by dropwise addition of EtOH at 25 °C. After classical workup, products were separated by flash chromatography (EtOAc/hexane) or by distillation. The isolated yields of desulfurized products were in accordance with those of GC analyses (±5%). Spectral data (^{1}H NMR, IR) and melting and boiling points of the desulfurization products were the same as those of authentic samples.

Acknowledgment. We are grateful to the Centre National de la Recherche Scientifique for financial support.

Registry No. **1** (R^1 = $C_6H_{13}CH(CH_3)$, R^2 = Et, n = 1), 130012-10-1; **1** (R^1 = $C_{12}H_{25}$, R^2 = Et, n = 1), 2169-02-0; **1** (R^1 = R^2 = $C_{12}H_{25}$, n = 1), 2168-96-9; **1** (R^1 = Ph_2CH, R^2 = Et, n = 1), 130012-11-2; **1** (R^1 = $C_6H_{13}CH(CH_3)$, R^2 = Et, n = 2), 130012-12-3; **1** (R^1 = $C_{12}H_{25}$, R^2 = Et, n = 2), 67232-64-8; **1** (R^1 = R^2 = $C_{12}H_{25}$, n = 2), 69734-28-7; **1** (R^1 = Ph_2CH, R^2 = Et, n = 2), 6974-50-1; **2** (R^1 = $C_6H_3CH(CH_3)$), 111-65-9; **2** (R^1 = $C_{12}H_{25}$), 112-40-3; **2** (R^1 = Ph_2CH), 101-81-5; **2** (R^1, R^2 = $C_6H_4C_6H_4$), 92-52-4; **3** (R^1 = C_6H_{13}, R^2 = CH_3, R^3-R^4 = $(CH_2)_2$), 6008-85-1; **3** (R^1 = C_6H_{13}, R^2 = CH_3, R^3-R^4 = $(CH_2)_3$), 83810-17-7; **3** (R^1 = C_6H_{13}, R^2 = CH_3, R^3 = R^4 = Et), 85199-50-4; **3** (R^1 = C_6H_{13}, R^2 = CH_3, R^3 = R^4 = Ph), 66918-44-3; **3** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3-R^4 = $(CH_2)_2$), 65851-13-0; **3** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3-R^4 = $(CH_2)_3$), 118817-77-9; **3** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3 = R^4 = Et), 115663-65-5; **3** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3 = H^4 = Ph), 85895-63-2; **3** (R^1 = R^2 = Ph, R^3-R^4 = $(CH_2)_2$), 6317-10-8; **3** (R^1 = R^2 = Ph, R^3-R^4 = $(CH_2)_3$, 10359-08-7; **3** (R^1 = R^2 = Ph, R^3 = R^4 = Et), 7282-09-9; **3** (R^1 = R^2 = R^3 = R^4 = Ph), 21122-23-6; **4** (R^1, R^2 = 4-*tert*-butyl-C_6H_9), 3178-22-1; **5** (R^1 = C_6H_{13}, R^2 = CH_3, R^3-R^4 = $(CH_2)_2$, 53970-40-4; **5** (R^1 = C_6H_3, R^2 = CH_3, R^3-R^4 = $(CH_2)_3$), 118817-78-0; **5** (R^1 = C_6H_{13}, R^2 = CH_3, R^3 = Ph), 13921-16-9; **5** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3-R^4 = $(CH_2)_2$), 97030-41-6; **5** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3-R^4 = $(CH_2)_3$), 130012-13-4; **5** (R^1, R^2 = 4-*tert*-butyl-C_6H_9, R^3 = Ph), 101448-85-5; **5** (R^1 = R^2 = Ph, R^3-R^4 = $(CH_2)_2$), 38793-64-5; **5** (R^1 = R^2 = Ph, R^3, R^4 = $(CH_2)_3$), 38793-65-6; **5** (R^1 = R^2 = R^3 = Ph), 21122-20-3; **6** (R^1 = $C_6H_1{}^3$, R^2 = R^3 = H, R^4 = Et), 64532-50-9; **6** (R^1 = C_6H_{13}, R^2 = R^3 = H, R^4 = Ph), 75717-41-8; **6** (R^1 = H, R^2 = C_5H_{11}, R^3 = Me, R^4 = Et), 130012-14-5; **6** (R^1 = H, R^2 = C_5H_{11}, R^3 = Me, R^4 = Ph), 93242-01-4; **6** (R^1 = H, R^2-R^3 = $(CH_2)_{10}$, R^4 = Et), 130012-15-6; **6** (R^1 = H, R^2-R^3 = $(CH_2)_{10}$, R^4 = Ph, 85894-83-3; **6** (R^1 = R^2 = CH_3, R^3 = Ph, R^4 = Et), 24468-79-9; **6** (R^1 = R^2 = CH_3, R^3 = R^4 = Ph), 24469-13-4; **6** (R^1 = H, R^2 = CH_3, R^3 = R^4 = Ph), 23261-40-7; **7** (R^1 = C_6H_{13}, R^2 = R^3 = H), 111-66-0; (*E*)-**7** (R^1 = H, R^2 = C_5H_{11}, R^3 = CH_3), 13389-42-9; (*Z*)-**7** (R^1 = H, R^2 = C_5H_{11}, R^3 = CH_3), 7642-04-8; (*E*)-**7** (R^1 = H, R^2, R^3 = $(CH_2)_{10}$), 1486-75-5; (*Z*)-**7** (R^1 = H, R^2, R^3 = $((CH_2)_{10})$, 1129-89-1; **7** (R^1 = R^2 = CH_3, R^3 = Ph), 768-49-0; (*Z*)-**7** (R^1 = H, R^2 = CH_3, R^3 = Ph), 766-90-5; (*E*)-**7** (R^1 = H, R^2 = CH_3, R^3 = Ph), 873-66-5; **8** (R^1 = R^2 = CH_3, R^3 = Ph), 538-93-2; **8** (R^1 = H, R^2 = CH_3, R^3 = Ph), 103-65-1; **9** (R^1 = R^2 = CH_3, R^3 = Ph, R^4 = Et, n = 1), 130012-16-7; **9** (R^1 = R^2 = CH_3, R^3 = R^4 = Ph, n = 1), 130012-17-8; **9** (R^1 = H, R^2-R^3 = $(CH_2)_{10}$, R^4 = Et, n = 1), 130012-18-9; **9** (R^1 = H, R^2, R^3 = $(CH_2)_{10}$, R^4 = Ph, n = 1), 130012-19-0; **9** (R^1 = R^2 = CH_3, R^3 = Ph, R^4 = Et, n = 2), 130012-20-3; **9** (R^1 = R^2 = CH_3, R^3 = R^4 = Ph, n = 2), 130012-21-4; **9** (R^1 = H, R^2-R^3 = $(CH_2)_{10}$, R^4 = Et, n = 2), 130012-22-5; **9** (R^1 = H, R^2, R^3 = $(CH_2)_{10}$, R^4 = Ph, n = 2), 130012-23-6; (*E*)-**9** (R^1 = H, R^2 = R^4 = Ph, R^3 = Me, n = 2), 30246-74-3; (*Z*)-**9** (R^1 = H, R^2 = R^4 = Ph, R^3 = Me, n = 2), 72568-90-2; **9** (R^1 = H, R^2 = C_4H_9, R^3 = CH_3, R^4 = Ph), 83180-27-2; (*E*)-**10** (R^1 = H, R^2 = C_4H_9, R^3 = CH_3), 14686-13-6; (*Z*)-**10** (R^1 = H, R^2 = C_4H_9, R^3 = CH_3), 6443-92-1; **11** (R^1 = H, R^2, R^3 = $(CH_2)_{10}$), 294-62-2; **11** (R^1 = H, R^2 = C_4H_9, R^3 = CH_3), 142-82-5; nickel diacetate, 373-02-4; *tert*-amyl alcohol, 75-85-4; dibenzothiophene *S*-oxide, 1013-23-6; dibenzothiophene *S*,*S*-dioxide, 1016-05-3; 2,2'-bipyridine, 366-18-7; quinoline, 91-22-5.

