone with trifluoroacetic anhydride (TFAA) [1c], and reaction with NH_2OH [3]. Unfortunately, all attempts to induce reaction between **7** and $BrCH_2COOH$ were unsuccessful, even under forcing conditions (refluxing DMF, 36 h). This was surprising, since the congeneric *o*-aminoacetophenone (**8**) reacted readily with $ClCH_2COOH$ (2 h at 130°) [3]. The failure of this approach necessitated a more convoluted synthetic route to **6**. Thus, the sydnone-carbaldehyde **12**, available in five steps from methyl anthranilate [3], was treated with PhMgBr to yield **13** in 31% yield which could be oxidized to ketone **14** (64%) with pyridinium dichromate (PDC) [7]. Subsequent oximation ($NH_2OH \cdot HCl$/pyridine) afforded the desired oxime **6** (72.5%) as a mixture of isomers (various crops and runs 1.15:1 to 25:1, presumably (*E*)/(*Z*)).

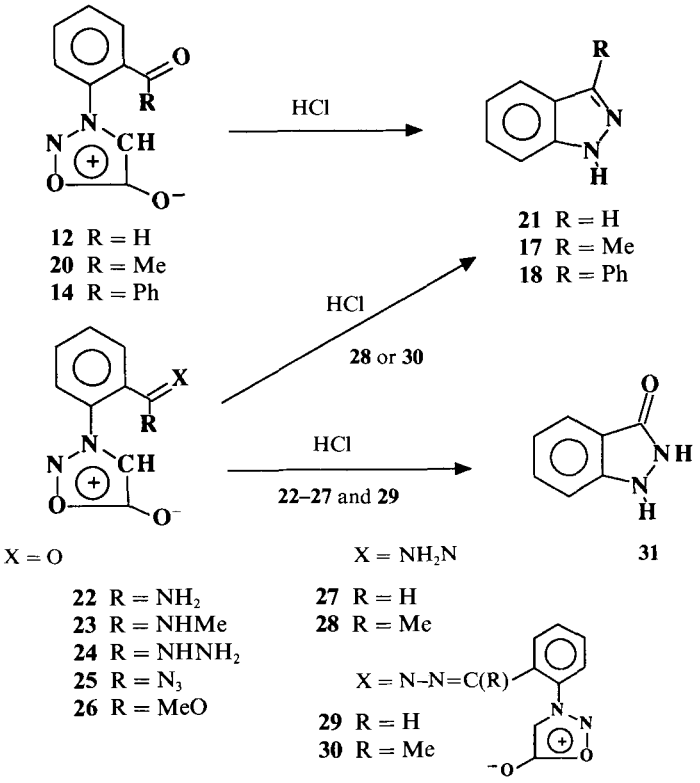
It was anticipated that treatment of the oximes **5**, **6**, **15** with HCl could lead to indazole derivatives *via* hydrazine formation/cyclization. Indeed, when aldoxime **6** was treated with concentrated HCl (followed by a basic workup), the aminoindazole **16** was formed in 28% yield. The mechanism presumably involves hydrazine formation, dehydration to the nitrile, and cyclization followed by tautomerization (*Scheme 4*). Since 3-(2-cyanophenyl)sydnone (**19**) [3] also forms **16** (in 39% yield) under the same conditions, its intermediacy in the acid hydrolysis of **5** appears reasonable.

Scheme 4



The ketoximes **15** and **6** (wherein conversion to the nitrile is precluded) formed the corresponding 3-substituted indazoles **17** and **18**, respectively, in 80% yield. Similarly, the sydnone aldehyde **12** and the ketones **20** and **14** gave indazoles **21**, **17**, **18** in 56%, 90%, 62% yield, respectively (*Scheme 5*). When R could be a leaving group, **22**–**26**

Scheme 5

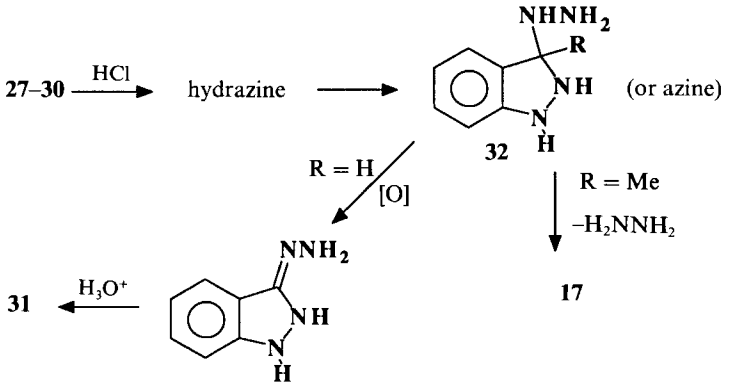


(R = NH_2 [8], NHMe [9], $NHNH_2$ [8], N_3 [8], MeO [8]), the indazolone **31** was isolated in good-to-excellent yield (61–96%). The same product **31** was obtained (in 50 and 96% yield, respectively) from the aldhydrazone **27** and corresponding azine **29**. In contrast, 3-methyl-1*H*-indazole (**17**) was derived (69 and 74%, respectively) from the ketohydrazone **28** and azine **30**. This difference in reactivity is presumably due to the availability of an alternative pathway for the aldehyde-derived species after initial hydrazine formation/cyclization (*Scheme 6*).

Thus, air oxidation of the intermediate hydrazine **32** may lead to a hydrazone which can be hydrolyzed to the indazolone **31**. However, without further work, it is unclear why this pathway would be chosen instead of aromatization to 3-hydrazinoindazole (*cf.* the imine to **16** tautomerization, *Scheme 4*). The ketohydrazone **28** (and azine) can form the cyclic intermediate **32** but therein expulsion of hydrazine only can occur.

