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Base catalysed rearrangement of *N*-alkyl-*O*-acyl hydroxamic acids: synthesis of 2-acyloxyamides

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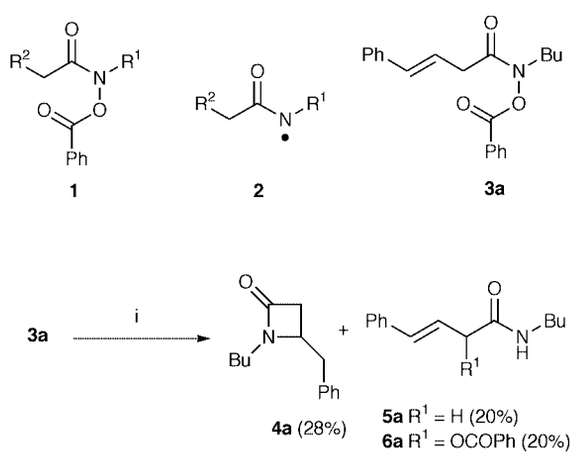
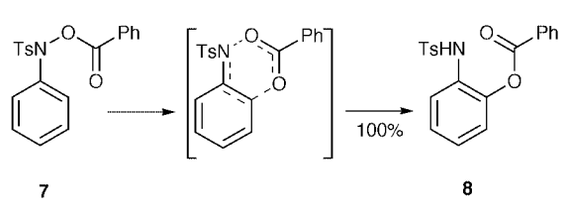
Activated *N*-alkyl-*O*-acyl hydroxamic acid derivatives **21a**–**t** undergo thermal and base catalysed rearrangement to give 2-acyloxyamides **22a**–**t** in good to excellent yields (50–100%). A range of inorganic and organic bases were screened for their efficiency in mediating the rearrangement **21** to **22**, however, simple organic bases such as Et_3N were found to be the most efficient. Both aromatic and aliphatic derived *O*-acyl groups were tolerated in the reaction. The electronic nature of the *O*-acyl group was found to effect the rate of the rearrangement with electron withdrawing groups (**21l** and **21o**) increasing the observed rate and electron donating groups (**21m** and **21n**) decreasing the observed rate. Cross-over experiments with **21a** and **21h** indicated a mechanism involving the intermediacy of free acyloxy anions. The requirement of a readily enolisable proton adjacent to the carbonyl group of the amide was found to be neccessary for the rearrangement as **21r** and **21t** both failed to rearrange under the reaction conditions investigated.

Introduction

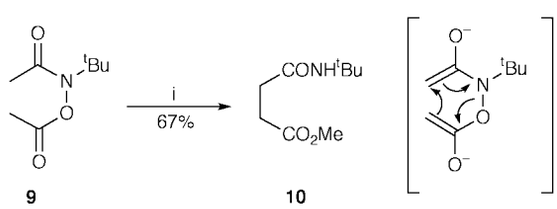
While hydroxamic acids and their derivatives were first studied over 100 years ago very few investigations into their chemistry have been reported.[1] This is suprising in light of the important biological properties of hydroxamic acid derivatives.[1] Even fewer synthetic studies have been reported on the reactions of *O*-acyl hydroxamic acids **1**. *N*-Alkyl-*O*-benzoyl hydroxamic acid derivatives **1** have recently been used as precursors to amidyl radicals **2** by both Zard and co-workers[2] and ourselves.[3] Amidyl radicals **2** could be conveniently generated from these precursors *via* homolytic cleavage of the N–O bond using either Bu_3SnH–AIBN[2,3a–c] or $Cu^{II}(OTf)_2$–DBN.†[3d] In this way it was possible to mediate a range of 4-*exo* cyclisations,[3a] 5-*exo* cyclisations,[2,3b,c] and tandem cyclisations.[2,3d] During these studies we noticed that some substrates produced varying amounts of 2-benzoyloxy amides as by-products.[3a,4] For example, reaction of the hydroxamic acid derivative **3a** with Bu_3SnH–AIBN in refluxing toluene furnished not only the expected cyclisation **4a** and reduction **5a** products but also the 2-benzoyloxyamide **6a** in 20% yield (Scheme 1).[2a] This transformation is similar to the reported thermal 1,3 rearrangement of *O*-benzoyl-*N*-(4-tolylsulfonyl)-*N*-arylhydroxylamine **7** which takes place on heating to 120 °C.[5] On the basis of ^{18}O tracer and kinetic experiments as well as examining substituent effects Oae and Sakurai[5] concluded that the mechanism of rearrangement of **7** was an intramolecular process, however the degree of polarisation in the transition state was dependant upon the overall substitution pattern of the compounds (Scheme 2). During the course of our work another related rearrangement was reported by Endo *et al.*[6] who described the KHMDS mediated anionic rearrangement of hydroxamic acid derivative **9** which gave **10** in 67% yield. The mechanism of the reaction was proposed to take place *via* a [3,3]-sigmatropic rearrangement of the di-enolate (Scheme 3). In light of these previous reports we hypothesised that the rearrangement observed in the reaction **3a**→**6a** might be occurring *via* a [3,3]-sigmatropic rearrangement of the enol form **11** of the substrate **3a** (Scheme 4) and we thus examined whether this reaction could be optimised to produce an efficient synthesis



