$CH_3)^+$, 4], 73 (100); HR-CIMS, calcd for $C_{18}H_{27}NO_4{}^{35}ClSi$ 384.1325, found 384.1381.

Anal. Calcd for $C_{18}H_{26}NO_4ClSi$: C, 56.31; H, 6.86; N, 3.65. Found: C, 56.29; H, 6.86; N, 3.69.

To a solution of **30** (4.01 g, 10.6 mmol) in 50 mL of distilled CH_2Cl_2 was added iodotrimethylsilane (3.1 mL, 22 mmol). The mixture was heated under reflux for 3 h, and after cooling CH_3OH (50 mL) was added. The solvent was removed and the residue in CH_2Cl_2 was washed with 10% aqueous Na_2SO_3. The white precipitate (944 mg) which separated from the CH_2Cl_2 displayed properties consistent with the carbamic acid structure **34**: mp 127 °C; IR (KBr) 1705 cm^{-1} (CO); EIMS, m/z 297 and 299 ($M^{+\cdot}$), 253 $(M - CO_2)^{+\cdot}$, 235 $(M - CO_2 - H_2O)^{+\cdot}$, 225 $(M - CO_2 - CO)^{+\cdot}$. The CH_2Cl_2 filtrate obtained after removal of the precipitate was washed with 10% $KHCO_3$ and water, dried over Na_2SO_4, filtered, and concentrated to give an oily residue (1.86 g). Column chromatography of the oil on 40 g of silica gel (Silicar 7, Mallinckrodt, 5% CH_3CN/CH_2Cl_2) gave 523 mg of a solid which, following two recrystallizations from THF/hexane and isopropyl alcohol, yielded 394 mg (14.7%) of (*E*)-6-hydroxyketamine (**3**) as colorless crystals: mp 114–115 °C; ^1H NMR ($CDCl_3$) δ 7.1–7.5 (nm, 4 H, Ar H), 4.5–4.85 (nq, 1 H, methine H), 4.15 (bs, exchanges with D_2O, OH), 2.12 (s, 3 H, NCH_3); IR (KBr) 1705 cm^{-1} (CO); EIMS, m/z (relative intensity) 253 and 255 ($M^{+\cdot}$, 2), 235 $[(M - H_2O)^{+\cdot}$, 2], 225 $[(M - CO)^{+\cdot}$, 145], 180 (100), 152 (90).

Anal. Calcd for $C_{13}H_{16}NO_2Cl$: C, 61.52; H, 6.36; N, 5.54. Found: C, 61.44; H, 6.35; N, 5.20.

Acknowledgment. We are indebted to W. N. Howald and K. P. Castagnoli for assistance with the mass spectrometry and to the American Federation for Pharmaceutical Education, H. A. B. Dunning Memorial Fellowship awarded to T. W. The VG70-70H mass spectrometer was purchased through NIH Biomedical Research Development Grant RR 09082. This research was supported by NIH Research Grants No. NS 17956 and AG-03104.

Registry No. **1**, 6740-88-1; **2**, 91003-16-6; **3**, 91003-25-7; **4**, 91003-09-7; **5**, 91003-10-0; **6**, 91003-11-1; **7**, 91003-12-2; **10**, 91003-13-3; **13**, 91003-15-5; **14**, 91003-17-7; **15**, 91003-14-4; **20**, 91003-18-8; **23**, 91032-21-2; **24**, 91003-27-9; **25**, 91003-20-2; **26**, 91003-19-9; **27**, 91003-21-3; **28**, 91003-22-4; **29**, 91003-23-5; **30**, 91003-26-8; **32**, 91003-24-6; benzyl chloroformate, 501-53-1; methyl chloroformate, 79-22-1.

Thermolysis of 3-Bromo-1-nitro-1*H*-indazoles in Benzene and Toluene. Formation of 1-Phenyl-1*H*-indazoles[1]

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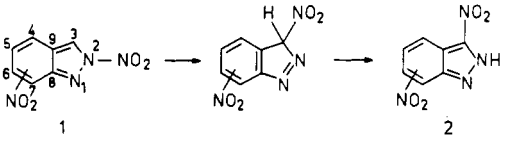
Thermolysis of the 3-bromo-1-nitro-1*H*-indazoles **5a,b** in refluxing benzene results in the evolution of bromine and NO_2 affording the 3-bromo-1*H*-indazoles **6a,b**, the dinitro-1*H*-indazoles **2a,b**, and the 1-phenyl-1*H*-indazoles **7a,b** and **8a,b**. In refluxing toluene only **6a,b** and **2a,b** are formed in addition to benzyl bromide. The structure assignments, particularly the assignment of the 1-position for the phenyl group in **7a,b** and **8a,b**, are based on ^{13}C NMR spectra. Possible mechanisms are presented for the loss of bromine and NO_2 and for the N-phenylation reaction found to occur in refluxing benzene.

