earity of the plots was taken as the criterion that no secondary photochemistry was occurring.

Supplementary Material Available: Figure 1 (showing the course of the dienol trapping reaction with chlorotrimethylsilane for 11), Figure 2 (showing the course of the deconjugation reaction for 1 in the presence and absence of base and sensitisor), Figure 3 (showing the variation of quantum yield of deconjugation for 11 with base concentration), and derivation of eq 1-5 (7 pages). Ordering information is given on any current masthead page.

Cycloadditions of 5-Nitropyrimidines with Ynamines. Formation of 3-Nitropyridines, *N*-5-Pyrimidyl-α-carbamoylnitrones, and 2,2a-Dihydroazeto[2,3-*d*]-3,5-diazocines[1]

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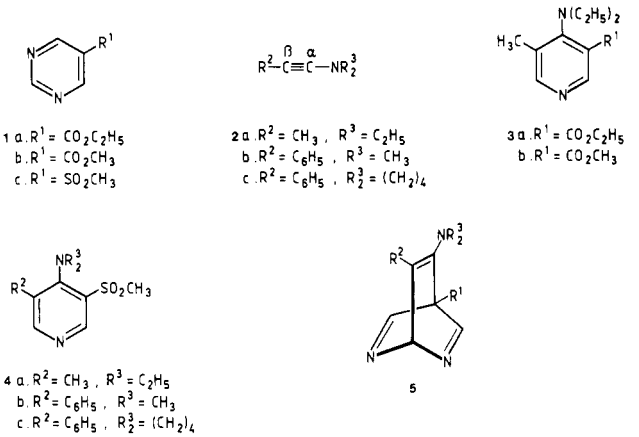
The reaction of pyrimidines containing an electron-withdrawing substituent at C5 with ynamines (**2**) has been investigated. 5-(Ethoxycarbonyl)- and 5-(methylsulfonyl)pyrimidine (**1a** and **1c**) undergo a [4 + 2] cycloaddition to yield the 3,4,5-trisubstituted pyridines **3a** and **4**, respectively. 5-Nitropyrimidines containing 2- and/or 4(6)-alkoxy or methyl groups (**6**) give a variety of products upon reaction with **2**. 4,6-Dimethoxy-5-nitropyrimidine (**6b**) gives a [4 + 2] cycloaddition reaction into the pyridine derivative **8a** upon reaction with 1-(diethylamino)propyne (**2a**). Nitrone **10a** is formed as the main product upon reaction of **2a** with 2,4-dimethoxy-5-nitropyrimidine (**6c**). 5-Nitropyrimidines unsubstituted at positions 4 and 6 (**6a,e–g**) give 2,2a-dihydroazeto[2,3-*d*]-3,5-diazocines (**7a–e**) upon reaction with 2 equiv of **2a**. 4-Methoxy-5-nitropyrimidine (**6d**) yields pyridine **8a** and nitrone **10b** upon reaction with **2a**, and from 4-methyl-5-nitropyrimidine (**6h**), the pyridines **8b** and **8c**, dihydroazetodiazocine **7e**, and a nitrone are formed. Ynamine **2b** is less reactive than **2a** and does not react to form dihydroazetodiazocines (**7**) with the 5-nitropyrimidines used in this study. Instead, nitrone **10c** and pyridine **11** are formed upon reaction of **2b** with **6a**, and nitrone **10d** is formed with pyrimidine **6g**.

Inverse electron-deman Diels-Alder reactions of electron-deficient nitrogen heterocycles like tetrazines and triazines with ynamines and enamines have been well studied in the past decades.[2,3] Pyrimidines are usually not electron deficient enough to participate in cycloaddition reactions. However, when they contain a strong electron-withdrawing group cycloaddition reactions become possible.[4,5]

In a previous communication, we have reported that 5-nitropyrimidine undergoes cycloadditions with enamines, yielding 2(3)-substituted 5-nitropyridines.[6] Reaction of 5-nitropyrimidine with 1-(diethylamino)prop-1-yne leads unexpectedly to the formation of a 2,2a-dihydroazeto-[2,3-*d*]-3,5-diazocine 1-oxide, showing that the nitro group is involved in this reaction.[7] As an extension of our studies on this rearrangement we investigated the reactions of ynamines with mono-, di-, and trisubstituted pyrimidines, containing an ethoxycarbonyl, methylsulfonyl, or nitro group on position 5.

Heating a solution of 5-(ethoxycarbonyl)pyrimidine (**1a**) with 1-(diethylamino)prop-1-yne (**2a**) in dioxane at 80 °C gives 4-(diethylamino)-3-(ethoxycarbonyl)-5-methylpyridine (**3a**). A similar reaction has been reported for the methyl ester **1b**, **3b** being formed.[4] The 3,4,5-trisubstitution pattern in **3a** was indicated by NMR spectroscopy.