Scheme 1 *Reagents and conditions*: i, Bu_3SnH, AIBN, toluene, 110 °C.



Scheme 2 *Reagents and conditions*: heat 120 °C.



Scheme 3 *Reagents and conditions*: i, KHMDS, −78 °C, THF; ii, CH_2N_2.

† DBN = 1,5-diazabicyclo[4.3.0]non-5-ene.

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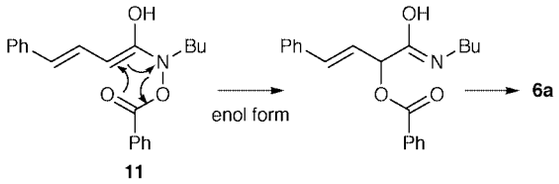
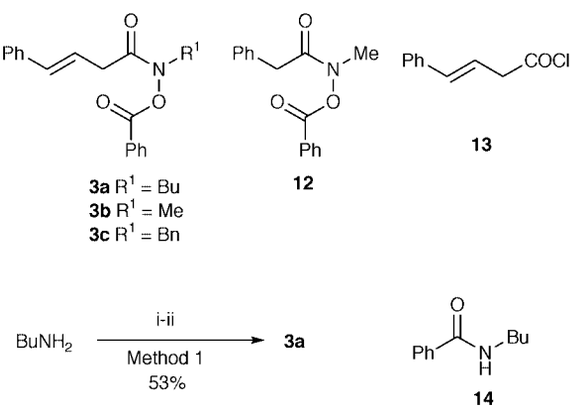


Scheme 4

of 2-benzoyloxyamide derivatives from *N*-alkyl-*O*-benzoyl hydroxamic acid derivatives **1**.

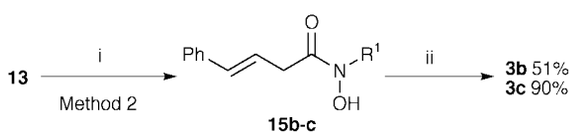
Synthesis of *N*-alkyl-*O*-benzoyl hydroxamic acids

We initially prepared a range of activated *N*-alkyl-*O*-benzoyl-4-phenylbut-3-enamide derivatives **3a**–**c** as well as the related *N*-methyl-*O*-benzoylphenylacetamide **12** in order to determine if the rearrangement could be mediated thermally. The precursors were prepared by one of two methods. The *N*-butyl precursor **3a** was prepared by a one-pot strategy in which butylamine was reacted with benzoyl peroxide in the presence of sodium carbonate followed by the addition of styrylacetyl chloride **13** according to the procedure of Psiorz and Zinner[7] (Scheme 5,



Scheme 5 *Reagents*: i, Bz_2O_2, Et_2O, Na_2CO_3; ii, **13**, CH_2Cl_2.

see method 1). While this approach was quick (3 h at room temperature) a significant amount of the amide **14** (30%) was also formed and the crude product was difficult to purify. As a consequence we prepared the other precursors **3b**,**c** and **12** *via* a two step strategy from the corresponding hydroxylamine hydrochloride salts. Hence, initial acylation with **13** or phenylacetyl chloride in the presence of Et_3N furnished *N*-alkylhydroxamic acids **15b**,**c** which were then *O*-benzoylated in a subsequent acylation step (benzoyl chloride, Et_3N at 0 °C) (Scheme 6). This two step procedure produced the desired

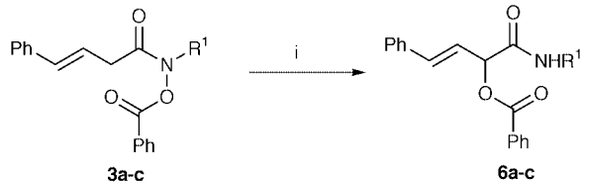


Scheme 6 *Reagents*: i, $R^1NHOH{\cdot}HCl$, Et_3N, CH_2Cl_2; ii, PhCOCl, Et_3N, CH_2Cl_2.

compounds in good overall yield (combined yield of both steps produced **3b** in 51%, **3c** in 90%, and **12** in 69% yield).