The first paper in the literature reporting nitration on the nitrogen atom of indazoles[3] described the synthesis of a number of 2-nitro-2*H*-indazoles **1a–d** and their thermal rearrangement to the 3-nitro-2*H*-indazoles **2a–d** which presumably occur via an initial migration of the nitro group to the adjacent carbon atom[4] (see Scheme I). Since then,

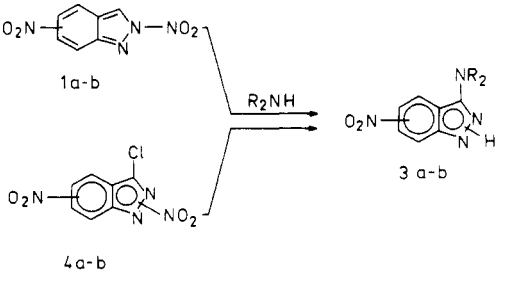
Scheme I



1 2

a, 5-NO_2; b, 6-NO_2; c, 4-NO_2; d, 7-NO_2

Scheme II



1a-b 3 a-b 4a-b

it has been shown that high yields of 3-nitro-substituted indazoles can be obtained in this way.[6,7] Moreover,

(1) Part 4 of our Indazoles Studies. For part 3 see ref 2.

(2) Waalwijk, P. S.; Cohen-Fernandes, P.; Habraken, C. L. *J. Org. Chem.*, submitted for publication.

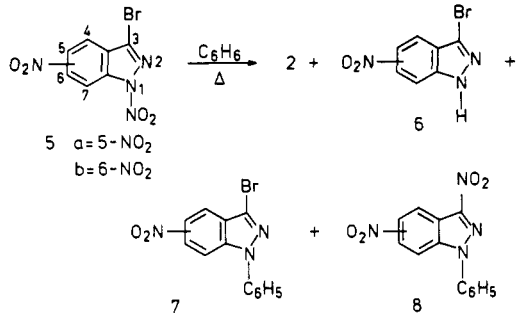
(3) Cohen-Fernandes, P.; Habraken, C. L. *J. Org. Chem.* **1971**, *36*, 3084–3086.

(4) (a) When indazole has an unsubstituted NH group there is the possibility of tautomerism and to our knowledge 1*H*- and 2*H*-tautomers have never been isolated as separate compounds, although they may enter chemical reactions predominantly in one form. An indication that the exchange of the NH proton is so fast that the "tautomeric mixture" behaves magnetically as a single compound is evident from the proton magnetic resonance spectra of these indazoles exhibiting a one-proton signal for H-3. For indazoles designated either as 1*H*- or 2*H*-indazoles the existence and therefor the participation in reactions of the other tautomer is understood. (b) Mechanistic Studies of the analogous thermal rearrangement of 1-nitropyrazoles to 3(5)-nitropyrazoles have established that all experimental data are compatible with a rate-determining 1,5-shift of the NO_2 group to give the 3*H*-pyrazole as an intermediate, which subsequently isomerizes to the 3(5)-nitropyrazole.[5] Consequently, now we assume for the thermal isomerization of 2-nitro-2*H*-indazoles that we are dealing with an identical case, i.e., an initial rearrangement to 3*H*-indazole followed by a fast 1,5-H shift to 3-nitro-2*H*-indazole as depicted in Scheme I.

(5) Janssen, J. W. A. M.; Habraken, C. L.; Louw, R. *J. Org. Chem.* **1976**, *41*, 1758–1762 and earlier publications cited therein.

0022-3263/84/1949-3310$01.50/0

Scheme III



Pevzner et al.[6] described the synthesis of tri- and tetranitroindazoles with a nitro group in the 2-position.