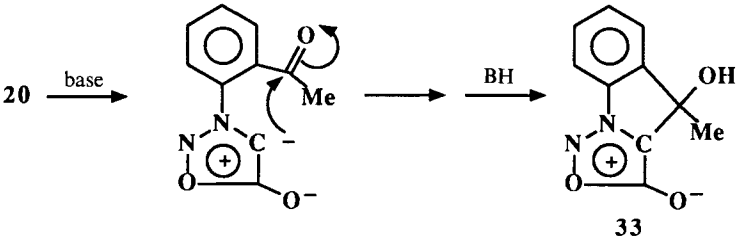
Interestingly, while the aldehyde-derived hydrazone **27** and azine **29** could be prepared easily [10], the preparation of the acetyl hydrazone **28** and azine **30** initially

Scheme 6



presented problems. Thus, treatment of **20** with hydrazine hydrate/Et_3N [10] gave mixtures of **28**, **30**, and a third sydnone which had not incorporated hydrazine (IR, NMR evidence). Conditions of concentration, temperature, and basicity conducive to the preparation of each compound alone were discovered (see *Exper. Part*), and the latter compound was shown to be a novel fused-ring sydnone **33**. It is probable that **33** is formed *via* abstraction of the sydnone ring proton (under unprecedentedly mild conditions) and subsequent cyclization (*Scheme 7*). Work is continuing in this area, and the reactivity of this unusual sydnone will be reported elsewhere.

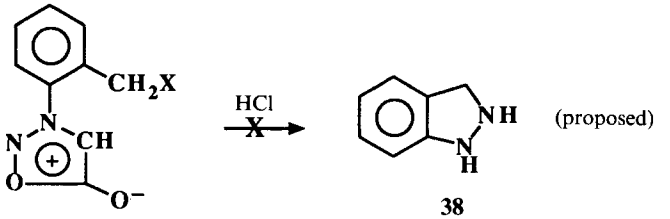
Scheme 7



It appeared likely that a saturated side chain with a leaving group, *cf.* **34**–**37**, would lead to an indazoline product **40** on HCl treatment (*Scheme 8*). Accordingly, the hydroxymethyl-, chloromethyl-, and azidomethyl-sydnones, **34**–**36**, respectively, were prepared as reported previously [3] [11]. The latter two could be converted to the aminomethyl-sydnone **37**. Thus, treatment of **35** with ammonia in a pressure vessel at 60° gave **37** in 78% yield. The azidomethyl species **36** could be reduced to the amine **37** in 84% yield *via Vaultier*'s mild, 'one-pot' iminophosphorane formation/hydrolysis process [12].

Disappointingly, an amorphous solid (apparently the same) was obtained from both **34** and **35** on treatment with HCl and subsequent basification. We suspect that this product may be an oligomer formed by hydrazine formation and subsequent intermolecular leaving-group displacement; however, its identity was not pursued further. A com-

Scheme 8

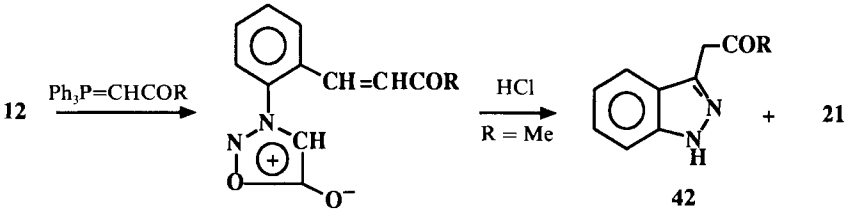


34 X = OH
35 X = Cl
36 X = N_3
37 X = NH_2

plex mixture was obtained from **36** and HCl. The corresponding hydrazine (dihydrochloride) could be obtained in 68% yield from **37** by HCl treatment, but upon basification an unstable product, presumably the amino hydrazine free base, resulted.

We now turned our attention to the possibility of heterocycle formation *via Michael* addition routes. Thus, 3-(2-formylphenyl)sydnone (**12**) was converted to the α,β-unsaturated aldehyde **39** (88%), ketone **40** (84%), and ester **41** (90%) *via* reaction with the corresponding *Wittig* reagents. Treatment of **39** and **41** with HCl gave extremely complex mixtures from which nothing could be isolated. The ketone **40**, in contrast, gave two major products **42** and **21** in 44% and 28% yield, respectively. The assignment of the

Scheme 9



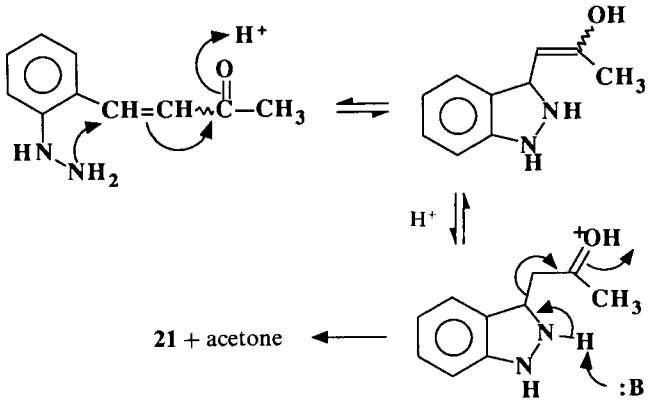
39 R = H
40 R = Me
41 R = MeO

former (presumably arising by *Michael* addition of the initially formed hydrazine and subsequent oxidation in air) is tentative, since it is an unstable oil for which a satisfactory microanalysis was not obtained. Its spectral data (IR, NMR) do strongly point to its identity as assigned.

The isolation of the parent indazole **21** was surprising and a possible mechanistic interpretation is shown in *Scheme 10*.