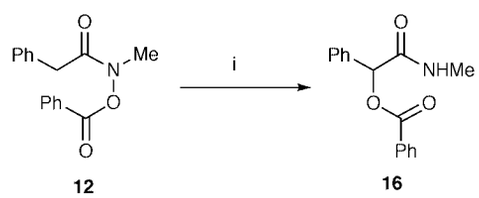
Thermal and base rearrangement of hydroxamic acid derivatives 3a–c and 12

We next attempted the thermal rearrangement of **3a**–**c** to give 2-benzoyloxyamides **6a**–**c** (Scheme 7). Initial reactions consisted of heating the *N*-methyl precursor **3b** at 110 °C in refluxing toluene for 24 h. After removal of the solvent, 250 MHz ^{1}H NMR analysis indicated that the reaction was



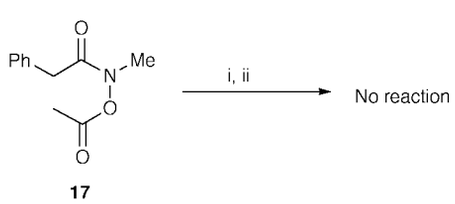
Scheme 7 *Reagents and conditions*: i, 140 °C, sealed tube, toluene, 1–4 days or see Table 1.

proceeding to give **6b**, albeit rather slowly (10% conversion). Increasing the temperature to 140 °C (using a sealed tube for 24 h) resulted in the completion of the reaction to give **6b** in 95% yield after chromatography. Utilising this approach it was also possible to obtain good yields of the *N*-butyl (**6a** 85%) and *N*-benzyl (**6c** 80%) analogues after 3 days and 4 days respectively. Having established that the thermal rearrangement of substrates **3a**–**c** was possible (presumably by reaction *via* their enol form **11**) we next investigated whether the addition of a base would help facilitate the rearrangement at a more convenient temperature. Hence, we screened the substrates **12** and **3a**–**b** using a variety of bases and under a variety of conditions of temperature and solvent (Table 1). Initial attempts at mediating the rearrangement of **12** with triethylamine at 40 °C in CH_2Cl_2 required extended reaction periods and furnished **16** in only 20% yield after 2 days (Scheme 8). However this could



Scheme 8 *Reagents and conditions*: i, Et_3N, see Table 1.

be improved by heating **12** with a catalytic amount of Et_3N at 110 °C in toluene (65%). Attempts to mediate the reaction using inorganic bases such as LiHMDS, NaHMDS and KHMDS in a range of solvents failed. This is in line with the observation of Endo *et al.* who reported the failure of the related *N*-methyl substituted substrate **17** to undergo rearrangement with KHMDS at a range of temperatures (Scheme 9).[6]



Scheme 9 *Reagents and conditions*: i, 2 eq. KHMDS, −78 °C, THF; ii, CH_2N_2.

They explained their results by postulating that the potassium enolate could not adopt the correct conformation for reaction *via* a cyclic transition state, primarily due to steric factors. Having shown that the organic base Et_3N was sufficient to facilitate the rearrangement of **12** we next examined a range of other organic bases. Hence, reaction of **3a** with either Et_3N or the more hindered Hunig's base (i-Pr_2EtN) furnished the desired rearranged compound **6a** in 63 and 48% yield respectively. In this case the use of the more hindered base slowed down the rate of the reaction. However, the use of 1 equivalent of the strong hindered phosphazene base **18** caused a rapid increase in the rate of the reaction (complete in 10 minutes at 0 °C) however the yield decreased considerably due to the formation of a second rearranged product **19** in 16% yield. The formation of this second product could be

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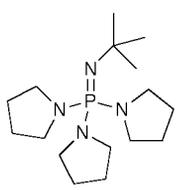
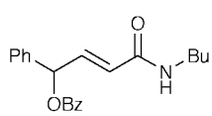
Table 1 Screening of bases in rearrangement reactions of **3a**–**b** and **12**