Recently, Wrzeciono et al. reported the reactions of 2,5- and 2,6-dinitro-2*H*-indazole (**1a** and **1b**) with secondary amines to give 3-di-R-amino-substituted indazoles[7,8] **3a,b** (Scheme II). Particularly with cyclic amines good yields were obtained. As they pointed out, it is remarkable that for 2,5-dinitro-2*H*-indazole (**1a**) the latter reaction, although performed at low temperature, was accompanied by rearrangement to 3,5-dinitro-2*H*-indazole (**2a**). In an earlier publication[10] these investigators reported that **3a,b** were obtained also, albeit in very low yield, from the reaction of secondary amines with the 3-chloroindazoles **4a,b**, which were considered to be 2-nitro-2*H*-indazoles (see Scheme II), and that this reacton was accompanied by vigorous evolution of gases. However, we doubt that **4a,b** really are 2-nitro-2*H*-indazoles as assigned by these authors. The final step of the synthesis of **4a,b** is a nitration on nitrogen which in principle might afford a mixture of the two isomeric 1-nitro-1*H* and 2-nitro-2*H* derivatives. In each case only one of the two possible isomers was obtained. From the ^{1}H NMR spectra it could not be decided whether the nitro group is located in the 1- or the 2-position and therefore a tentative assignment was based on chemical arguments.[10] Since then, we have shown that for the analogous 3-bromoindazoles nitration on nitrogen takes place exclusively in the 1-position.[11] This finding, we believe, indicates that for the 3-chloroindazoles the 1-position also is the preferred location of nitration on nitrogen and that the reactivities reported of **4a,b** are typical of 3-halogeno-1-nitro-1*H*-indazoles.

In this paper we report the results of the thermolysis reactions of the 3-bromo-1-nitro-1*H*-indazoles **5a** and **5b** in benzene and toluene solution.

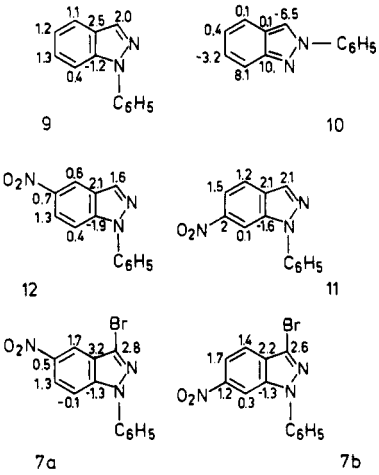
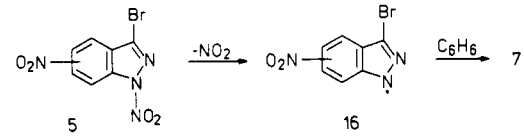


Figure 1. Substituent effects of the *N*-phenyl group[2] for indazoles.[11-13] Negative signs denote upfield shifts.

Scheme IV



Results and Discussion

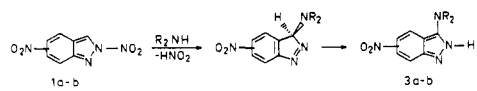
Heating **5a** in refluxing benzene solution was accompanied by the evolution of brown fumes in the condenser and after four days no **5a** was found to be present. The products obtained from this thermolysis reaction mixture are **2a**, 3-bromo-5-nitro-1*H*-indazole (**6a**), and the 1-phenyl-1*H*-indazoles **7a** and **8a**. Similarly, the thermolysis of **5b** in benzene afforded **2b**, 3-bromo-6-nitro-1*H*-indazole (**6b**), and the 1-phenyl-1*H*-indazoles **7b** and **8b** (Scheme III). In toluene solution however, the thermolysis of **5a** and **5b** gave entirely different results. Only 24 h were needed for the conversion of all 1-nitro-1*H*-indazole instead of the four days of the reaction in refluxing benzene. In addition a quite substantial amount of benzyl bromide was formed. No arylation was observed and the indazoles obtained from **5a** and **5b** in each case were the corresponding dinitroindazoles **2a** and **2b** and the 3-bromo derivatives **6a** and **6b**, respectively (see Table I). For benzene the fumes in the condenser during the thermolysis showed positive tests for the presence of both NO_2 as well as for bromine. But in the thermolysis in toluene only NO_2 could be detected in the condenser. GC analysis of the reaction mixtures indicated that traces of bromobenzene were present in the reaction of the thermolysis in benzene (Table I).