The ^1H NMR spectrum of **3a** exhibits two singlets in the aromatic region (see Table I). The hydrogen-bearing carbon atoms show a long-range J_{C-H} coupling constant of about 11 Hz in the ^{13}C NMR spectrum, indicating that the hydrogens occupy the 2- and 6-positions.[8] Furthermore, a long-range quartet coupling pattern is observed for C6, indicating that the CH_3 is at C5.[8]

No reaction was observed when **1a** was reacted with the phenylaminoacetylenes **2b** or **2c**, indicating the lower reactivity of these ynamines. A similar observation was reported for the reaction of 2,4-dicyanopyrimidines with ynamines.[5]

5-(Methylsulfonyl)pyrimidine (**1c**) reacts with **2a** in a similar way as **1a** to yield 4-(diethylamino)-5-methyl-3-(methylsulfonyl)pyridine (**4a**). The reactivity of **1c** is

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Scheme I

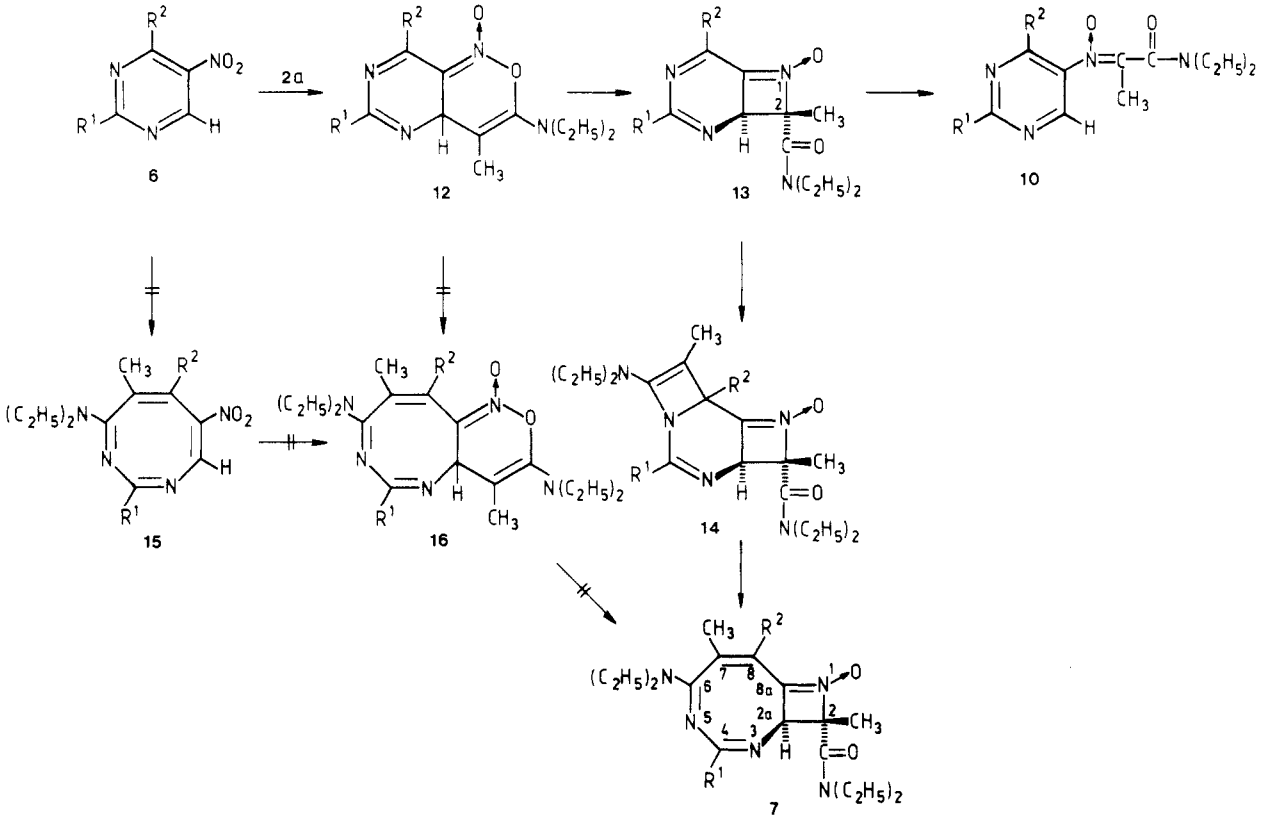


Table I. Melting Points and Spectroscopic Data of Pyridines 3, 4, 8, and 11

		^{1}H NMR, δ		^{13}C NMR, δ (J, Hz)				
compd	mp, °C	H6	H2	C2	C3	C4	C5	C6
3a		8.35	8.56	149.6 (181)	124.0	156.2	130.2	154.0 (176)
4a	109–110	8.58	9.05	149.1 (187)	*a*	156.0	*a*	157.6 (178)
4b	144–145	8.55	9.16	150.8 (189)	*a*	157.1	*a*	157.4 (181)
4c	170–171	8.50	9.15	150.7 (188)	*a*	153.5	*a*	156.9 (180)
8a	59–60	8.83		155.1	133.7	151.1	124.8	148.6 (179)
8b	45–47	8.37	8.63	144.8 (185)	143.1	150.0	131.3	154.4 (172)
8c		8.27		148.8	146.8	149.0	130.3	152.1 (176)
11	86–87	8.27	8.72	146.6 (186)	140.0	149.3	131.3	154.3 (179)

[a] Two resonances at about 135 ppm, which could not be assigned.

Table II. Yields of Products from Reaction of Compounds 6a–h with 2a

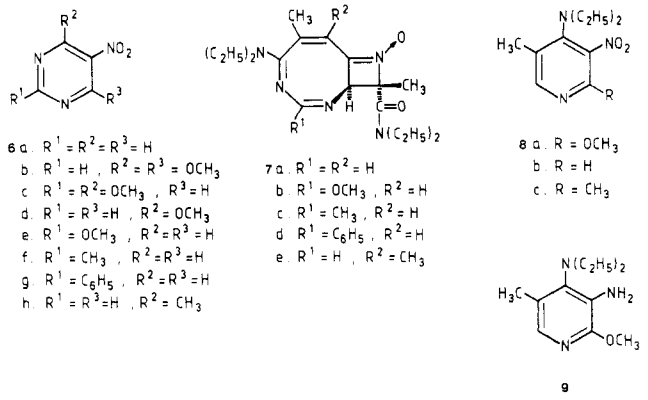
	yield, %		
compd	8	10	7
6a	*b*		50
6b	52		
6c		68	
6d	21	38	
6h	13 (**8b**), 2.5 (**8c**)	15[a]	50[a]
6e–g			40–60

[a] Yields determined from NMR spectra of the crude reaction mixture and the isolated amounts of **8b** and **8c**. [b] Trace.