Substrate	Base[a]	Solvent	Temp/°C	Time/h	Yield (%)
12	Et_3N	CH_2Cl_2	40	48	20
12	Et_3N[b]	Toluene	110	12	65
12	NaHMDS	CH_2Cl_2	40	72	0
12	NaHMDS	THF	40	72	0
12	KHMDS	CH_2Cl_2	40	24	0
12	LiHMDS	Toluene	40	24	0
3a	Et_3N	CH_2Cl_2	40	4	63
3a	$^iPr_2EtN$	CH_2Cl_2	40	12	48
3a	**18**	CH_2Cl_2	0	0.2	19[c]
3a	**18**[b]	CH_2Cl_2	0	24	22[d]
3b	Et_3N	CH_2Cl_2	20	24	53
3b	Et_3N	CH_2Cl_2	40	4	56
3b	Et_3N	Toluene	110	0.5	85
3b	Et_3N[b]	Toluene	110	0.5	58

[a] 1 eq. of base. [b] 0.1 eq. of base. [c] 16% of compound **19** was also detected. [d] No **19** was detected.



18



19

suppressed if only a catalytic amount of **18** was used as base but the overall yield still remained low. The most convenient method for facilitating the rearrangements in good yield was to use either a stoichiometric amount of Et_3N at 40 °C in CH_2Cl_2 or a catalytic amount (10 mol%) of Et_3N in refluxing toluene (110 °C).

Effect of *N*-acyl and *O*-acyl substituents

The rearrangement described furnishes secondary 2-benzoyloxyamide derivatives **6a**–**c** and **16** which after deprotection of the benzoyl group would lead to secondary 2-hydroxyamides. In particular since 2-hydroxyamides are useful intermediates for the preparation of ethanolamines,[8] oxoindoles[9] and oxazolidinediones[10] new methods for their synthesis are of great interest. Few methods for the synthesis of 2-hydroxyamides are currently available. Most methods include oxidation of tertiary amide enolates with various reagents (MoO_5-peroxide,[11] sulfonyloxaziridines,[12] and dimethyldioxirane[13]), and reaction of α-hydroxyesters with amines.[10] While the former approach is useful for the synthesis of tertiary amides it is less applicable to primary and secondary amides while the latter approach often leads to low reaction yields. There have been very few methods for the synthesis of secondary 2-hydroxyamides directly, the most successful include a Lewis acid catalysed coupling between isocyanides and aldehydes[14] and the base promoted reaction of *O*-sulfonated hydroxamic acid derivatives in the presence of water.[15] Consequently we next investigated the scope and limitation of our rearrangement to furnish 2-hydroxyamide derivatives by examining the reaction of a range of different substrates. In particular we were interested in determining the effect of different *O*-acyl substituents upon the rearrangement as these would ultimately end up as "protecting groups" which would liberate 2-hydroxyamides after deprotection. Hence a range of compounds were prepared by initial acylation of *N*-methylhydroxylamine hydrochloride to produce **20a**–**h** (Table 2) followed by *O*-acylation to give **21a**–**u** (Table 3) using the same procedure as shown

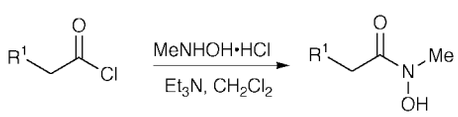
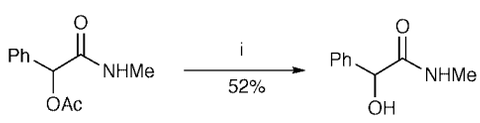


Table 2 Synthesis of hydroxamic acids **20a**–**h**

Substrate	R^1	Yield (%)
20a	4-MeC_6H_4	88
20b	4-$MeOC_6H_4$	86
20c	4-ClC_6H_4	71
20d	2-Thienyl	80
20e	$CH{=}CH_2$	55
20f	$(CH_2)_3Me$	98
20g	1-Naphthyl	87
20h	2-Naphthyloxy	96

in Scheme 6, method 2. Rearrangement was then carried out using Et_3N in either refluxing toluene or CH_2Cl_2 to give the rearranged compounds **22a**–**u** (Table 4). While benzoyl esters have been used as protecting groups for the alcohol functionality the acetate protecting group is one of the most common ester protecting groups[16] and we were thus gratified to find that the replacement of the *O*-benzoyl group with *O*-acetyl or *O*-pivaloyl was possible furnishing 2-acetoxyamide (**22a** and **22i**) and 2-pivaloyloxyamide (**22b** and **22j**) derivatives respectively. Deprotection of **22a** using K_2CO_3 in MeOH[17] was facile liberating the known 2-hydroxyacetamide[18] **23** in 52% yield (Scheme 10). Interestingly replacement of the



22a **23**

Scheme 10 *Reagents*: i, K_2CO_3, MeOH, H_2O.