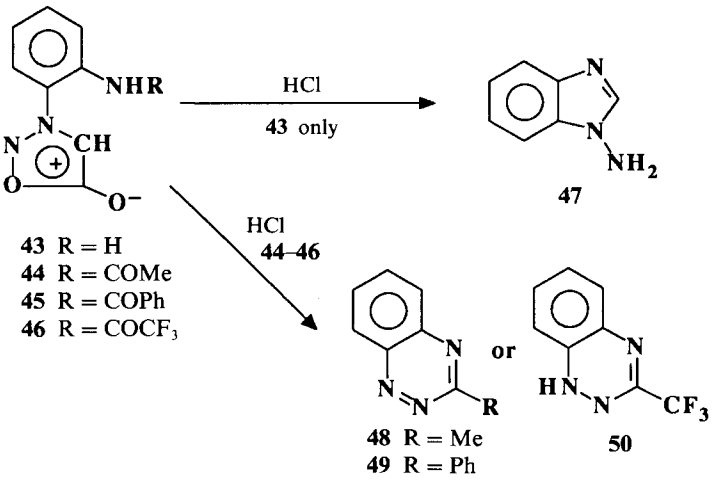
An exciting avenue for novel heterocycle formation was the possibility that an intermediate iminium ion or *N*-formyl species (after initial sydnone ring protonation with

Scheme 10



HCl) might be intercepted by a nucleophilic side chain (*Scheme 2, Path b*). Accordingly, we prepared 3-(2-aminophenyl)sydnone (**43**) [13] and derivatives **44**–**46** in order to test this premise. Gratifyingly, **43** reacted with HCl to give 1-amino-1*H*-benzimidazole (**47**) in 57% yield, apparently by attack of the NH_2 group upon an intermediate cation or *N*-formyl species (*Scheme 11*). While we have no experimental proof for the proposed mechanism, it is hard to envisage a satisfactory alternative. Somewhat surprisingly, the

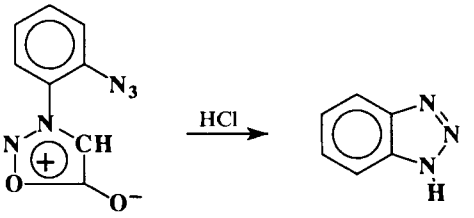
Scheme 11



amine **43** proved to be the only compound in this study which exhibited this interesting behavior. For example, the potentially nucleophilic amide derivatives **44** and **45** (prepared from **43** and Ac_2O or benzoyl chloride) gave low yields of the corresponding benzotriazines **48** and **49** (20% and 36%, respectively), presumably *via* hydrazine attack at the amide C=O group. Interestingly, the trifluoroacetamido species **46** gave **47** (14%)

and a compound tentatively identified as the dihydro-benzotriazine **50** (33%). The latter type of compound is presumed to be an intermediate in all of the amide examples, suffering oxidation in air to the fully aromatic species. Why **50** does not aromatize under the same conditions remains unclear.

Scheme 12



51 **52**

3-(2-Azidophenyl)sydnone (**51**) (derived from **43** and $NaNO_2/HN_3$) [14] gave benzotriazine **52** in 45% yield after HCl treatment (*Scheme 12*). Again, formation of **52** is best rationalized as involving initial hydrazine formation followed by acid-catalyzed cyclization/expulsion of N_2 and subsequent aromatization in air.

Overall, we have shown that *ortho*-substituted arylsydnones are effective precursors to various heterocycles *via* sydnone-ring hydrolysis and subsequent cyclization. It is planned to further explore the intriguing situation with 3-(2-aminophenyl)sydnone (**43**) (wherein complete cleavage of the sydnone ring did not occur and NH_2-group interception of an incipient cation instead took place) to include other nucleophilic side chains.

Experimental Part

General. M.p. (not corrected): *Electrothermal* apparatus, open capillaries. IR Spectra (ν [cm^{-1}]): *Perkin-Elmer 1330* and *1600* series (KBr). ^{1}H-NMR Spectra (δ [ppm] from TMS): *Varian EM360* (60 MHz) or *IBM NR/100* (100 MHz). Low-resolution MS (*m/z* [amu] (%base peak)): *Finnigan MAT INCOS 50* (EI, 70 eV). Elemental analyses were performed by Midwest Microlab, Indianapolis, Indiana.

Starting Materials. 3-(2-Acetylphenyl)sydnone oxime (**15**) [3], 3-(2-acetylphenyl)sydnone (**20**) [3], 3-{2-[1-(hydroximino)ethyl]phenyl}sydnone (**12**) [3], 3-{2-[(hydroximino)methyl]phenyl}sydnone (**5**) [3], 3-(2-cyanophenyl)sydnone (**19**) [3], 3-(2-carbamoylphenyl)sydnone (**22**) [8], 3-[2-(*N*-methylcarbamoyl)phenyl]sydnone (**23**) [9], 3-[2-(hydrazinocarbonyl)phenyl]sydnone (**24**) [8], 3-(2-azidocarbonylphenyl)sydnone (**25**) [8], 3-[2-(methoxycarbonyl)phenyl]sydnone (**26**) [8], 3-[2-(hydroxymethyl)phenyl]sydnone (**34**) [3], 3-[2-(chloromethyl)phenyl]-sydnone (**35**) [15], 3-[2-(azidomethyl)phenyl]sydnone (**36**) [9], 3-(2-aminophenyl)sydnone (**43**) [13], 3-(2-acetamidophenyl)sydnone (**44**) [16], 3-[2-(trifluoroacetamido)phenyl]sydnone (**46**) [16], and 3-(2-azidophenyl)sydnone (**51**) [11] were prepared by literature methods.