greater than that of **1a**, as demonstrated by the fact that **1c** is able to react with the less reactive ynamines **2b** and **2c**, yielding the pyridine derivatives **4b** and **4c**. The structures of **4a–c** were established by their respective ^{1}H NMR spectra and further confirmed by the ^{13}C NMR spectra (See Table I).

The pyrimidine–pyridine ring transformation can be described to take place by an initial regiospecific addition of the ynamines **2a–c** across the C2 and C5 positions of the pyrimidine ring. The more electron-rich β-carbon atom in **2** adds to the least sterically hindered electron-deficient C2 atom of the pyrimidine. The cycloadduct **5** formed converts into the corresponding pyridine derivative by loss of hydrogen cyanide. Attempts to isolate **5** failed.

Previously we have shown that 5-nitropyrimidine (**6a**) and its 2-methoxy (**6e**), 2-methyl (**6f**), and 2-phenyl derivatives (**6g**) undergo an interesting ring-expansion reaction when subjected to treatment with **2a**, leading to the formation of 2,2a-dihydroazeto[2,3-*d*]-3,5-diazocine 1-oxides **7a–d**.[7]



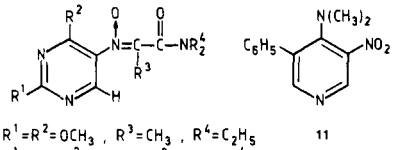
The ring transformation of **6** into **7** has been described to occur by an initial [4 + 2] cycloaddition involving the

nitrovinyl moiety of the pyrimidine ring. The nitronate ester **12** formed rearranges into the azete oxide **13** by a 1,3-sigmatropic shift (see Scheme I). The C6–N5 double bond in the pyrimidine ring of **13** undergoes a [2 + 2] cycloaddition with ynamine **2a** to give product **7**.[7]

In order to study the influence of substituents in 5-nitropyrimidine on the course of the ring expansion, we investigated the reactions of 4,6-dimethoxy-5-nitropyrimidine (**6b**), 2,4-dimethoxy-5-nitropyrimidine (**6c**), 4-methoxy-5-nitropyrimidine (**6d**), and 4-methyl-5-nitropyrimidine (**6h**) with **2a** (see Table II).