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O-benzoyloxy group in **12** with the electron withdrawing *O*-4-nitrobenzoyloxy group **21c** markedly increased the rate of the rearrangement. This electronic effect was found to be general with electron withdrawing *O*-aryloxy substituents increasing the rate of the rearrangement (*e.g.* **21l** and **21o**) and electron releasing *O*-aryloxy subsituents significantly retarding the rate of the reaction (*e.g.* **21n** and **21m**). Although we did not undertake a detailed kinetic study of these electronic effects it was clearly observable in the series of rearrangements of the 2-thienyl substituted hydroxamic derivatives **21k**–**21o**. These results indicated that there must be a significant build up of negative charge on the oxygen of the N–O bond in the transition state for the reaction suggesting that the rearrangement is not a truly concerted process but either an intramolecular rearrangment in which the N–O bond is partially broken before formation of the C–O bond or an ionic intermolecular reaction proceeding *via* a free acyloxy anion. Further evidence for the latter mechanism was obtained from a cross-over experiment, hence when a 1:1 mixture of **21a** and **21h** was reacted with a stoichiometric amount of Et_3N at 110 °C in toluene for 5 days a 1:1:1:1 mixture of the expected rearranged **22a**, **22h** and cross-over products **22f**, **22v** were obtained respectively (as determined by comparison with authentic samples by GC) (Scheme 11). That this cross-over was not occurring by some other process (such as base catalysed transesterification of the products **22a** and **22h** after rearrangement) was discounted by subjecting a 1:1 mixture of the

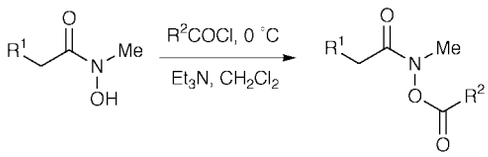
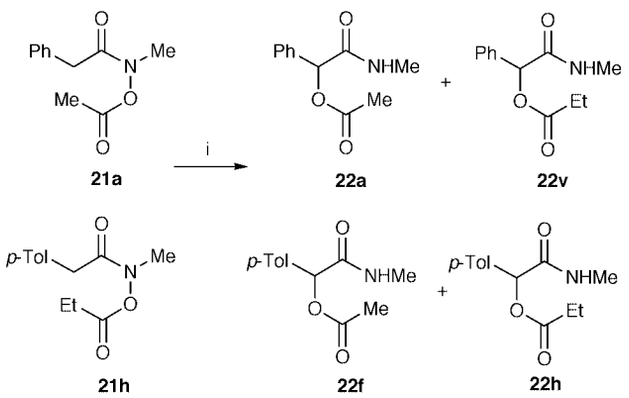


Table 3 Synthesis of *O*-acyl hydroxamic acid derivatives **21a**–**t**

Substrate	R^1	R^2	Yield (%)
21a	Ph	Me	80
21b	Ph	t-Bu	72
21c	Ph	4-$NO_2C_6H_4$	52
21d	Ph	CCl_3	0[a]
21e	4-$MeOC_6H_4$	Me	89
21f	4-MeC_6H_4	Me	80
21g	4-ClC_6H_4	Me	74
21h	4-MeC_6H_4	Et	90
21i	CH=CHPh	Me	75
21j	CH=CHPh	t-Bu	29
21k	2-Thienyl	Ph	82
21l	2-Thienyl	4-$NO_2C_6H_4$	88
21m	2-Thienyl	4-$MeOC_6H_4$	82
21n	2-Thienyl	4-MeC_6H_4	88
21o	2-Thienyl	4-ClC_6H_4	94
21p	2-Thienyl	Me	66
21q	$CH=CH_2$	4-$NO_2C_6H_4$	70
21r	$(CH_2)_3Me$	4-$NO_2C_6H_4$	77
21s	1-Naphthyl	4-$NO_2C_6H_4$	77
21t	2-Naphthyloxy	4-$NO_2C_6H_4$	82

[a] 10% of the rearranged compound **22d** was isolated.