Clay-Supported Iron(III) Nitrate: A Multifunctional Reagent. Oxidation and Nitration of Nitrogen Bridgehead Compounds[1]

Mária Balogh,[†] Pascal Pennetreau,[‡] István Hermecz,*[,†] and André Gerstmans[‡]

Research Centre, Chinoin Pharmaceutical and Chemical Works Ltd., H-1325, Budapest, P.O. Box 110, Hungary, and Institut de Chimie, Université de Liège, Start-Tilman 4000 Liège, Belgium

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Ethyl 9-(hydroxyimino)-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate (**1**) is oxidized to the 9-nitro derivative **2** at ambient temperature with K-10 montmorillonite clay-supported iron(III) nitrate (Clayfen). The reaction involves direct oxidation of the hydroxyimino group, as shown by mass spectral analysis of ^{15}N-labeled compounds. The 9,9-dinitro derivative **3** was prepared from either **2** or **1** and Clayfen in refluxing methylene chloride. Analogues of **1** with a 9-formyl group (**4**) or a 9-((dimethylamino)methylene) group (**5**) were also converted into **2** and **3** by Clayfen. Similar nitration of pyridoquinazolinone **7** to **8** was accompanied by some dehydrogenation of the starting compound to **9**. Nitration of the oxazepino[1,2-*a*]pyrimidine-3-carboxylate **10** with an equimolar quantity of Clayfen gave the 10,10-dinitro compound **11**, whereas use of 0.5 equiv of Clayfen led to ring contraction, giving **2**.

Nitrogen bridgehead heterocycles have a wide variety of biological activities.[2] 4-Oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates contain an active methylene group[3] in position 9, which permits versatile transformations. For example, the introduction of a hydroxyimino group enhances the antiallergic activity.[4] We are interested in the transformations (especially oxidation, substitution, and hydrolysis) of the substituents in position 9 of this bicyclic ring system.