The assignment of the phenyl group in **7a,b** and in **8a,b** to the 1-position in all four molecules was based on their ^{13}C NMR spectra. Substitution on nitrogen of indazoles has been shown previously to result in an upfield shift for the carbon in the five-membered ring adjacent to the pyrrolic N and a downfield shift for the carbon adjacent to the pyridine N.[2,11] In Table II the ^{13}C chemical shift data of **7a,b**, **8a,b** and reference compounds **9**, **10**, and **11** are collected. The observed ^{13}C resonances for the C-3 and the C-8 are in complete agreement with the substituent effect of the phenyl group[2,11,12] in the 1-position and therefore it can be concluded that in **7a,b** and **8a,b** the phenyl group is located on N-1 (Figure 1).

(6) Pevzner, M. S.; Gladkova, N. V.; Lopukhova, G. A.; Bedin, M. P.; Dolmatov, V. Yu. *Zh. Org. Khim.* **1977**, *13*, 1300–1305.

(7) (a) Wrzeciono, U.; Linkowska, E.; Latawiec-Doros, S. J.; Kosno, T. W. *Pharmazie* **1983**, *38*, 85–88. (b) Wrzeciono, U.; Linkowska, E.; Jankowiak, D. *Ibid.* **1981**, *36*, 673–677. (c) Wrzeciono, U.; Linkowska, E. *Ibid.* **1980**, *35*, 593–596.

(8) This reaction resembles the cine nucleophilic substitution reaction of 1,4-dinitropyrazoles.[9] In that reaction the nucleophile enters the ring ortho to the position of the leaving group resulting in a 3*H*-pyrazole. The ultimate product is then formed in a subsequent fast 1,5-hydrogen shift. Similarly, in the reaction of 2,5- and 2,6-dinitroindazole with cyclic amines, the first step could be the formation of a 3*H*-indazole followed by rearrangement to the product obtained:[4a]



(9) (a) Berbee, R. P. M.; Habraken, C. L. *J. Heterocycl Chem.* **1981**, *18*, 559–560. (b) Cohen-Fernandes, P.; Erkelens, C.; Eendenburg, C. C. M. van; Verhoeven, J. J.; Habraken, C. L. *J. Org. Chem.* **1979**, *44*, 4156–4160. (c) Habraken, C. L.; Poels, E. K. *Ibid.* **1977**, *42*, 2893–2895.

(10) Wrzeciono, U.; Linkowska, E.; Felińska, W. *Pharmazie* **1978**, *33*, 419–424.

(11) Cohen-Fernandes, P.; Erkelens, C.; Habraken, C. L. *Org. Magn. Reson.* **1982**, *19*, 225–227.

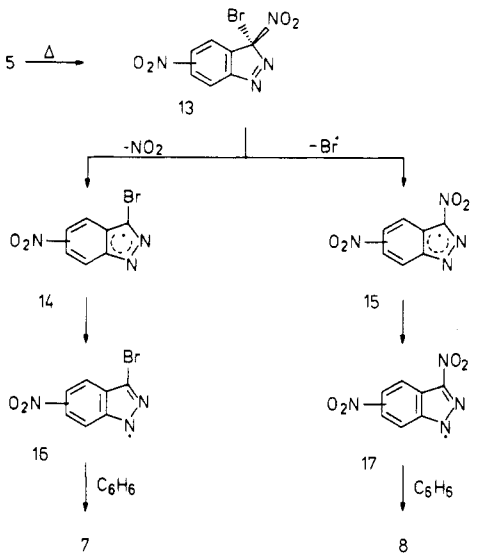
(12) Elguero, J.; Fruchier, A.; Carmen Pardo, M. del *Can. J. Chem.* **1976**, *54*, 1329–1331.