3-[2-(1-Hydroxybenzyl)phenyl]sydnone (**13**). To a stirred soln. of **12** (0.90 g, 4.71 mmol) in anh. THF (15 ml) at 0° was added PhMgBr (1.70 ml, 5.18 mmol, 3M in Et_2O) dropwise under N_2. After 0.5 h, the mixture was quenched with NH_4Cl (0.28 g, 5.18 mmol) in H_2O (40 ml) and extracted with CH_2Cl_2 (3 × 50 ml). The combined extracts were dried (Na_2SO_4) and evaporated. Column chromatography on silica gel (CH_2Cl_2 as eluant) afforded 0.39 g (31%) of **13** as a yellow oil. IR (film): 3375, 3150, 3060, 3020, 2900, 1750, 1600, 1500, 1450, 1365, 1185, 1050, 950, 770. ^{1}H-NMR ($CDCl_3$): 7.68–7.18 (*m*, 9 H); 6.25 (*s*, 1 H); 5.85 (*s*, 1 H); 4.05 (*s*, 1 H). MS: 269 ([M + 1]$^+$), 238 ([M − NO]$^+$), 210 ([M − [NO + CO]]$^+$), 180, 165, 132, 105, 91, 77, 51. Satisfactory microanalysis values were not obtained.

3-(2-Benzoylphenyl)sydnone (**14**). To a stirred soln. of **13** (14.80 g, 55.22 mmol) in CH_2Cl_2 (830 ml) was added pyridinium dichromate (29.80 g, 79.20 mmol) at r.t. After 2 days, the mixture was filtered and evaporated. Column chromatography on silica gel (CH_2Cl_2 as eluant) gave, after trituration with Et_2O/petroleum ether, 9.42 g (64%) of **14** as yellow microcrystals. M.p. 113–114°. IR (KBr): 3130, 3080, 3010, 1750, 1680, 1600, 1450, 1290, 950, 790. ^{1}H-NMR ($CDCl_3$): 7.78–7.53 (*m*, 9 H); 6.62 (*s*, 1 H). MS: 266 (M^+), 208 ([M – [NO + CO]]$^+$), 193, 179, 165, 152. Anal. calc. for $C_{15}H_{10}N_2O_3$: C 67.67, H 3.76, N 10.53; found: C 67.43, H 3.84, N 10.43.

3-[(Hydroximino)(phenyl)methyl]sydnone (**6**). To **14** (1.50 g, 5.64 mmol) in EtOH (22 ml) was added $NH_2OH \cdot HCl$ (1.13 g, 16.2 mmol) in pyridine (6 ml), and the mixture was heated at 100°. After 40 h, the mixture was evaporated, washed with H_2O (30 ml), and extracted with CH_2Cl_2 (3 × 30 ml). The combined extracts were dried (Na_2SO_4) and triturated with Et_2O (30 ml) to yield 1.15 g (72.5%) of **6** as an off-white, crystalline solid. Recrystallization from CH_2Cl_2/petroleum ether gave the title compound as a colourless solid. M.p. 164.5–166.5°. IR (KBr): 3400–3100, 3130, 3020, 1730, 1420, 1360, 940, 773, 690. ^{1}H-NMR ((D$_6$)DMSO): 11.70 (*s*, 1 H); 7.85–7.40 (*m*, 9 H); 7.20 (*s*, 1 H). Anal. calc. for $C_{15}H_{11}N_3O_3$: C 64.06, H 3.91, N 14.95; found: C 63.89, H 4.08, N 14.71.

3-[2-(Hydrazonomethyl)phenyl]sydnone (**27**). A mixture of **12** (0.50 g, 2.63 mmol), hydrazine hydrate (64%, 4 ml), Et_3N (4 ml), and abs. EtOH (8 ml) was heated for a few min on the steam bath. After cooling to r.t., the mixture was poured into H_2O (25 ml) and left overnight. The resultant crystals were collected by filtration and washed with Et_2O to yield **27** as a tan powder 0.38 g (71%). M.p. 116–118°. IR (KBr): 3425, 3275, 3150, 1753, 1435, 1343, 1070, 758, 722. ^{1}H-NMR ($CDCl_3$): 6.57 (*s*, 1 H); 7.50 (*m*, 4 H); 8.14 (*m*, 3 H). Anal. calc. for $C_9H_8N_4O_2$: C 52.94, H 3.92, N 27.45; found: C 52.64, H 3.84, N 27.52.

3-{{{{[2-(Sydnon-3-yl)phenyl]methylidene}hydrazono}methyl}phenyl}sydnone (**29**). a) Via **12**. To compound **12** (0.50 g, 2.63 mmol) was added a mixture of Et_3N (4 ml), hydrazine hydrate (64%, 4 ml), and abs. EtOH (4 ml). The soln. was warmed gently, then poured into H_2O (20 ml), and left overnight. The resultant solid was isolated by filtration and washed with hot MeOH (10 ml) to afford **29** as a yellow powder: 0.20 g (20%). M.p. 238–240°. IR (KBr): 3107, 3050, 1755, 844, 767. ^{1}H-NMR ((D$_6$)DMSO): 8.5–7.6 (*m*, 12 H, 2 CH(sydnone), 2 CH(azine), 8 arom. H). Anal. calc. for $C_{18}H_{12}N_6O_4$: C 57.45, H 3.19, N 22.34; found: C 57.45, H 3.24, N 22.24.

b) Via **12** *and Hydrazone* **27**. Compounds **12** (0.025 g, 0.132 mmol) and **27** (0.025 g, 0.117 mmol) were stirred together in EtOH (5 ml) at 25° for 15 min. The resulting solid was filtered to give a yellow powder: 0.030 g (68%); identical in all respects (IR, m.p.) to an authentic sample prepared as described above.