Oximes can be converted directly into nitro compounds by the use of a variety of oxidizing agents: *N*-bromosuccinimide–30% hydrogen peroxide–nitric acid,[5] per-

[†] Research Centre.
[‡] Institut de Chemie.

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Table I. Preparation of Nitro Compounds 2a–d and Dinitro Compounds 3a,b, 6, and 11a,c

entry	R	product	yield, %	mp, °C (solvent)	formula MW	UV λ_{max}	UV (log ε)	IR, cm^{-1} $\nu_{C=O}$ (ester)	IR, cm^{-1} $\nu_{C=O}$ (ring)	IR, cm^{-1} ν_{NO_2}
1a	H	**2a**	35	211	$C_{11}H_{13}N_3O_5$	385	226	1740	1680	1590
10a	H	**2a**	21	(EtOH)	267.243	(4.56)	(4.27)			1370
1b	6-Me	**2b**	34	220–221	$C_{12}H_{15}N_3O_5$	384	226	1740	1685	1585
4b	6-Me	**2b**	32	(EtOH)	281.270	(4.52)	(4.23)			1370
1a	H	**3a**	25	146–147	$C_{11}H_{12}N_4O_7$	308		1740	1680	1595
2a	H	**3a**	68	(EtOH)	312.242	(3.87)				1570
										1390
										1380
1b	6-Me	**3b**	31	oil	$C_{12}H_{14}N_4O_7$	312		1745	1685i	1580
2b	6-Me	**3b**	71		326.268	(3.81)			1710	1365
5	6-Me	**6**	12	230–231	$C_{12}H_{12}N_4O_7$	402	222	1730	1660	1570
					324.253	(3.83)	(3.67)			1320
4c	8-Me	**2c**	54	193–194	$C_{12}H_{15}N_3O_5$	388	228	1740	1690	1575
10c	8-Me	**2c**	22	(EtOH)	281.270	(4.44)	(4.17)			1350
4d	7-Me	**2d**	24	186–187	$C_{12}H_{15}N_3O_5$	392	230	1750	1690	1600
				(EtOH)	281.270	(4.42)	(4.12)			1360
10a	H	**11a**	60	131–132	$C_{12}H_{14}N_4O_7$	310		1750	1690	1580
				(EtOH)	326.268	(3.86)				1370
10c	8-Me	**11c**	47	120–121	$C_{13}H_{16}N_4O_7$	310		1740	1680	1570
				(EtOH)	340.295	(3.84)				1360

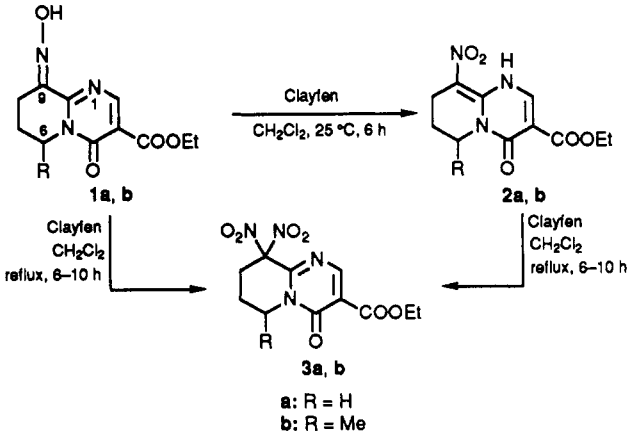
oxytrifluoroacetic acid,[6] an equimolar mixture of 100% nitric acid and ammonium nitrate,[7] nitric acid,[8] and dinitrogen tetraoxide in ether.[9] Nitrous acid in a well-stirred two-phase ether–water mixture leads to the formation of nitrimines, especially when the oxime site is sterically hindered;[10] the oxidation of oximes with nitrous acid is used for the recovery of the parent aldehydes and ketones.[11]

Laszlo et al. have used clay-supported copper(II) nitrate (Claycop) and iron(III) nitrate (Clayfen) as potential sources of the nitrosonium ion (NO^+) in a series of organic reactions, mainly oxidations and nitrations.[12] These novel heterogeneous reagents offer advantages over conventional homogeneous reagents because the reactions can be carried out under mild conditions with high yields and selectivities. We now report the use of Clayfen [K-10 montmorillonite-supported iron(III) nitrate] for transformations of several biologically active nitrogen bridgehead compounds.[13]

We have found that ethyl 9-(hydroxyimino)-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate and its 6-methyl analogue (**1a,b**) can be transformed into the 9-nitro derivatives **2a,b** at ambient temperature in the presence of 0.5 equiv of Clayfen[14,15] (Table I, Scheme I).