Scheme 11 *Reagents and conditions*: i, Et_3N, toluene, 110 °C, 144 h.

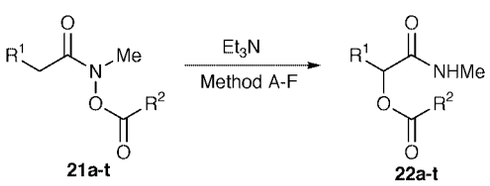


Table 4 Rearrangement of *O*-acyl hydroxamic acid derivatives **21a**–**t**

Substrate	R^1	R^2	Method[a]	Time/h	Yield (%)
21a	Ph	Me	A	24	75
21b	Ph	t-Bu	A	24	65
21c	Ph	4-$NO_2C_6H_4$	A	12	100
21d	Ph	CCl_3	—	—	—[b]
21e	4-$MeOC_6H_4$	Me	B	144	94
21f	4-MeC_6H_4	Me	B	120	74
21g	4-ClC_6H_4	Me	B	21	100
21h	4-MeC_6H_4	Et	B	120	82
21i	CH=CHPh	Me	A	24	99
21j	CH=CHPh	t-Bu	C	2	82
21k	2-Thienyl	Ph	D	24	100
21l	2-Thienyl	4-$NO_2C_6H_4$	E	2	100
21m	2-Thienyl	4-$MeOC_6H_4$	E	72	0[c]
21n	2-Thienyl	4-MeC_6H_4	E	24	100
21o	2-Thienyl	4-ClC_6H_4	E	4	100
21p	2-Thienyl	Me	E	1	90
21q	$CH=CH_2$	4-$NO_2C_6H_4$	D	24	50
21r	$(CH_2)_3Me$	4-$NO_2C_6H_4$	F	72	0
21s	1-Naphthyl	4-$NO_2C_6H_4$	A	12	86
21t	2-Naphthyloxy	4-$NO_2C_6H_4$	A	48	0

[a] Method A = 0.2 eq. Et_3N, toluene, 110 °C; Method B = 1.0 eq. Et_3N, toluene, 63 °C; Method C = 1.0 eq. Et_3N, CH_2Cl_2, rt; Method D = 0.6 eq. Et_3N, CH_2Cl_2, rt; Method E = 0.2 eq. Et_3N, CH_2Cl_2, 40 °C; Method F = 1.0 eq., Et_3N, toluene, sealed tube 140 °C. [b] See Table 3. [c] 95% when conducted at 110 °C with 0.1 eq. Et_3N.

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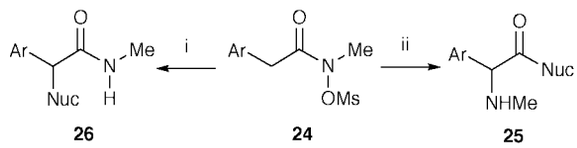
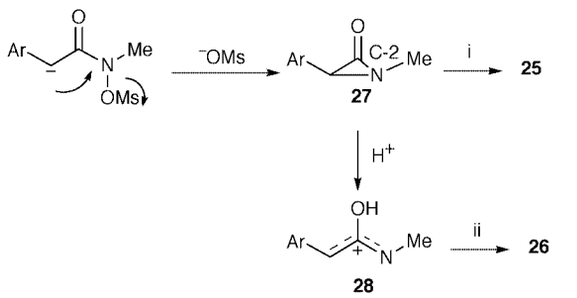
rearranged compounds **22a** and **22h** to the same reaction conditions (Et_3N for 5 days at 110 °C). Under these conditions no scrambling of the acyl groups to furnish cross-over products **22f** and **22v** occurred (as determined by GC). Recently, Hoffmann and co-workers described the base (Et_3N) mediated reactions of structurally related *O*-sulfonated hydroxamic acid derivatives **24** in the presence of nucleophiles.[19] With strong nucleophiles, products **25** were formed while with weak nucleophiles products analogous to those observed in our chemistry (*e.g.* **26**) were obtained (Scheme 12). They explained



Scheme 12 *Reagents*: i, Et_3N, weak nucleophile; ii, Et_3N, strong nucleophile.

the formation of products **25** and **26** by postulating an initial deprotonation followed by α-lactam **27** formation and ring opening to give **28** followed by trapping with weak nucleophiles (Scheme 13). With strong nucleophiles, trapping of