3-[2-(1-Hydrazonoethyl)phenyl]sydnone (**28**). A soln. of **20** (1.00 g, 4.90 mmol) in hot EtOH (40 ml) was added dropwise over 20 min to a stirred soln. of Et_3N (1 ml), hydrazine hydrate (3 ml), and EtOH (30 ml) at 60°. The mixture was refluxed for 1.5 h and cooled to r.t., then poured into H_2O (150 ml). The soln. was reduced to 40 ml and then extracted with CH_2Cl_2 (3 × 40 ml), and the combined extracts were separated and dried (Na_2SO_4). Evaporation *in vacuo* and recrystallization from CH_2Cl_2/petroleum ether afforded the title compound as off-white needles: 0.65 g (61%). M.p. 98–100°. IR (KBr): 3389, 3342, 3201, 3084, 1743, 944, 756. ^{1}H-NMR ($CDCl_3$): 1.95 (*s*, 3 H); 5.50 (*s*, 2 H); 6.50 (*s*, 1 H); 7.50–7.65 (*m*, 4 H). Anal. calc. for $C_{10}H_{10}N_4O_2$: C 55.00, H 4.59, N 25.09; found: C 54.85, H 4.48, N 25.45.

3-{2-{1-{1-{[2-(Sydnon-3-yl)phenyl]ethylidene}hydrazono}ethyl}phenyl}sydnone (**30**). Compounds **20** (0.033 g, 0.16 mmol) and **28** (0.035 g, 0.16 mmol) in EtOH (10 ml) and H_2SO_4 (1 drop) were stirred for 4 h at 60°. The yellow solid that resulted was collected by filtration to yield the title compound: 0.060 g (93%). M.p. 205–208°. IR (KBr): 3127, 1719, 1614, 1361, 761. ^{1}H-NMR ((D$_6$)DMSO): 1.99 (*s*, 6 H); 7.59 (*s*, 2 H); 7.64 (*s*, 8 H). Anal. calc. for $C_{20}H_{16}N_6O_4$: C 59.40, H 3.96, N 20.79; found: C 59.09, H 4.29, N 20.60.

*3,4-Dihydroxy-5-methyl-4*H*-[1,2,3]oxadiazolo[3,4-a]indol-10-ium Hydroxide Inner Salt* (**33**). a) Via **20** *and Hydrazine Hydrate*. Compound **20** (0.250 g, 1.23 mmol) was dissolved in hot EtOH (5 ml) and added dropwise to a hot soln. of hydrazine hydrate (64%, 2 ml) and Et_3N (1 ml). The mixture was heated at reflux for 1 h and poured into H_2O (10 ml). Reduction of volume under a stream of air caused the formation of colorless crystals which were collected by filtration to yield the title compound: 0.150 g (60%). M.p. 184–187°. IR (KBr): 3292, 2989, 1725, 1708, 1487, 1140, 941, 770, 734. ^{1}H-NMR ((D$_6$)DMSO): 1.87 (*s*, 3 H); 5.48 (*s*, 1 H); 7.70–7.87 (*m*, 4 H). MS: 205, 204 (M^+), 174 ([M – NO]$^+$), 146 (100%, [M – [NO + CO]]$^+$). Anal. calc. for $C_{10}H_8N_2O_3$: C 58.82, H 3.92, N 13.73; found: C 58.51, H 3.90, N 13.50.

b) Via **20** *and* $MeNH_2$. Compound **20** (0.500 g, 2.46 mmol) in MeOH (10 ml) and $MeNH_2$ (40%, 2 ml) was heated in a *Parr* bomb at 80° for 2 h. Evaporation of the soln. under a stream of air afforded crystals which were washed with i-PrOH to give colorless plates: 0.300 g (60%); identical (m.p., IR, NMR) to an authentic sample of **33** prepared as described above.

c) Via **20** *and* NH_3. Compound **20** (0.300 g, 1.47 mmol) in MeOH (10 ml) saturated with NH_3 was heated in a *Parr* bomb for 12 h at 80°. Evaporation under a stream of air afforded colorless plates: 0.175 g (58%); identical (m.p., IR, NMR) to an authentic sample of **33**.

3-[2-(Aminomethyl)phenyl]sydnone (**37**). a) Via *Reduction of* **36**. Compound **36** (4.0 g, 18.43 mmol) in THF (20 ml) and H_2O (0.829 g, 46.075 mmol) was stirred for 15 h. The THF was evaporated *in vacuo* and the resulting oil was dissolved in CH_2Cl_2 (50 ml) and extracted with 10% HCl (4 × 125 ml). The aq. layers were combined and basified with 20% NaOH. Extraction with CH_2Cl_2 (5 × 100 ml) and evaporation *in vacuo* afforded a tan solid. Recrystallization from CH_2Cl_2/petroleum ether gave **37** as white crystals: 2.95 g (84%). M.p. 77–78°. IR (KBr): 3400, 3325, 3110, 2880, 2940, 1750, 1450, 1365, 955, 775, 740. ^{1}H-NMR ($CDCl_3$): 1.5 (*s*, 2 H, exchanges with D_2O); 3.78 (*s*, 2 H); 6.82 (*s*, 1 H); 7.30–7.71 (*m*, 4 H). Anal. calc. for $C_9H_9N_3O_2$: C 56.54, H 4.71, N 21.99; found: C 56.37, H 4.69, N 21.80.

b) Via **35** *and* NH_3. Compound **35** (1.00 g, 4.75 mmol) was added to MeOH saturated with NH_3 gas (35 ml) and heated at 60° in a *Parr* bomb for 2 h. The mixture was poured into H_2O (40 ml) and extracted with CH_2Cl_2 (3 × 30 ml). The org. layer was dried (Na_2SO_4) and evaporated *in vacuo*. Recrystallization (CH_2Cl_2/petroleum ether) afforded colorless crystals: 0.71 g (78%); identical (m.p., TLC, IR) to an authentic sample of **37**.