The structures of compounds **2** were determined by UV, IR, MS, and ^1H and ^{13}C NMR spectroscopy. The intense IR absorption bands at 1585–1590 and 1370 cm^{-1} suggested the presence of a nitro group, while the band at 3450 cm^{-1} could be assigned to the NH group. The H2 signal appears as a doublet at δ_H 8.36 in the ^1H NMR spectrum of **2a** (Table II) and becomes a singlet after addition of D_2O. The NH-1 (hydrogen bonded to the 9-nitro group) could be detected at δ_H 14.18 ppm. Compound **2b** was identical with an authentic sample prepared from the 9-bromotetrahydropyridopyrimidine-3-carboxylate.[16]

Scheme I



When the reactions of **1a,b** were carried out in boiling methylene chloride with 1 equiv of Clayfen, the corresponding 9,9-dinitro compounds **3a,b** were obtained. IR absorption bands at 1595, 1570 and 1390, 1380 cm^{-1} indicated the presence of two nitro groups (Table I). Mononitro compounds **2a,b** were also converted into **3a,b** in good yields by using 1 equiv of Clayfen in boiling methylene chloride.

Although many imino compounds can be cleaved into carbonyl compounds with Clayfen,[17] we could not detect any 9-oxotetrahydropyridopyrimidine-3-carboxylate[18] by TLC. We therefore wished to determine whether the formation of **2** from **1** involved oxidation of the hydroxyimino group or nitration of the enamine β-position followed by elimination of the nitroso group. The ^{15}N-enriched oxime **1b** (prepared with ^{15}N-enriched sodium nitrite, 50% ^{15}N) was converted into **2b** and **3b** under the same conditions used for the unlabeled compounds (Scheme II).

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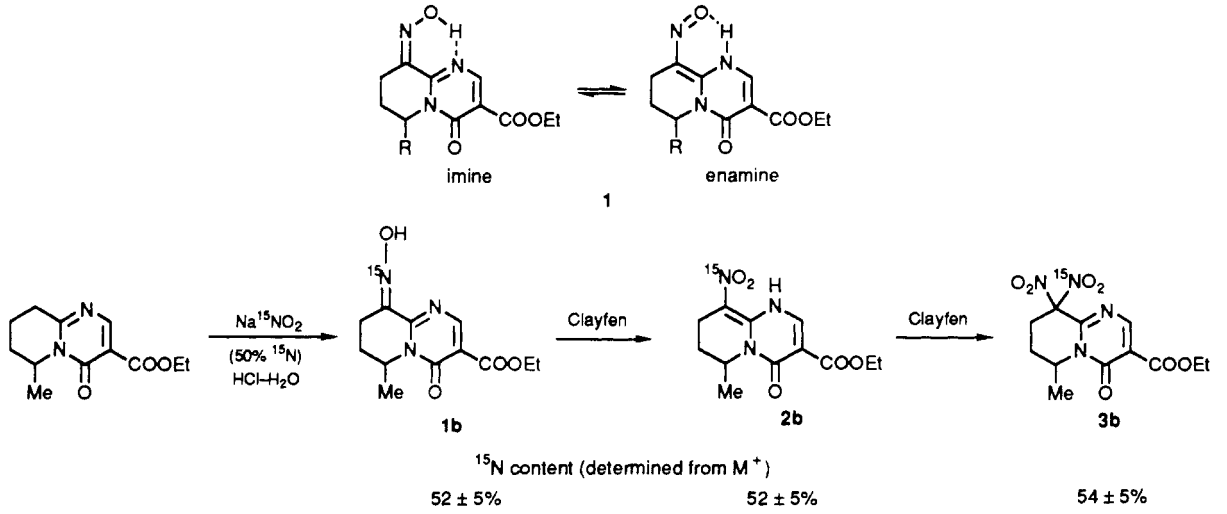
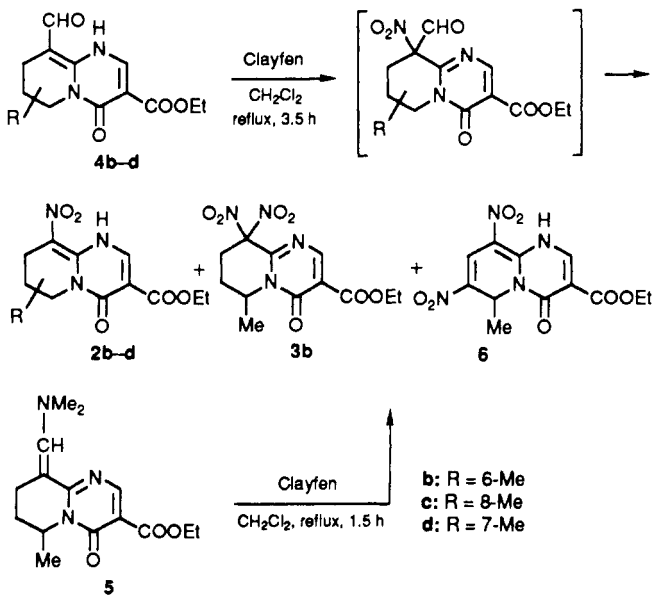
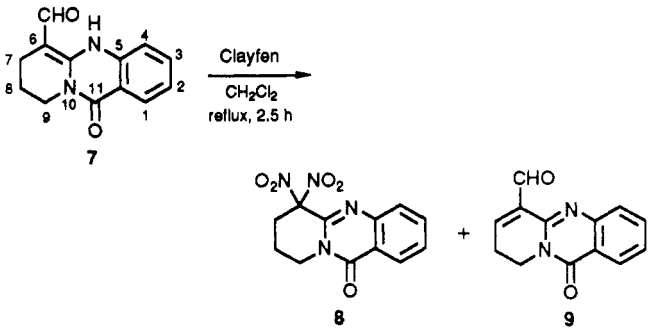
Scheme II