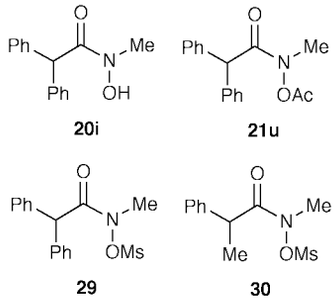


Scheme 13 *Reagents*: i, strong nucleophile; ii, weak nucleophile.

the C-2 of the intermediate α-lactam **27** was implicated to explain the formation of the products **25**.[20] They too observed that the electronic nature of the *O*-sulfonyl substituent affected the rate of reaction. Groups that were better able to stabilise a negative charge (*i.e.* better leaving groups) led to increased rates of product formation.[18] They also reported the same effect for substitution at the aryl group in **24**.[18] This effect was also paralleled in our chemistry with the chloro-substituted compound **21g** reacting substantially faster than the methoxy-substituted precursor **21e**.

Having established that the most efficient *O*-acyloxy substituent in terms of rate of migration was the 4-nitroaryloxy substituent we next varied the nature of the *N*-acyl group from activating **21q** and **21s** (*i.e.* groups which facilitate enolisation) to deactivating **21r** and **21t**. While it was possible to mediate the migrations of both **21q** and **21s** it was not possible to facilitate the rearrangement of the two unactivated precursors even under harsh reaction conditions. This type of limitation was also reported in the base mediated reactions of *O*-sulfonyl hydroxamic acid derivatives.[19] In these reactions the relative difficulty of the substrate to undergo facile enolisation is the most likely cause for this reactivity difference. However, the failure of the diphenyl analogue **21u** to undergo rearrangement (7 days, Et_3N, 110 °C) is not consistent with proton removal by base being the rate determining step indicating that the actual mechanism is likely to be substrate dependant. It is of note that the related *O*-sulfonylated derivative **29** was also reported not to undergo base mediated reaction as was the related methyl substituted precursor **30**.[19b]

In conclusion we have reported the efficient base catalysed rearrangement of *O*-acyl hydroxamic acid derivatives to 2-acyloxyamides. While the mechanism for the transformation still remains unclear, the observation that cross-over of acyloxy



substituents occurs during the course of the reaction indicates a free acyloxy anion is likely to be involved for the derivatives **21a** and **21h**. The failure of strong inorganic bases to mediate the transformation, however, is puzzling and currently unexplained. The requirement of a readily enolisable proton adjacent to the carbonyl of the amide remains a limitation, however, a wide array of potentially useful products can be prepared by this methodology.

Experimental

Melting points were recorded on a Stuart Scientific SMP1 melting point apparatus and are uncorrected. Accurate mass determinations were performed either on a Kratos MS80 at the University of Warwick or on a LC-MS SSS at Knoll Pharmaceuticals. Microanalyses were recorded on a Leeman Labs Inc. CE440 Elemental Analyser. Infra-red spectra were recorded in a solution cell, as Nujol mulls or neat, as stated in the text, on a Perkin-Elmer 1720X Fourier transform spectrometer. ^{1}H NMR spectra were recorded at either 250, 300, or 400 MHz on a Bruker ACF250, Bruker DPS300 or Bruker ACP400 instrument respectively. Chemical shifts are quoted in parts per million (ppm) and referenced to the appropriate solvent peak. Coupling constants (*J*) are given in hertz (Hz). ^{13}C NMR spectra were recorded at 62.9, 75, and 100.6 MHz. GC were run on a Shimadzu GC-14A using a BP10 column with a column temperature of 190 °C and injection temperature of 225 °C. Chemicals used in the experimental were obtained from either Lancaster or Sigma-Aldrich at the highest grade available. All solvents were purchased from Fisons Scientific Equipment at SLR grade and purified, when needed by literature methods. Flash chromatography was carried out on silica gel (Merck Kieselgel $60F_{254}$, 230–400 mesh). TLC was carried out using aluminium backed plates precoated with silica (0.2 mm, $60F_{254}$).

Synthesis of *N*-hydroxy-*N*-alkylacetamides. General procedure

Method 1: To a solution of *N*-alkylhydroxylamine hydrochloride (15 mmol) in dichloromethane (100 cm^3) at 0 °C was added triethylamine (30 mmol). The mixture was stirred for 10 min and a solution of the appropriate acid chloride (15 mmol) in dichloromethane (75 cm^3) was added dropwise over 45–60 minutes. The mixture was warmed to room temperature and stirred for 1 hour. The mixture was washed with dilute HCl (50 cm^3) and brine (50 cm^3) and dried over $MgSO_4$. Evaporation of the solvent gave the crude products which were purified by chromatography (petroleum ether–ethyl acetate 1 : 2).