Table I. Products of Thermolysis of 5a and 5b in Refluxing Benzene (4 days) and in Toluene (1 day)[a]

substrate	solvent	product			C_6H_5Br[b]	$C_6H_5CH_2Br$[b]	NO_2[c]	Br_2[c]
5a	C_6H_6	7a, 27%	8a, 7%	6a, 23%	2a, 19%	<1%	+	+
	$C_6H_5CH_3$			6a and 2a, 28%		52%	+	−
5b	C_6H_6	7b, 26%	8b, 10%	6b, 34%	2b, 39%	<1%	+	+
	$C_6H_5CH_3$			6b, 33%	2b, 45%	49%	+	+

[a] Percentages give the maximum yield obtained in one of several thermolysis experiments. For experimental details of thermolysis and workup procedures see Experimental Section. [b] Estimated by GLC in the crude reaction mixture. [c] Identified in the fumes in the condenser in the first few hours after the beginning of the reaction.[20,21]

Scheme V



The products, particularly the 1-phenyl-1*H*-indazoles **7a,b** and **8a,b** formed in benzene solution and benzyl bromide generated in toluene strongly suggest a radical process. N–N bond cleavage in **5a,b** can give NO_2 and an indazolyl radical. Subsequently homolytic substitution of a benzene molecule by this indazolyl radical gives the 1-phenyl-1*H*-indazoles **7a,b** (Scheme IV). Such a homolytic phenylation has been observed for pyrazolyl radicals generated in benzene solution.[14,15] However, simple N–N bond cleavage (Scheme IV) does not explain the formation of the 3-nitro-1-phenyl-1*H*-indazoles **8a,b** in benzene nor the formation of the dinitroindazoles **2a,b** (Scheme III). A substitution of the bromine in position 3 by NO_2 generated by the homolysis is highly improbable. Therefore, on the present information, we advance the incomplete mechanism as depicted in Scheme V. An initial intramolecular rearrangement leads to intermediate **13** which subsequently cleaves homolytically to give either NO_2 or a bromine atom and the corresponding indazolyl radicals. Intramolecular migrations of nitro groups involving shifts from a nitrogen to a carbon atom in the five-membered ring are known for indazoles[3,7] and triazoles,[16] and they are particularly well documented for pyrazoles.[5] In the present case however, **13** cannot undergo hydrogen migration to give the 3-substituted 1*H*- or 2*H*-indazoles. Loss of NO_2 or Br· would lead to the observed products.

Neutral azole radicals may, in principle, be either π or σ in nature.[5,14,15] Presumably **13** initially gives the π radicals **14** and **15** (Scheme V) but the products obtained indicate the ultimate generation of the σ radicals **16** and **17**. However, it is remarkable that only 1-phenyl-substituted indazoles are formed instead of mixtures of both 1- and 2-phenylindazoles.[17] It is questionable whether this

(13) Bouchet, P.; Fruchier, A.; Joncheray, G. *Org. Magn. Reson.* **1977**, *9*, 716–718.
(14) Janssen, J. W. A. M.; Cohen-Fernandes, P.; Louw, R. *J. Org. Chem.* **1975**, *40*, 915–920.
(15) Hanson, P. "Advanced Heterocyclic Chemistry"; Academic Press: New York, 1979; Vol. 25, p 280–289.
(16) (a) Habraken, C. L.; Cohen-Fernandes, P. *J. Chem. Soc., Chem. Commun.* **1972**, 38. (b) Pevzner, M. S.; Kulibabina, T. N.; Loffe, S. L.; Maslina, I. A.; Gidaspov, B. V.; Tartakovskiĭ, V. A. *Khim. Geterotsikl. Soed.* **1979**, *15*, 550–554.
(17) For example as is observed for the asymmetric 3(5)-methylpyrazolyl radical:[14]

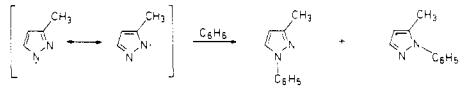
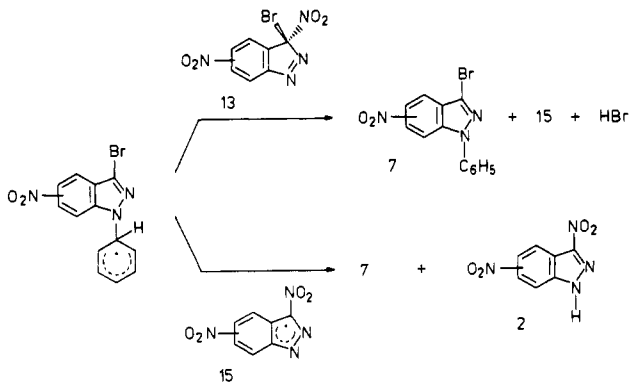