3-[2-(2-Formylethenyl)phenyl]sydnone (**39**). A soln. of **12** (0.100 g, 0.526 mmol) and (formyl)(methylidene)-triphenylphosphorane (0.176 g, 0.577 mmol) in CH_2Cl_2 (20 ml) was stirred at r.t. for 1 h. The solvent was removed *in vacuo* and the residue recrystallized from hot EtOH to give the title compound as tan crystals: 0.100 g (88%). M.p. 146–147°. IR (KBr): 3120, 3025, 2750, 2840, 1765, 1675, 1140, 1115, 945, 770. ^{1}H-NMR ($CDCl_3$): 6.62 (*d*, 1 H); 6.88 (*s*, 1 H); 7.40 (*d*, 1 H); 7.12–8.01 (*m*, 4 H); 9.72 (*d*, 1 H). Anal. calc. for $C_{10}H_8N_2O_3$: C 61.11, H 3.70, N 12.96; found: C 61.05, H 3.64, N 12.72.

3-[2-(3-Oxobut-1-enyl)phenyl]sydnone (**40**). A soln. of **12** (0.400 g, 2.1 mmol) and (acetyl)(methylidene)triphenylphosphorane (0.675 g, 2.1 mmol) in CH_2Cl_2 (50 ml) was stirred at r.t. for 1 h. The solvent was evaporated *in vacuo* and the resultant solid recrystallized from hot EtOH to give the title compound as colorless crystals: 0.407 g (84%). M.p. 164–165°. IR (KBr): 3120, 2950, 1770, 1690, 1620, 1370, 1280, 980, 770, 740. ^{1}H-NMR ($CDCl_3$): 2.29 (*s*, 3 H); 6.65 (*d*, 1 H); 6.85 (*s*, 1 H); 7.76 (*d*, 1 H); 7.26–7.71 (*m*, 4 H). Anal. calc. for $C_{12}H_{10}N_2O_3$: C 62.61, H 4.35, N 12.17; found: C 62.44, H 4.02, N 12.07.

3-{2-[2-(Methoxycarbonyl)ethenyl]phenyl}sydnone (**41**). A soln. of **12** (0.50 g, 2.63 mmol) and methyl (triphenylphosphoranylidene)acetate (0.176 g, 2.63 mmol) in CH_2Cl_2 (50 ml) was stirred at r.t. for 20 min. The solvent was removed *in vacuo* and the residue recrystallized from hot EtOH to afford **41** as colorless crystals: 0.58 g (90%). M.p. 152–153°. IR (KBr): 3120, 3050, 2980, 1765, 1715, 1445, 1295, 775, 740. ^{1}H-NMR ((D_6)DMSO): 3.67 (*s*, 3 H); 6.30–8.01 (*m*, 7 H). Anal. calc. for $C_{12}H_{10}N_2O_4$: C 58.54, H 4.07, N 11.38; found: C 58.47, H 3.93, N 11.35.

3-(2-Benzamidophenyl)sydnone (**45**). To a stirred soln. of **43** (0.500 g, 2.82 mmol) in benzene (15 ml) and anh. pyridine (1.5 ml) was added benzoyl chloride (3 equiv., 8.46 mmol, 1.18 g) dropwise. The mixture was heated at 65° for 15 min. Basification to pH 9 with $NaHCO_3$ (sat. aq. soln.) caused precipitation of the product as a tan solid. Recrystallization from hot EtOH afforded **45** as colorless needles: 0.660 g (83%). M.p. 181–183°. IR (KBr): 3260, 3096, 1749, 1731, 1684, 1538, 1304. ^{1}H-NMR ((D_6)DMSO): 7.52–7.85 (*m*, 10 H); 10.53 (*s*, 1 H). Anal. calc. for $C_{15}H_{11}N_3O_3$: C 64.06, H 3.91, N 14.95; found: C 64.11, H 4.04, N 14.98.

Reactions with HCl. General Procedure. To the sydnone was added conc. HCl (1 ml/0.10 g sydnone) dropwise with swirling. If after the addition of the first drop, a vigorous reaction ensued, the mixture was cooled in ice during the addition of the remaining acid. In contrast, if no vigorous gas evolution was observed, the mixture was heated on the steam bath, until all bubbling had ceased. The reaction mixture was evaporated overnight at r.t. under a stream of air and then basified using sat. aq. $NaHCO_3$, until all bubbling ceased. Extraction with CH_2Cl_2 and evaporation *in vacuo* usually afforded the appropriate product(s). The exceptions were the indazolinone **31**, and indazoles **21**, **17**, **18** which were filtered from the basic aq. soln. without extraction. In many cases, column chromatography was necessary for the separation of multiple products and/or purification.

Reaction with 3-{2-[(Hydroxyimino)methyl]phenyl}sydnone (**5**). To **5** (0.300 g, 1.47 mmol) was added conc. HCl (3 ml), and a vigorous, exothermic reaction was observed. The usual workup afforded crystals: 0.055 g (28%); m.p. 150–151°, which were identical in all respects to an authentic sample of *3-amino-1H-indazole* (**16**) [17].

Reaction with **15**. To **15** (0.500 g, 2.28 mmol) was added conc. HCl (5 ml) at 0°. Following removal of the mixture from the ice-bath, a violent reaction occurred. The usual workup afforded a solid: 0.240 g (80%); m.p. 108–110°, which was recrystallized from hot H_2O and found to be identical (m.p., TLC, IR) to an authentic sample of *3-methyl-1H-indazole* (**17**) [18].

Reaction with **6**. To **6** (0.500 g, 1.78 mmol) was added conc. HCl (5 ml) at 0°. Removal of the mixture from the ice-bath initiated a reaction as seen by gas evolution. The usual workup afforded a solid, 0.275 g (80%); m.p.