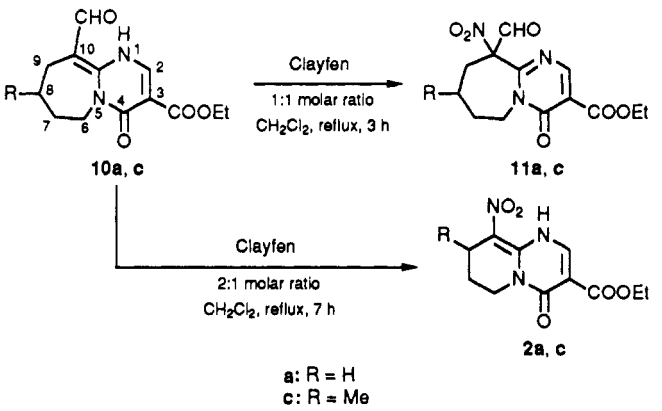
Scheme III



Scheme IV



Scheme V



The ^{15}N content (±5%) of **2b** and **3b** was determined from M^+ in their mass spectra by taking the natural isotope distribution into consideration. Isotope dilution was not observed; **1b**, **2b**, and **3b** had the same ^{15}N content within experimental error. Accordingly, the oxidation of **1b** with Clayfen involves oxidation of the hydroxyimino group.

Under milder conditions (0.5 equiv of Clayfen at ambient temperature), only oxidation of the oxime group of 1 occurred. Under more vigorous conditions (1 equiv of Clayfen at reflux), nitration at position 9 (formally on the β-carbon of the enamine) also took place.

Nitration of ethyl 9-formyl-6-methyl-1,6,7,8-tetrahydro-4-oxo-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate (**4b**)[19] with Clayfen yielded **2b** (32%) and **3b** (5%) (Scheme III). The formyl group was eliminated either by oxidation to a carboxy group followed by spontaneous decarboxylation[20] or by hydrolytic cleavage.

No reaction occurred when 9-unsubstituted ethyl 6-methyl-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate was treated with Clayfen under any of the above conditions. Nitration of ethyl 9-((dimethylamino)methylene)pyridopyrimidine-3-carboxylate (**5**)[19] gave **2b** (49.8%), **3b** (12.3%), and another dinitro compound, **6**, which contained nitro groups at positions 7 and 9 as well as an additional C–C double bond (Scheme III). The ^1H NMR H-8 signal of **6** appears as a doublet at δ_H 8.33 ppm, indicating long-range coupling with H-6 (^4J = 1 Hz).

Reaction of the tricyclic formyl compound **7**[21] with Clayfen gave 6,6-dinitro-6,7,8,9-tetrahydro-11*H*-pyrido[2,1-*b*]quinazolin-11-one (**8**) (34%) together with **9** (12%), a dehydrogenated derivative of the starting tricyclic compound. In the spectra of **9**, the IR band at 1710 cm^{-1} and

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Table II. ^{1}H NMR Data on Compounds 2a–d, 3a,b, 6, and 11a,c

compd no.	R	1-NH[a]	2-H	6-H$_e$	6-H$_a$	7-H$_e$	7-H$_a$	8-H$_e$	8-H$_a$	9-H$_e$	9-H$_a$	Me
2a	H	14.18	8.36 d[b] (J = 6 Hz)	4.04 m		1.95 m		2.90 t (J = 6 Hz)		–		–
2b	6-Me	14.19	8.42 d[b] (J = 6 Hz)	5.18 m		1.92 m		2.88 m				1.26 d (J = 6.5 Hz)
2c	8-Me	14.27 (J ~ 6.2 Hz)	8.34 d[b] (J = 6.2 Hz)	4.68 dddd[c]	3.37 ddd[c]	1.95 dddd[c]	1.87 dddd[c]	–	3.48 m[c]			1.25 d (J = 7 Hz)
2d	7-Me	14.04 (J ~ 6 Hz)	8.36 d[b] (J = 6 Hz)	4.46 ddd[c]	3.13 dd[c]	–	2.03 m	3.08 ddd[c]	2.39 dd[c]	–		1.16 d (J = 6.5 Hz)
3a	H	–	8.64 s	4.12 t (J = 6.5 Hz)		2.16 m		3.25 m		–		–
3b	6-Me	–	8.62 s	5.08 m		2.19 m		3.32 m		–		1.51 d (J = 6 Hz)
6[d]	6-Me	13.15	8.62 s	6.32 dq (J = 6 Hz, J = 1 Hz)		–		8.33 d (J = 1 Hz)		–		1.44 d (J = 6 Hz)
11a	H	–	8.48 s	4.25 m		1.98 m		1.98 m		3.05 m		
11c	8-Me	–	8.48 s	5.20 m	3.18 m	2.11 m (J = 6 Hz, J = 2 Hz)	1.96 m (J = 3 Hz)	–	1.79 m	3.06 ddd (J = 15 Hz, J = 3.5 Hz, J = 2.0 Hz)	2.63 dd (J = 15 Hz, J = 12.5 Hz)	1.18 d (J = 6.5 Hz)