Table II. ^{13}C Chemical Shifts[a-c] of 3-Bromo-1-phenyl-1*H*-indazoles 7a,b and 8a,b and Reference Compounds 9, 10, and 11

compd	C-3	C-4	C-5	C-6	C-7	C-8	C-9
1-phenyl-1*H*-indazole (**9**)	135.4	121.5	121.3	127.1	110.4	138.7	125.3
2-phenyl-2*H*-indazole (**10**)	126.9	120.5	120.5	122.6	118.1	149.9	122.9
3-bromo-6-nitro-1-phenyl-1*H*-indazole (**7b**)	123.5	121.8	117.2	147.8	107.8	138.1	127.2
3,6-dinitro-1-phenyl-1*H*-indazole (**8b**)	148.5	122.5	120.5	147.7	109.0	137.2	119.8
6-nitro-1-phenyl-1*H*-indazole (**11**)[19]	136.1	122.8	116.1	146.6	106.9	136.8	128.0
3-bromo-5-nitro-1-phenyl-1*H*-indazole (**7a**)	126.2	118.4	143.2	123.2	111.2	141.5	124.5
3,5-dinitro-1-phenyl-1*H*-indazole (**8a**)	150.1	117.8	145.4	123.8	113.9	142.0	116.2

[a] In ppm relative to Me_4Si. [b] The solvent was Me_2SO-d_6 for compound **8a** and $CDCl_3$ for all other compounds. [c] The ^{13}C chemical shifts of the carbon atoms of the phenyl group are in the range of 121.1–124.2 (C-2), 126.6–129.8 (C-4), 129.4–130.3 (C-3), and 137.2–140.7 (C-1).

Scheme VI



would indicate that the electron is indeed located entirely on the nitrogen in position 1.

Intermediate **13**, in principle, can react also in chain propagation reactions. For example the benzyl radical generated in toluene by hydrogen abstraction, presumably

$$13 + C_6H_5CH_2\cdot \rightarrow C_6H_5CH_2Br + 17$$

both by bromine as well as by the indazolyl radicals, can react with **13** forming benzyl bromide and radical **17**. In benzene, in the homolytic phenylation, **13** might be involved in reactions such as the one depicted in Scheme VI. In this scheme also a possible termination reaction is presented.

Obviously, our experimental results do not allow the mechanistic questions raised to be settled. So, for example, it cannot be decided whether **7a,b** are formed via initial rearrangement to **13**, direct homolysis, or by both routes. In summary, these thermolysis reactions of 3-bromo-1-nitro-1*H*-indazoles present a novel facet of the interesting reactivity characteristic of *N*-nitroindazoles. Considerable work remains to be done before the mechanisms of the above described reactions will be understood.

Experimental Section

The 3-bromo-1-nitro-1*H*-indazoles **5a** and **5b** were synthesized by N-nitration of 3-bromo-5-nitro- and 3-bromo-6-nitro-1*H*-indazoles as reported previously.[12,18] 1-Phenyl-1*H*-indazole (**9**),[2] 2-phenyl-2*H*-indazole (**10**),[2] and 6-nitro-1-phenyl-1*H*-indazole (**11**)[19] were prepared as described in the literature. All melting points are uncorrected. For microanalyses, mass spectra, and high-resolution ^1H and ^{13}C NMR spectra see the description in preceding paper.[2] ^1H NMR spectra were also recorded on a JEOL PS-100 and IR spectra (KBr) were recorded on a Beckmann-IR instrument. GLC analyses were performed on 3-m SP2100 capillary column using *p*-bromotoluene as an internal standard. The separation of products by short column technique on silica H (Merck) according to Stahl was performed as described by Hunt and Rigby.[20] For the detection of nitroindazoles on TLC spraying with Rhodamine B (0.05% in ethanol) solution was used.

General Procedure of the Thermolyses and of the Isolation of the Products. 5a or **5b** (4.0–8.0 mmol) in 24–50 mL of either dry benzene or dry toluene were refluxed for the appropriate time (see Table I) while being kept under a slow stream of N_2. Qualitative tests[21,22] for Br_2 and NO_2 in the brown fumes in the condenser were performed within a few hours after the start of the reaction. The reaction was followed by checking samples on TLC (3:1 chloroform–ethyl acetate). Bromobenzene or benzyl bromide were determined by GLC analysis before separation and isolation of the indazoles formed. After flash evaporation the residue of a thermolysis in toluene was taken up in 50 mL of chloroform. This chloroform solution was extracted with 20 mL of 2.0 N NaOH solution, resulting in an orange chloroform suspension containing primarily the 3-bromo-5- or -6-nitro-1*H*-indazole (**6a** or **6b**) and a clear orange aquous layer containing primarily the 3,5- or 3,6-dinitro compounds **2a** or **2b**. Final identification was done by isolation and subsequent comparison with spectral data of authentic samples.