Reaction of **6b** with **2a** leads to a slow but exclusive formation of 4-(diethylamino)-2-methoxy-5-methyl-3-nitropyridine (**8a**). IR spectra of this compound show a strong band at about 1540 cm^{-1} and a less discernable band at about 1370 cm^{-1}, confirming the presence of the nitro group. The $^1J_{C-H}$ coupling constant value of 179 Hz of the ^{13}C resonance at 148.6 ppm indicates the presence of a hydrogen at C6. The fact that this resonance signal has a long range quartet coupling proves the presence of the methyl group at C5.[8] The other observed long-range couplings (doublet (11 Hz) at 155.1 ppm and quintet at 124.8 ppm) in the ^{13}C NMR spectrum of **8a** agree with the proposed structure. Reduction of **8a** over Pd/C gave the 5-amino compound **9**, which was also characterized by its spectral data.

It is of interest to mention that in the reaction mixture obtained from **6b** with **2a** no trace of a diazocine derivative was detected. Apparently the addition of the ynamine does not involve the 4π-electron system of the nitrovinyl moiety of **6b** but takes place across the C2 and C5 positions. It gives an intermediate of type **5** from which **8a** is formed by loss of methoxy cyanide. This preferred addition across C2 and C5 is probably due to steric interference by the substituents at C4 and C6 and the electron-donating character of the methoxy groups deactivating the C4(C6) position for addition to the electron-rich β-carbon atom of **2a**. Reaction of **6c** with **2a** follows a course different from that of **6b**. As the sole product a white compound is isolated to which the structure *N*-(2,4-dimethoxypyrimidin-5-yl)-α-[(diethylamino)carbonyl]-α-methylnitrone (**10a**) was assigned. The IR spectra show strong absorption bands at 1640 cm^{-1}, indicative for an amide and lack absorptions characteristic for a nitro group. The ^{13}C NMR spectrum exhibits, apart from the pyrimidine resonances, peaks in the low-field region at 162–164 (carbonyl group) and at 143.7 ppm due to the presence of a carbon atom located between C=O and N–O in the nitrone.[9] No trace of a 3-nitropyridine derivative was detected in the reaction mixture.



10 a. $R^1=R^2=OCH_3$, $R^3=CH_3$, $R^4=C_2H_5$
b. $R^1=H$, $R^2=OCH_3$, $R^3=CH_3$, $R^4=C_2H_5$
c. $R^1=R^2=H$, $R^3=C_6H_5$, $R^4=CH_3$
d. $R^1=C_6H_5$, $R^2=H$, $R^3=C_6H_5$, $R^4=CH_3$

11

Since four-membered cyclic nitrones may undergo ring opening into α-carbamoylnitrones,[9] it seems reasonable to suppose that the formation of **10a** occurs by ring opening of the unstable intermediate dihydroazetopyrimidine **13** ($R^1 = R^2 = OCH_3$) (see Scheme I). That a subsequent cycloaddition of a second ynamine across the N5–C6 double bond to form a diazocine derivative **7** does not take place can be ascribed to the presence of the electron-donating methoxy group deactivating the C=N bond for a nucleophilic addition by the ynamine. The presence of a methoxy group at C2 prevents the competitive [4 + 2] cycloaddition across the C2–C5 bond. Reaction of **6d** with **2a** presents an intermediate case; as the main product the carbamoyl nitrone **10b** is isolated, in addition to the pyridine derivative **8a**. A diazocine derivative could not be detected in the reaction mixture. The structure of **10b** was based on the same arguments used for the characterization of **10a**. The formation of both **10b** and **8a** seems to indicate that two independently occurring cycloaddition reactions take place: a [4 + 2] cycloaddition across the C2–C5 bond leading to a type **5** cycloadduct and subsequently to **8a** and by a cycloaddition involving the nitrovinyl moiety leading to **13** (R^1 = H; $R^2 = OCH_3$) and subsequently to **10b**. That **13** (R^1 = H; $R^2 = OCH_3$) does not undergo a further cycloaddition leading to **7** is due to the presence of the methoxy group making the C=N bond less electrophilic.