[a] Broad signal. [b] Singlet after D_2O addition. [c] For the coupling constants, see Table IV. [d] In acetone-d_6.

the ^{1}H NMR singlet at δ_H 8.08 ppm proved the presence of a formyl group. Because of the C-6–C-7 double bond, H-7 shows a one-proton triplet at δ_H 6.57 ppm (Scheme IV).

An interesting difference was observed in the reactivity of ethyl 10-formyl-1,4,6,7,8,9-hexahydro-4-oxazepino[1,2-*a*]pyrimidine-3-carboxylate (**10a,c**), depending on the quantity of Clayfen present (Scheme V).

At a 1:1 molar ratio of the reactants, the expected 10,10-dinitro derivatives **11a,c** were formed (no other products could be detected by TLC), whereas in the presence of 0.5 equiv of Clayfen, **10** was transformed into **2** by a ring-contraction reaction.[23] The product **2a** isolated from this unexpected reaction was identical with the authentic sample prepared from the 9-(hydroxyimino)-pyridopyrimidine-3-carboxylate (**1a**).

In order to determine which part of the seven-membered ring is eliminated in the course of the ring contraction, we introduced a methyl group into position 8 (**10c**). When **10c** underwent ring contraction, the product was identical with ethyl 8-methyl-9-nitro-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate (**2c**) and not with the 7-methyl derivative **2d**; this was shown by comparison of their ^{1}H NMR spectra.[24] Thus the carbon atom bearing the formyl group (C-10) and the adjacent carbon atom (C-9) are involved in the reaction, but the exact mechanism remains to be elucidated.

The proton–proton coupling constants obtained from the 400-MHz ^{1}H NMR spectra show that the 7- and 8-methyl derivatives **2d** and **2c** exist exclusively in a single conformation with an equatorial methyl group (Table IV); this result is in accordance with the results of conformational analysis of dimethyl-6,7,8,9-tetrahydro-4*H*-pyrido-[1,2-*a*]pyrimidin-4-ones.[25]

Experimental Section

All melting points are uncorrected. Combustion analysis for C, H, and N gave results within 0.3% of theory. UV spectra were obtained in ethanol on a UNICAM SP 800 spectrometer. IR spectra were determined with KBr disks on a ZEISS UR 20 spectrophotometer. The ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ with BRUCKER WP-80 DS and VARIAN VXR 400 MHz spectrometers. Chemical shifts were determined on the δ scale with tetramethylsilane (δ = 0) as internal standard. Mass spectra were measured with a JEOL D 300 spectrometer operating at 70 eV. The progress of the reactions was monitored by TLC [silica gel 60 F_{254}, Merck, benzene/MeOH (4:1) and ethyl acetate/$CHCl_3$ (2:1)]. Silica gel 60 (Merck, 70–230 mesh ASTM) was used for column chromatography.

Clayfen was freshly prepared for all experiments. For details of the preparation and stability[26] of this reagent see ref 12a.

Oxidation of Oximes 1a,b to Ethyl 9-Nitro-4-oxo-1,6,7,8-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates (2a,b) (Scheme I). Method A. A mixture of **1a** or **1b**[4] (10 mmol), Clayfen[15] (5 g, 5 mmol), and CH_2Cl_2 (100 mL) was stirred at room temperature for 6 h. The clay was filtered off and washed with CH_2Cl_2 (2 × 50 mL), and the filtrate was evaporated to dryness and purified by column chromatography with benzene/MeOH

(22) Hermecz, I.; Horváth, Á.; Mészáros, Z.; Pongor-Csákvári, M.; Tóth, G.; Szilősy, Á. *J. Chem. Soc., Perkin Trans. 2* **1985**, 1873.

(23) When 0.5 equiv of Clayfen was used, a small quantity of dinitro compounds (generally less than 10%) was isolated together with the mononitro compounds on each occasion.