Upon cooling of the reaction mixtures of the thermolysis of **5a** and of **5b** in boiling benzene an orange-brown solid precipitated consisting of a mixture of **2a** and **6a** in the case of **5a** and of primarily **2b** contaminated with **6b** in the case of **5b**, respectively. After filtration column chromatography (chloroform–ethyl acetate 3:1 or chloroform–methanol 4:1) was performed for further separation and purification. After quite some experimentation finally two methods were used to obtain the 1-phenyl-1*H*-indazoles from the benzene filtrate. (A) The benzene was evaporated and the residue was first separated by column chromatography (chloroform–ethyl acetate 3:1) affording a mixture of **7a** and **8a** and **7b** and **8b** respectively. These mixtures then were put on a second column (chloroform–carbon tetrachloride 1:1). (B) The filtrate diluted with an additional 50 mL of benzene was extracted with three 100-mL portions of 1 N sodium hydroxide to separate the 1-phenyl-1*H*-indazoles from the N-unsubstituted indazoles. The residue obtained from the extracted benzene solution, after workup and evaporation of the benzene, was then separated by column chromatography (toluene). Nevertheless purification proved difficult and in one case only (**7b**) we succeeded in finally obtaining a sample giving a satisfactory elemental analysis. On the other hand, spectral data, particularly high-resolution mass spectral determination of the molecular ion of **7a**, **8a**, and **8b** were in complete agreement with the assigned structures.

3-Bromo-5-nitro-1-phenyl-1*H*-indazole (7a): light yellow crystals; mp 132–133 °C (ethanol–chloroform 10:1); high-resolution mass spectrum, calcd for $C_{13}H_8BrN_3O_2$ 316.9799 and 318.9779, found 316.9806 and 318.9793; IR 1340 and 1500 cm^{-1} (C-NO_2), 1085 (C-Br); ^1H NMR (100 MHz, $CDCl_3$) δ 8.8 [d, 1, $J_{4,6}$ = 1.9 Hz, H-4], 8.46 [dd, 1, $J_{6,7}$ = 9, 5 Hz, H-6], 7.87 [d, 1, H-7], 7–7.8 [m, 5].

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3-Bromo-6-nitro-1-phenyl-1*H*-indazole (7b): long yellow needles; mp 172–172.5 °C (ethanol–chloroform 10:1). Anal. Calcd for $C_{13}H_8BrN_3O_2$: C, 49.09; H, 2.55; N, 13.21. Found: C, 48.98; H, 2.75; N, 13.07. IR 1345 and 1500 cm^{-1} (C–NO_2); ^1H NMR (300 MHz, Me_2SO-d_6) δ 8.55 [s, 1, H-7], 8.15 [d, 1, $J_{4,5}$ = 10 Hz, H-5], 7.98 [d, 1, H-4], 7.81–7.84 [d, 2, $J_{2'3'}$ = 8 Hz, H-2'], 7.65–7.68 [t, 2, $J_{3'4'}$ = 8 Hz, H-3'], 7.54–7.57 [t, 1, H-4'].

3,5-Dinitro-1-phenyl-1*H*-indazole (8a): yellow crystals; mp 152–152.5 °C (ether–acetone 1:1); high-resolution mass spectrum, calcd for $C_{13}H_8N_4O_4$ 284.0545; found 284.0551; IR 1350 and 1520 cm^{-1} (C–NO_2); ^1H NMR (100 MHz, Me_2SO-d_6) δ 9.44 [d, 1, $J_{4,6}$ = 4 Hz, H-4], 8.57 [dd, 1, $J_{6,7}$ = 10 Hz, H-6], 7.98 [d, 1, H-7], 7.64–7.90 [m, 5, H phenyl].