Since 4-methoxy-5-nitropyrimidine (**6d**) reacts with **2a** to both an open-chain nitrone and a pyridine derivative, we became interested in the reaction of 4-methyl-5-nitropyrimidine (**6h**). As the methyl group is less electron donating than the methoxy group, we may expect that if an intermediate of type **13** is formed, a subsequent cycloaddition across the N5–C6 bond in **13** is more favourable for R^1 = H and $R^2 = CH_3$ than for R^1 = H and $R^2 = OCH_3$. Reaction of **6h** with **2a** gives four distinct compounds as indicated by the NMR spectrum of the crude reaction mixture (see Table II). Two pyridine derivatives **8b** and **8c** could be isolated and separated by column chromatography on alumina. These products result from a cycloaddition across the C2 and C5 positions of the pyrimidine and subsequent loss of methylcyanide to give **8b** or hydrogen cyanide to yield **8c**, respectively. The observed preferential loss of methyl cyanide is not without precedent and has also been observed in reactions of 2-methyl- and 2,4-dimethyl-1,3,5-triazines with **2a**.[10] The dihydroazetodiazocine **7e** could also be isolated using column chromatography on alumina. Unfortunately, this compound could not be obtained in a pure state, probably due to decomposition. However, the ^1H and ^{13}C NMR spectra of this compound show a strong similarity with those of the dihydroazetodiazocines **7a–d**.[7] Especially the resonances at 7.84 ppm and 4.40 ppm (J = 2.4 Hz) in the ^1H NMR spectrum (H4 and H2a, respectively) and at 86.1 ppm (C2) and 58.9 ppm (J = 151 Hz, C2a) in the ^{13}C NMR spectrum are indicative for structure **7e**. The fourth compound, featuring singlets in the ^1H NMR spectrum of the pyrimidine hydrogens at 9.12 ppm and 8.58 ppm, is probably the *N*-5-pyrimidyl-α-carbamoylnitrone (**10**, R^1 = H; $R^2 = R^3 = CH_3$; $R^4 = C_2H_5$). However, this compound could not be isolated, because it does not crystallize from the reaction mixture and decomposes on silica gel and alumina during column chromatography.

The question can be raised whether in the formation of **7** the addition of the second molecule of ynamine **2a** takes place after the six-membered 1,2-oxazine ring in **12** has been converted into the four-membered azete oxide or alternatively, whether the addition preceeds the ring contraction, i.e., formation of **16**, either via **12** or **15**, which then converts to **7** (see Scheme I). In the reaction of **6** with **2a** both four-membered cyclic nitrones **7** and open-chain nitrones **10** can be formed, depending on the substitution pattern. This suggests that the dihydroazetopyrimidine

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13 can be considered as intermediate in the formation of both types of products.

The ring contraction of the 1,2-oxazine ring into the dihydroazete oxide occurs in a stereospecific fashion.[9] Only when a six-membered ring is fused with the 1,2-oxazine ring was the same stereochemistry observed that we found for the dihydroazetodiazocine oxides 7.[7] This also suggests that the ring contraction takes place when a six-membered ring is fused with the 1,2-oxazine, therefore excluding 16 as an intermediate.

Bearing in mind that (dimethylamino)phenylacetylene (**2b**) is a less reactive dienophile than **2a**, we investigated the reaction of **6a** and **6g** with **2b** in order to study the course of the reaction, when changing the dienophile. Reaction of **6a** with **2b** only gave the open-chain nitrone **10c** besides a small amount of 4-(diethylamino)-5-nitro-3-phenylpyridine (**11**). No indication for the formation of a diazocine was found. Reaction of **6g** with **2b**, also yields only a nitrone, i.e., **10d**, and no diazocine or pyridine derivative. These results show that **2b** is sufficiently reactive to undergo a cycloaddition with the nitrovinyl part of **6** (R^2 or R^3 = H), yielding intermediates of type **12** and **13**. However, apparently **2b** is not reactive enough to undergo a subsequent cycloaddition with the N5–C6 bond in **13** before ring opening into **10** occurs.

Experimental Section

Melting points are uncorrected. The ^{1}H NMR spectra ($CDCl_3$) were recorded with a Varian EM-390 90-MHz spectrometer using tetramethylsilane as internal reference. ^{13}C NMR spectra were recorded with a Bruker CXP-300 spectrometer. Mass spectra were obtained with a JEOL JMS-D-100 spectrometer. Infrared spectra were recorded on a Hitachi EPI-G3 spectrophotometer.

4-(Diethylamino)-3-(ethoxycarbonyl)-5-methylpyridine (3a). A solution of 152 mg (1 mmol) of **1a**[11] and 200 mg (1.8 mmol) of **2a** in 2 mL of dioxane was heated at 80 °C for 1 h. Column chromatography of the concentrated reaction mixture on silica gel with ether as eluent gave **3a**: yield 150 mg (64%); oil; mass spectrum, m/e 236.154 (M^+ calculated for $C_{13}H_{23}N_2O_2$ 236.153).

4-(Diethylamino)-5-methyl-3-(methylsulfonyl)pyridine (4a). A solution of 158 mg (1 mmol) of **1c**[12] and 200 mg (1.8 mmol) of **2a** in 25 mL of ether was refluxed for 3 h. Column chromatography of the concentrated reaction mixture on silica gel with ether as eluent gave **4a**: yield 160 mg (66%); white crystals (toluene/hexane), mp 109–110 °C; mass spectrum, m/e 242.109 (M^+ calcd 242.109).