108–112°, which was recrystallized from hot H_2O and found to be identical (m.p., TLC, IR) to an authentic sample of *3-phenyl-1H-indazole* (**18**) [19].

Reaction with **19**. To **19** (0.150 g, 0.802 mmol) was added conc. HCl (2 ml), and the mixture was heated (1 min). The usual workup afforded crystals which were filtered from Et_2O to yield **16**, 0.041 g (39%); m.p. 150–152°, identical (m.p., IR, NMR) to an authentic sample [17].

Reaction with **27**. To **27** (0.335 g, 1.64 mmol) was added conc. HCl (5 ml), and a vigorous reaction was observed. Evaporation, basification, and filtration afforded a solid, 0.110 g (50%); m.p. 215–220°, which was identical (m.p., IR) to an authentic sample of *2,3-dihydro-1H-indazolin-3-one* (**31**) [20].

Reaction with **29**. To **29** (0.150 g, 0.426 mmol) was added conc. HCl (3 ml), and the mixture was heated for 5 min. Evaporation, basification, and filtration afforded a solid, 0.055 g (96%); m.p. 220–225°, which was identical (m.p., IR) to an authentic sample of **31** [20].

Reaction with **28**. To **28** (0.300 g, 1.38 mmol) was added conc. HCl (3 ml). Evaporation, basification, and filtration afforded a solid: 0.170 g (94%). M.p. 104–106°. Recrystallization from hot H_2O afforded needles, 0.125 g (69%); m.p. 108–111°, identical (m.p., IR) to an authentic sample of **17** [18].

Reaction with **30**. To **30** (0.145 g, 0.359 mmol) was added conc. HCl (2 ml), and the mixture was heated for 1 min. Evaporation, basification, and filtration afforded a solid: 0.045 g (95%). M.p. 106–108°. Recrystallization from hot H_2O gave needles, 0.035 g (74%); m.p. 108–111°, identical (m.p., IR) to an authentic sample of **17** [18].

Reaction with **26**. To **26** (0.200 g, 0.910 mmol) was added conc. HCl (2 ml), and the mixture was heated for 30 min. Basification, during the usual workup, formed a precipitate which was filtered, washed with Et_2O (5 ml), dried, and recrystallized from hot EtOH to give colorless crystals, 0.095 g (78%); m.p. 232–235°, identical (m.p., IR, NMR, MS) to **31** [20].

Reaction with **22**. To **22** (0.160 g, 0.730 mmol) was added conc. HCl (3 ml), and the mixture was heated (5 min). Basification during the usual workup caused a precipitate to form which was filtered and washed with Et_2O to yield **31**, 0.080 g (82%); m.p. 230–234°, identical (m.p., IR, NMR) to an authentic sample [20].

Reaction with **23**. To **23** (0.175 g, 0.853 mmol) was added conc. HCl (2 ml) and a vigorous reaction ensued. The mixture was then warmed slightly for 1 min to ensure completion of the reaction. Basification during the usual workup caused precipitation of a solid which was collected by filtration and washed with Et_2O to yield **31**, 0.070 g (61%); m.p. 230–234°, identical (m.p., IR, NMR) to an authentic sample [20].

Reaction with **24**. To **24** (0.400 g, 1.83 mmol) was added conc. HCl (5 ml), and the mixture was heated for 5 min. Basification during the usual workup caused precipitation of a solid which was filtered and washed with Et_2O to yield **31**, 0.235 g (96%); m.p. 229–233°, identical (m.p., IR) to an authentic sample [20].

Reaction with **25**. To **25** (0.400 g, 1.74 mmol) was added conc. HCl (5 ml), and the mixture was heated (5 min). Following basification, the solid that formed was filtered and washed with Et_2O to yield **31**, 0.060 g (87%); m.p. 228–232°, identical (m.p., IR) to an authentic sample [20].

Reaction with **12**. To **12** (0.100 g, 0.526 mmol) was added conc. HCl (1 ml). Following a vigorous reaction, the mixture was heated an additional minute on the steam bath. The usual workup afforded a solid, 0.035 g (56%); m.p. 144–146°, which was identical (m.p., IR, NMR, MS) to *1H-indazole* (**21**) [21].

Reaction with **20**. To **20** (0.200 g, 0.980 mmol) was added conc. HCl (2 ml), and the mixture was heated (2 min). During the basification step in the usual workup, a precipitate formed which was removed by filtration, washed with cold H_2O (5 ml), and dried to yield an off-white solid. Recrystallization from hot H_2O afforded crystals, 0.117 g (90%); m.p. 110–111°, identical (m.p., TLC, IR) to authentic **17** [18].

Reaction with **14**. To **14** (0.080 g, 0.308 mmol) was added conc. HCl (1 ml), and the mixture was heated (5 min). The usual workup afforded a solid which was recrystallized from CH_2Cl_2/petroleum ether to give colorless crystals, 0.036 g (62%); m.p. 112–115°, identified (m.p., TLC, IR, NMR, MS) as **18** by comparison with an authentic sample [19].

Reaction with **40**. To **40** (0.450 g, 1.96 mmol) was added conc. HCl (5 ml), and the mixture was heated gently on the steam bath (30 min). The usual workup afforded an oil (0.300 g). Column chromatography using silica gel and eluting with CH_2Cl_2/acetone 20:1 afforded two products. The minor product eluted first and after evaporation *in vacuo* afforded a solid, 0.065 g (28%); m.p. 138–142°, which was identical (m.p., TLC, IR) to an authentic sample of **21**. Further elution afforded the major product, an oil (0.150 g) tentatively assigned as *3-(2-oxopropyl)-1H-indazole* (**42**). IR (KBr): 3309, 2948, 1714, 1622, 1499, 1349, 1163, 1075, 745. ^{1}H-NMR ($CDCl_3$): 2.16 (*s*, 3 H); 4.07 (*s*, 2 H); 7.09–7.63 (*m*, 4 H); 9.88 (*s*, 1 H). ^{13}C-NMR ($CDCl_3$): 205; 141; 140; 127; 122; 120; 119; 110; 42; 29. MS: 174 (M^+).