6-Nitro-1-phenyl-1*H*-indazole (11):[19] ^1H NMR (300 MHz, $CDCl_3$) δ 8.61 [m, 1, $J_{5,7}$ = 1.8 Hz, $J_{4,7}$ = 0.5 Hz, $J_{3,7}$ = 0.9 Hz, H-7], 8.31 [d, 1, H-3], 8.07 [dd, 1, $J_{4,5}$ = 8.8 Hz, H-5], 7.90 [dd, 1, H-4], 7.67–7.71 [d (broad), 2, $J_{2'3'}$ = 7.5 Hz, H-2'], 7.56–7.61 [t (broad), 2, $J_{3'4'}$ = 7.5 Hz, H-3'], 7.42–7.47 [tt, 1, $J_{2'4'}$ = 1.2 Hz, H-4'].

3,6-Dinitro-1-phenyl-1*H*-indazole (8b): light yellow crystals; mp 192–193.5 °C (ether–acetone 1:1); high-resolution mass spectrum, calcd for $C_{13}H_8N_4O_4$ 284.0545, found 284.0542; IR 1515 and 1335 cm^{-1} (C–NO_2); ^1H NMR (300 MHz, Me_2SO-d_6) δ 8.63 [d, 1, $J_{5,7}$ = 1.9 Hz, H-7], 8.5 [d, 1, $J_{4,5}$ = 8.7 Hz, H-4], 8.41 [dd, 1, H-5], 7.91–7.95 [d (broad) 2, $J_{2'3'}$ = 8 Hz, H-2'], 7.37–7.78 [t (broad), 2, $J_{3'4'}$ = 8 Hz, H-3'], 7.65–7.70 [t (broad), 1, H-4'].

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Appendix

Attempt to Synthesize 7b. No bromination products were obtained, i.e., neither bromination occurs in the phenyl ring nor in the 3 or any other position in the indazole nucleus when 11 was subjected to the following bromination reactions: Br_2 in refluxing acetic acid for 1–24 h; dioxane and Br_2 in ether solution; dioxane and Br_2 in dioxane solution; Br_2–$FeBr_3$ in carbon tetrachloride. Only unreacted 11 was recovered.

Registry No. **2a**, 91178-53-9; **2b**, 91178-54-0; **5a**, 83553-83-7; **5b**, 83553-84-8; **6a**, 67400-25-3; **6b**, 70315-68-3; **7a**, 91178-55-1; **7b**, 91178-56-2; **8a**, 91178-57-3; **8b**, 91178-58-4; **10**, 3682-71-1; **11**, 91178-59-5; C_6H_5Br, 108-86-1; $C_6H_5CH_2Br$, 100-39-0; NO_2, 10102-44-0; Br_2, 7726-95-6.

Generation of Azomethine Ylides via the Desilylation Reaction of Immonium Salts

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Generation of intermediates having azomethine ylide reactivity was achieved by the reaction of several ethanol or thioimidate derivatives with methyl iodide followed by treatment of the resulting imine with (trimethylsilyl)methyl triflate. Desilylation of the resulting salt with cesium fluoride generates an azomethine ylide which undergoes a subsequent 1,3-dipolar cycloaddition reaction with added dipolarophiles. The cycloadduct formed when dimethyl acetylenedicarboxylate is used as the dipolarophile undergoes loss of ethanol or methyl mercaptan to give *N*-methyl-2-phenyl-3,4-dicarbomethoxypyrrole. Reaction of the analogous thioimidate ylide with acetylene dipolarophiles also proceeds smoothly and affords related cycloadducts. The cesium fluoride induced desilylation reaction shows all the characteristics of a concerted cycloaddition, including stereospecificity when dimethyl fumarate and maleate are used as the dipolarophiles.

The 1,3-dipolar cycloaddition reaction represents one of the best methods for the synthesis of five-membered heterocyclic ring systems.[1,2] The ease of the cycloaddition, the rapid accumulation of polyfunctionality in a relatively small molecular framework, the high stereochemical control of the cycloaddition, and the fair predictability of its regiochemistry have contributed to the popularity of the reaction in organic synthesis.[3,4] In the realm of alkaloid synthesis, in which a premium is put on the rapidity of construction of polyfunctional, highly bridged carbon and heteroatom networks, the dipolar cycloaddition reaction has now emerged as a prominent synthetic method.[5] Most of the studies to date have hinged upon the use of nitrones,[6-11] nitrile oxides,[12-16] and azomethine imines.[17] Fewer accounts have been concerned with azomethine

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