Anal. Calcd $C_{11}H_{18}N_2O_2S$ (M_r 242.34): C, 54.52; H, 7.49. Found: C, 54.79; H, 7.39.

4-(Dimethylamino)-5-phenyl-3-(methylsulfonyl)pyridine (4b). A solution of 158 mg (1 mmol) of **1c** and 300 mg (2.0 mmol) of **2b**[13] in 10 mL of dioxane was refluxed for 24 h. Column chromatography of the concentrated reaction mixture on silica gel using ether as eluent gave **4b**: yield 80 mg (29%); white crystals (toluene/hexane), mp 144–145 °C.

Anal. Calcd for $C_{14}H_{16}N_2O_2S$ (M_r 276.35): C, 60.84; H, 5.84. Found: C, 61.07; H, 5.87.

5-Phenyl-4-pyrrolidino-3-(methylsulfonyl)pyridine (4c). This compound was prepared according to the procedure described for **4b**: yield of **4c**, 43%, white crystals (toluene/hexane), mp 170–171 °C.

Anal. Calcd for $C_{16}H_{18}N_2O_2S$ (M_r 302.39): C, 63.55; H, 6.00. Found: C, 63.83; H, 5.95.

4-(Diethylamino)-2-methoxy-5-methyl-3-nitropyridine (8a). A solution of 925 mg (5 mmol) of **6b**[14] and 2.0 g (18 mmol) of **2a** in 30 mL of dioxane was refluxed for 24 h. After concentration of the solution, 20 mL of dichloromethane was added, and the organic layer was washed with 1 N hydrochloric acid and water. The organic layer was dried and concentrated, and the residue was chromatographed on silica gel with petroleum ether/ethylaceate (4:1) as eluent. The yellow **8a** was isolated: yield, 620 mg (52%); yellow crystals (methanol/water), mp 59–60 °C; mass spectrum, m/e 239.128 (M^+ calcd 239.127).

Anal. Calcd for $C_{11}H_{17}N_3O_3$ (M_r 239.27): C, 55.21; H, 7.16. Found: C, 55.38; H, 7.38.

3-Amino-4-(diethylamino)-2-methoxy-5-methylpyridine (9). A solution of 239 mg (1 mmol) of **8a** in 50 mL of ethanol was hydrogenated over 200 mg 5% palladium on charcoal during 2 h. Preparative TLC on silica gel with chloroform/ethylacetate (4:1) gave **9**: yield, 152 mg (73%); oil; IR (film) 3430 and 3330 cm^{-1} (NH_2); ^{1}H NMR δ 7.25 (s, 1 H), 4.05 (s br, 2 H, NH_2), 3.91 (s, 3 H, OCH_3), 3.05 (q, 4 H, NEt_2), 2.12 (s, 3 H, CH_3), 1.00 (t, 6 H, NEt_2); ^{13}C NMR δ 152.6 (C2), 140.0 (C4), 135.0 (J = 176 Hz, C6), 130.0 (C3), 125.8 (C5); mass spectrum, m/e 209.153 (M^+ calcd for $C_{11}H_{19}N_3O$ 209.153).

***N,N*-Diethyl-2-[(2,4-dimethoxy-5-pyrimidyl)imino]-propanamide *N'*-Oxide (10a).** To a solution of 185 mg (1 mmol) of **6c**[15] in a mixture of 10 mL of ether and 2 mL of dichloromethane was added 200 mg (1.8 mmol) of **2a** in 10 mL of ether. The mixture is stirred for 1 h. The white solid (**10a**) was collected and washed with ether: yield, 200 mg (68%); white crystals (diisopropylether/toluene), mp 143–144 °C; ^{1}H NMR δ 8.45 (s, 1 H, pyrimidine), 4.08 and 4.05 (2 s, 6 H, 2 OCH_3), 3.45 (m, 4 H, NEt_2), 2.07 (s, 3 H, CH_3) 1.25 (m, 6 H, NEt_2); ^{13}CNMR δ 164.8, 163.3, 154.7 (J = 187 Hz, C6), 143.7 (C=NO), 123.2 (C5).

Anal. Calcd for $C_{13}H_{20}N_4O_4$ (M_r 296.32): C, 52.69; H, 6.80. Found: C, 52.88; H, 6.56.