(24) The authentic ethyl 8-methyl-9-nitro-4-oxo-1,6,7,8-tetrahydro-4*H*-pyridopyrimidine-3-carboxylate (**2c**) and ethyl 7-methyl-9-nitro-4-oxo-1,6,7,8-tetrahydro-4*H*-pyridopyrimidine-3-carboxylate (**2d**) were prepared from the corresponding 9-formyl compounds **4c,d** by nitration with Clayfen.

(25) Podányi, B.; Hermecz, I.; Vasvári-Debreczy, L.; Horváth, Á. *J. Org. Chem.* **1986**, *51*, 394.

(26) *WARNING*: Clayfen decomposes above 59 °C, and it retains its activity for only a few hours at room temperature.

Table III. ^{13}C NMR Data on Compounds 1b, 2a,b, 3a,b, and 11a

C	1b, R = 6-Me	2a, R = H	2b, R = 6-Me	3a, R = H	3b, R = 6-Me	11a, R = H
3-$COOCH_2CH_3$	14.2	14.3	14.3	14.2	14.2	14.2
3-$COOCH_2CH_3$	61.4	61.6	61.6	62.0	61.9	61.9
3-$COOCH_2CH_3$	163.7	162.2	162.2	162.6	162.6	162.6
6-CH_3	17.4	-	17.1	-	19.0	-
2	157.4	145.0	145.0	155.7	155.4	154.9
3	115.1	106.7	106.9	119.1	119.4	118.9
4	157.3	156.1	155.7	157.2	156.8	157.4
6	46.7	41.9	47.0	42.8	49.4	42.9
7	17.9	19.0	19.3	17.3	24.5	25.3
8	24.5	23.4	24.1	29.9	27.4	24.8
9	147.5	111.0	110.1	116.5	116.4	34.4
9a	154.7	148.4	147.6	149.7	149.5	-
10	-	-	-	-	-	124.1
10a	-	-	-	-	-	153.8

Table IV. Proton–Proton Coupling Constants for Compounds 2c,d

	$J_{6a,6e}$	$J_{6a,7a}$	$J_{6a,7e}$	$J_{6e,7a}$	$J_{6e,7e}$	$J_{7a,7e}$	$J_{7a,8a}$	$J_{7a,8e}$	$J_{7e,8a}$	$J_{8a,8e}$	$^4J_{6e,8e}$	$^4J_{6e,8a}$
2c	14.5	13.0	4.0	4.5	3.0	14.0	13.0	-	2.5	-	-	1.5
2d	13.5	10.0	-	4.0	-	-	10.0	5.0	-	16.5	2.5	-

(99:1) as eluent. Yields, melting points, and physical data are given in Table I. For ^1H NMR data, see Table II; for ^{13}C NMR data, see Table III.

Preparation of Ethyl 9,9-Dinitro-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates (3a,b) from Oximes 1a,b. Method B. A mixture of **1a** or **1b**[4] (10 mmol), Clayfen (10 g, 10 mmol), and CH_2Cl_2 (100 mL) was stirred under reflux for 6–10 h. The clay was filtered off and washed with CH_2Cl_2 (2 × 50 mL), and the filtrate was evaporated in vacuo and purified by column chromatography with benzene/MeOH (99:1) as eluent (Table I).

Preparation of Ethyl 9,9-Dinitro-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates (3a,b) from 9-Nitro Compounds 2a,b. Method C. A mixture of **2a** or **2b** (5 mmol), Clayfen (5 g, 5 mmol), and CH_2Cl_2 (50 mL) was stirred under reflux for 6–10 h. The inorganic solid was filtered off and washed with CH_2Cl_2 (50 mL). The filtrate was evaporated to dryness, yielding pure dinitro compounds **3a,b** (Table I).

Reactions of Ethyl 9-Formyl-6(7 or 8)-methyl-4-oxo-1,6,7,8-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates (4b–d) with Clayfen (Scheme III). Method D. A mixture of 9-formyl compounds[19] **4b–d** (10 mmol), Clayfen (5 g, 5 mmol), and CH_2Cl_2 (100 mL) was stirred under reflux for 3.5 h. The clay was filtered off and washed with CH_2Cl_2 (50 mL), and the filtrate was evaporated and purified by column chromatography with benzene/MeOH (100:1) for **2b**, $CHCl_3$ for **2c**, and $CHCl_3$/MeOH (100:1) for **2d**. Yields and physical data are listed in Table I. In the reaction of **4b**, dinitro derivative **3b** was also isolated in 5% yield.

Nitration of Ethyl 9-((Dimethylamino)methylene)-6-methyl-4-oxo-6,7,8,9-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylate (5) (Scheme III). Method E. A mixture of **5**[19] (10 mmol), Clayfen (10 g, 10 mmol), and CH_2Cl_2 (100 mL) was stirred and refluxed for 1.5 h. The inorganic solid was filtered off, and the filtrate was evaporated and chromatographed with $CHCl_3$ as eluent. Compounds **2b** (1.4 g, 50%), **3b** (0.4 g, 12%), and **6** (0.4 g, 12%, M^+ 324) were isolated. For physical data, see Table I.