Reaction with **41**. To **41** (0.400 g, 1.63 mmol) was added conc. HCl (5 ml), and the mixture was heated (5 min). The usual workup afforded an oil (0.036 g) which was shown by TLC to be a complex mixture of products.

Reaction with **39**. To **39** (0.052 g, 0.241 mmol) was added conc. HCl (1 ml). The usual workup afforded almost nothing from repeated extraction with CH_2Cl_2 or hot EtOH.

Reaction with **34**. To **34** (0.200 g, 1.04 mmol) was added conc. HCl (2 ml), and the mixture was warmed for 1 min until bubbling ceased. Basification afforded a precipitate which was filtered to give an off-white solid: 0.160 g. M.p. 165–175°. IR (KBr): 3332, 3056, 2919, 1742, 1605, 1500, 1451, 1349, 833, 754. The compound formed is thought to be an oligomer.

Reaction with **35**. To **35** (0.300 g, 1.425 mmol) was added conc. HCl (5 ml), and the mixture was heated for 20 min in attempt to dissolve the sydnone. Evaporation and basification afforded a precipitate which was filtered to give an off-white solid (0.085 g), which was identical (m.p., IR) to the presumed oligomeric product from the reaction of **34** with HCl.

Reaction with **36**. To **36** (0.825 g, 4.32 mmol) was added conc. HCl (5 ml), and the mixture was warmed for 30 min, until bubbling had ceased. The usual workup afforded a black oil (0.095 g). Column chromatography proved the mixture to be mostly baseline material with a low yield of a mixture of two very closely running substances which were not isolated.

Reaction with **37**. To **37** (0.825 g, 4.32 mmol) was added conc. HCl (10 ml), and the mixture was warmed until bubbling ceased. During basification, a solid formed which was isolated, 0.400 g (68%). M.p. 248–250°. IR (KBr): 3220–2600, 1565, 1525, 1130, 760. MS: 137 (M^+). Anal. calc. for $C_7H_{13}N_3 \cdot 2\,HCl$: C 40.00, H 6.19, N 20.00; found: C 39.66, H 6.11, N 19.45. The data seem to fit well for the presumed dihydrochloride of *ortho*-(aminomethyl)-phenylhydrazine. Basification of the latter with sat. aq. $NaHCO_3$ and extraction with CH_2Cl_2 afforded an oil which was purified by column chromatography to give an unstable oil-solid, 0.220 g, which is thought to be the corresponding hydrazine. IR (CH_2Cl_2): 3373, 3228, 2981, 2910, 2858, 1592, 1468, 1247, 1133, 750.

Reaction with **43**. Compound **43** (0.200 g, 1.13 mmol) was reacted with conc. HCl (2 ml) and warmed slightly for 1 min. The usual workup afforded a solid, 0.085 g (57%); m.p. 147–150°, identical in all respects (TLC, IR, MS) to an authentic sample of *1-amino-1*H*-benzimidazole* (**47**) [22].

Reaction with **44**. To **44** (0.850 g, 3.88 mmol) was added conc. HCl (10 ml) dropwise in an ice-bath. The usual workup afforded an oil (0.326 g) which was eluted through a column of silica gel with CH_2Cl_2/acetone 20:1. The major product was collected as a bright yellow solid, 0.110 g (20%); m.p. 93–94°, which was found to be identical (m.p., IR, NMR, MS) to an authentic sample of *3-methyl-1,2,4-benzotriazine* (**48**) [23].

Reaction with **46**. To **46** (0.450 g, 1.63 mmol) was added conc. HCl (5 ml), and the mixture was warmed (1 min). The usual workup afforded a crude solid (0.170 g) which appeared to be a mixture of two compounds (TLC). The mixture was eluted through a column of silica gel with CH_2Cl_2/acetone 20:1. The major product was collected first as colorless flakes, 0.105 g (33%); m.p. 175–178°, tentatively identified as *1,2-dihydro-3-(trifluoromethyl)-1,2,4-benzotriazine* (**50**). IR (KBr): 3342, 3198, 1522, 1265, 1157, 750. MS: 201 (M^+), 184, 132, 105, 90, 77, 69, 63. Anal. calc. for $C_8H_6F_3N_3$: C 47.76, H 2.99, N 20.90; found: C 47.82, H 2.96, N 20.76.

Further elution afforded a minor product, 0.030 g (14%); m.p. 147–149°, which was found to be identical (m.p., TLC, IR) to an authentic sample of **47** [22].

Reaction with **45**. To **45** (0.370 g, 1.32 mmol) was added conc. HCl (5 ml) in an ice-bath. Upon sitting at r.t. (15 min), the reaction proceeded with bubbling. The usual workup afforded an oil (0.286 g). Column chromatography (silica gel) using CH_2Cl_2/acetone 20:1 as eluant afforded a major product which was recrystallized from benzene/petroleum ether to afford yellow crystals (0.0975 g, 36%, m.p. 120–121°). The product was identical (IR, NMR, MS) to an authentic sample of *3-phenyl-1,2,4-benzotriazine* (**49**) [24].

Reaction with **51**. To **51** (0.175 g, 0.862 mmol) was added conc. HCl (2 ml), and the mixture was heated, until bubbling ceased (5 min). The usual workup afforded an oil (0.090 g) which was eluted through a column of silica gel with CH_2Cl_2/acetone 20:1. The major product was collected as an off-white solid, 0.045 g (45%); m.p. 89–90°, and identified (m.p., TLC, IR) as *benzotriazole* (**52**) by comparison with an authentic sample [25].

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