***N,N*-Dimethyl-2-phenyl-2-[(2-phenyl-5-pyrimidyl)imino]acetamide *N'*-Oxide (10d).** To a solution of 100 mg (0.5 mmol) of **6g**[16] in 5 mL of dichloromethane was added 150 mg (1 mmol) of **2b** in 5 mL of dichloromethane. The mixture was stirred for 3 h at room temperature. After concentration, 20 mL of ether was added, and the white solid (**10d**) was collected and washed with ether: yield, 140 mg (81%); white crystals (toluene/hexane), mp 186–188 °C; ^{1}H NMR δ 8.78 (s, 2 H, pyrimidine), 8.5–7.2 (m, 10 H, phenyl), 3.17 and 3.14 (2 s, 6 H, $N(CH_3)_2$); ^{13}C NMR δ 164.7, 163.1, 152.8 (J = 186 Hz, C4 and C6), 144.3 (C=NO); mass spectrum, m/e 346.143 (M^+ calcd for $C_{20}H_{18}N_4O_2$ 346.143).

4-Methyl-5-nitropyrimidine (6b). To a stirred suspension of silver acetate (from 10.0 g of silver nitrate and 15.0 g of sodium acetate) in 50 mL of water was added a suspension of 3.0 g (15 mmol) of 2,6-dihydrazino-4-methyl-5-nitropyrimidine[17] in 30 mL of water. The mixture became black, and nitrogen evolved. After 0.5 h 150 mL of dichloromethane was added. After the mixture was stirred for 0.5 h, the aqueous layer was neutralized with sodium hydrogen carbonate and stirring continued for 1 h. The mixture was filtered over hyflo, and the black solid was washed three times with alternatively 10 mL of methanol and 50 mL of dichloromethane. The aqueous layer was extracted three times with 100 mL of dichloromethane. The organic layers were dried over magnesium sulfate and concentrated. Column chromatography on silica gel with dichloromethane as eluent gave **6h** as a liquid: yield, 310 mg (15%); ^{1}H NMR δ 9.27 and 9.23 (2 s, 2 H, H2 and H6), 2.88 (s, 3 H, CH_3); mass spectrum, m/e 139.038 (M^+ calcd for $C_5H_5N_3O_2$ 139.038).

Reaction of 6a with 2b. To a solution of 125 mg (1 mmol) of **6a**[18] in 3 mL of dichloromethane was added 200 mg (1.4 mmol) of **2b** in 2 mL of dichloromethane. After being stirred for 1 h, the solution was concentrated, 4 mL of toluene was added, and the precipitate (**10c**) was collected and washed with toluene and hexane: yield, 120 mg (44%); white crystals (toluene), mp 187–188 °C; ^{1}H NMR δ 9.12 (s, 1 H, H2 pyrimidine), 8.80 (s, 2 H, H4 and H6 pyrimidine), 7.30 (s, 5 H, phenyl), 3.19 and 3.17 (2 s, 6 H, $N(CH_3)_2$); ^{13}C NMR δ 162.8, 158.6 (J = 209 Hz, C2 pyrimidine), 144.7 (C=NO).

Anal. Calcd for $C_{14}H_{14}N_4O_2$ (M_r 270.28): C, 62.21; H, 5.22. Found: C, 62.41; H, 4.95.

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The filtrate was concentrated and subjected to column chromatography on silica gel with ether/hexane (1:1) as eluent. The first yellow band (**11**) was isolated: yield, 20 mg (8%); yellow crystals (hexane, -20 °C), mp 86-87 °C; mass spectrum, *m/e* 243.101 (M^+, calcd 243.101).

Anal. Calcd for $C_{13}H_{13}N_3O_2$ (M_r 243.26): C, 64.18; H, 5.39. Found: C, 64.34; H, 5.40.

Reaction of 6d with 2a. To a solution of 155 mg (1 mmol) of **6d**[19] in 3 mL of dichloromethane was added 200 mg (1.8 mmol) of **2a** in 2 mL of dichloromethane. After being stirred for 2 h, the solution was concentrated. The residue was dissolved in 3 mL of ether, and 50 mL of hexane was added. The white precipitate (**10b**) was filtered and washed with hexane: yield, 100 mg (38%); white crystals (toluene/hexane), mp 119-120 °C; ^1H NMR δ 8.60 (s, 1 H), 8.42 (s, 1 H), 3.90 (s, 3 H, OCH_3), 3.5-3.0 (m, 4 H, NEt_2), 1.82 (s, 3 H, CH_3), 1.15-0.9 (m, 6 H, NEt_2); ^{13}C NMR δ 162.8 (C4, pyrimidine), 158.8 (J = 207 Hz, C2 pyrimidine), 152.5 (J = 181 Hz, C6 pyrimidine), 143.9 (C=NO).

Anal. Calcd for $C_{12}H_{18}N_4O_3$ (M_r 266.30): C, 54.12; H, 6.81. Found: C, 54.40; H, 6.66.

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The filtrate was concentrated and subjected to column chromatography on silica gel with hexane/dichloromethane (4:1) as eluent. The yellow band (**8a**) was isolated: yield, 50 mg (21%).