Reaction of 6-Formyl-5,7,8,9-tetrahydro-11*H*-pyrido[2,1-*b*]quinazolin-11-one (7) with Clayfen (Scheme IV). A mixture of tricyclic formyl compound **7**[21] (2.28 g, 10 mmol) and Clayfen (10 g, 10 mmol) was refluxed in CH_2Cl_2 (200 mL) for 2.5 h. The clay was filtered off, and after evaporation in the residue was chromatographed with $CHCl_3$ as eluent to yield **8** (1.0 g, 34%): mp 165 °C (EtOH); mass spectrum, *m/e* 290 (M^+), 244 (M – 46), 214 (M – 76), 197 (M – 93), 185 (M – 105); λ_{max} 292 nm (log ϵ 3.90); ν_{max} 1690 (C=O), 1590, 1570, 1330 cm^{-1} (NO_2); ^1H NMR ($CDCl_3$) δ 2.15 m (8-H_2), 3.26 (7-H_2), 4.15 t (J = 6.5 Hz, 9-H_2), 7.45–7.95 m (2,3,4-H), 8.30 m (1-H). Anal. Calcd for $C_{12}H_{10}N_4O_5$ (290.238): C, 49.66; H, 3.47; N, 19.30. Found: C, 49.41; H, 3.33; N, 19.41.

9: yield, 0.27 g (12%); λ_{max} 372 (log ϵ 2.97), 313 (3.42), 301 (3.51), 265 (3.81), 224 nm (4.41); ν_{max} 1710 (C=O, formyl), 1680 cm^{-1} (C=O, ring); ^1H NMR ($CDCl_3$) δ 3.04 dt (J = 6.5 Hz, 8-H_2), 4.25 t (J = 6.5 Hz, 9-H_2), 6.57 t (J = 6.5 Hz, 7-H), 7.42–7.88 m (2,3,4-H), 8.08 s (6-CHO), 8.28 dt (J = 7.5 Hz, 1-H). Anal. Calcd for $C_{13}H_{10}N_2O_2$ (226.236): C, 69.02; H, 4.46; N, 12.38. Found: C, 68.68; H, 4.22; N, 12.27.

10,10-Dinitro-4-oxo-4,6,7,8,9,10-hexahydroazepino[1,2-*a*]-pyrimidine-3-carboxylates (11a,c) (Scheme V). Method F. A mixture of formyl compound[22] **10a** or **10c** (10 mmol), Clayfen (10 g, 10 mmol), and CH_2Cl_2 (100 mL) was stirred under reflux for 3 h. The inorganic solid was filtered off, and the solution was filtered through a short column of silica gel and evaporated to dryness.

11a: mass spectrum, *m/e* 326 (M^+), 280 (M – 46), 250 (M – 76), 234 (M – 92), 219 (M – 107), 204 (M – 122), 189 (M – 137). Physical data on **11a** and **11c** are listed in Table I. ^1H NMR and ^{13}C NMR data can be found in Tables II and III, respectively.

Preparation of Ethyl 9-Nitro-4-oxo-1,6,7,8-tetrahydro-4*H*-pyrido[1,2-*a*]pyrimidine-3-carboxylates (2a,c) by Ring Contraction (Scheme V). Method G. A mixture of formyl compound[22] **10a** or **10c** (10 mmol) and Clayfen (5 g, 5 mmol) was refluxed in CH_2Cl_2 (100 mL) for 7 h. After filtration, the solvent was evaporated to dryness, and the residue was purified by column chromatography with $CHCl_3$ as eluent.

2a: yield 0.57 g (21.4%); mp 211–212 °C (EtOH); mass spectrum, *m/e* 267 (M^+), 251 (M – 16), 250 (M – 17), 249 (M – 18), 237 (M – 30), 222 (M – 45), 221 (M – 46), 175 (M – 92). This product was identical with an authentic sample prepared from **1a** (see above).

2c: yield 0.61 g (21.7%); mp 192–193 °C (EtOH). For physical data, see Table I; for ^1H NMR data, see Table II. Compound **11c** (0.47 g, 13.8%) was also isolated.

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Registry No. **1a**, 129986-68-1; **1b**, 64399-30-0; **2a**, 129986-69-2; **2b**, 111573-66-1; **2c**, 129986-70-5; **2d**, 129986-71-6; **3a**, 129986-72-7; **3b**, 129986-73-8; **4b**, 70999-37-0; **4c**, 71165-59-8; **4d**, 71165-64-5; **5**, 71165-23-6; **6**, 129986-74-9; **7**, 92883-84-6; **8**, 129986-75-0; **9**, 130011-59-5; **10a**, 102738-34-1; **10c**, 129986-76-1; **11a**, 129986-77-2; **11c**, 129986-78-3; clayfen, 10421-48-4.

Supplementary Material Available: Microanalytical and mass spectral data for compounds **2a–d**, **3a,b**, **6**, and **11a,c** (Table V) (1 page). Ordering information is given on any current masthead page.