Reaction of 6h with 2a. To a solution of 139 mg (1 mmol) of **6h** in 10 mL of dichloromethane was added 250 mg (2.3 mmol) of **2a**. After being stirrred for 0.5 h, the solution was concentrated. Column chromatography on alumina (act IV) with ether gave 27 mg (13%) of **8b** and 5.4 mg (2.4%) of **8c**. **8b**: yellow solid; mp 45-47 °C; mass spectrum, *m/e* 209.116 (M^+ calcd for $C_{10}H_{15}N_3O_2$ 209.116). **8c**: yellow oil; mass spectrum, *m/e* 223.132 (M^+, calcd for $C_{11}H_{17}N_3O_2$ 223.132).

Further elution of the column with ethyl acetate gave **7e**. This compound was not very stable and could not be isolated in a pure state: ^1H NMR δ 7.86 (d, J = 2.3 Hz, 1 H, H4), 4.42 (d, J = 2.3 Hz, 1 H, H2a); ^{13}C NMR δ 168.4 (C=O), 159.9 (C6), 159.2 (J = 194 Hz, C4), 149.5 (C8a), 132.6 (C7), 125.8 (C8), 86.1 (C2), 58.9 (J = 151 Hz, C2a).

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A Mechanistic Study on the Degenerate Ring Transformation of 5-Nitropyrimidine into 2-Substituted 5-Nitropyrimidines with Nitrogen-15-Labeled Amidines

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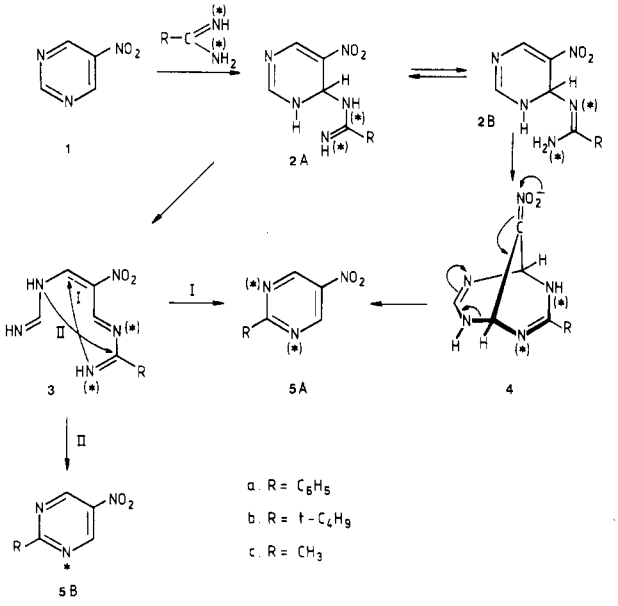
The conversion of 5-nitropyrimidine (**1**) with ^{15}N-labeled benzamidine, pivalamidine, and acetamidine into the corresponding 2-substituted 5-nitropyrimidines (**5**) has been investigated. It was found that three mechanisms are involved in this degenerate ring transformation: (a) an ANRORC mechanism leading to incorporation of the N-C-N fragment of the amidine into the pyrimidine ring of **5**; (b) an ANRORC mechanism which involves the incorporation of a C-N fragment of the amidine; (c) a regiospecific 1,4-cycloaddition reaction also leading to incorporation of a C-N fragment. The replacement of the N_1-C_2 fragment of the pyrimidine ring by the N-C moiety of the amidine dominates over the N-C-N incorporation.

The ability of pyrimidines and pyrimidinium salts to undergo ring transformations with ammonia, potassium amide, and hydrazine is very well documented.[1-3] Recently it has been reported that 5-nitropyrimidine (**1**) when treated with ambident nucleophiles such as benzamidine or pivalamidine gives 2-phenyl- and 2-*tert*-butyl-5-nitropyrimidine (**5a** and **5b**), respectively (Scheme I).[4] These so-called degenerate ring transformations were supposed to occur according to an ANRORC mechanism, involving the reactive Meisenheimer σ-adduct **2A** ⇄ **2B**, the open-chain product **3**, and/or the bicyclic adduct **4**. NMR evidence for the intermediacy of either **3** or **4** has not been obtained, and no ^{15}N-labeling experiments were carried out to substantiate the proposed mechanism.

Amidines, containing on the amidine carbon an alkyl group with active hydrogens, react with **1** in a completely different manner. When reacted with phenylacetamidine, **1** yields exclusively 2-amino-5-nitro-3-phenylpyridine (**10**) and not 2-benzyl-5-nitropyrimidine.[4] Reaction of **1** with acetamidine, in which the hydrogens of the methyl group

Scheme I



are less acidic than those in the methylene group of phenylacetamidine, gives a mixture of 2-methyl-5-nitro-

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