***N*-Hydroxy-*N*-methylphenylacetamide.** Yield 91%; white crystalline solid, mp 55–56 °C (from hexane); mixture of two rotomers (Found: C, 65.45; H, 6.6. $C_9H_{11}NO_2$ requires C, 65.4; H, 6.8%); ν_{max}(Nujol)/cm^{-1} 3158, 3018, 1628, 1520, 1490, and 1216; δ_H(300 MHz; $CDCl_3$) 3.12 (3H, s, NMe, major rotomer), 3.37 (3H, s, NMe, minor rotomer), 3.70 (2H, s, CH_2, minor rotomer), 3.60 (2H, s, CH_2, major rotomer), 7.10–7.30 (5H, m, Ph), and 9.26 (1H, br s, OH); δ_C(75.5 MHz; $CDCl_3$) for both rotomers 36.4 (q), 37.2 (q), 39.0 (t), 39.4 (t), 127.1 (d), 127.5 (d),

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128.9 (d), 129.0 (d), 129.4 (d), 129.8 (d), 133.8 (s), 135.5 (s), 166.0 (s), and 172.8 (s); *m/z* EI 165.0793 (M^+, $C_9H_{11}NO_2$ requires 165.0790), 165 (M^+, 6%), 148 (3), 119 (9), 91 (68), and 83 (100).

***N*-Hydroxy-*N*-methyl-4-phenylbut-3-enamide 15b.** Yield 95%; white crystalline solid, mp 64–65 °C (from hexane) (Found: C, 68.8; H, 6.8; N, 7.5. $C_{11}H_{13}NO_2$ requires C, 69.1; H, 6.85; N, 7.3%); ν_{max}(Nujol)/cm^{-1} 3125, 1612, 1520, and 1476; δ_H(300 MHz; $CDCl_3$) 3.29 (3H, s, NMe), 3.40 (2H, d, *J* 8.0, CH_2), 6.22–6.50 (2H, m, CH=CH), and 7.20–7.40 (5H, m, Ar), OH not observed; *m/z* CI 192.1029 (MH^+, $C_{11}H_{14}NO_2$ requires 192.1023), 192 (MH^+, 43%), 176 (100), 162 (7), 117 (22), and 91 (9).

***N*-Hydroxy-*N*-benzyl-4-phenylbut-3-enamide 15c.** Yield 95%; white crystalline solid, mp 106–108 °C (from hexane); mixture of two rotomers (Found: C, 76.2; H, 6.4; N, 5.3. $C_{17}H_{17}NO_2$ requires C, 76.4; H, 6.4; N, 5.2%); ν_{max}(Nujol)/cm^{-1} 3130, 2922, 1607, and 1492; δ_H(250 MHz; $CDCl_3$) 3.27–3.49 (2H, br m, CH_2, both rotomers), 4.85 (2H, br s, CH_2Ph both rotomers), 6.16–6.50 (2H, br m, CH=CH both rotomers), and 7.17–7.37 (10H, br m, Ar both rotomers), OH not observed; *m/z* CI 268.1338 (MH^+, $C_{17}H_{18}NO_2$ requires 268.1338), 267 (M^+, 12%), 251 (11), 144 (56), 117 (100), and 91 (91).

***N*-Hydroxy-*N*-methyl-2-(4-methylphenyl)acetamide 20a.** Yield 88%; white crystalline solid, mp 40–41 °C (from hexane); mixture of two rotomers. (Found: C, 66.7; H, 7.3; N, 7.7. $C_{10}H_{13}NO_2$ requires C, 67.0; H, 7.3; N, 7.8%); ν_{max}(Nujol)/cm^{-1} 3150, 3012, 1624, 1514, and 1422; δ_H(300 MHz; $CDCl_3$) 2.31 (3H, s, CMe, major and minor rotomer), 3.18 (3H, s, NMe, major rotomer), 3.32 (3H, s, NMe, minor rotomer), 3.65 (2H, s, CH_2, minor rotomer), 3.71 (2H, s, CH_2, major rotomer), 7.12 (4H, m, Ph), and 9.20 (1H, br s, OH); δ_C(75.5 MHz; $CDCl_3$) for both rotomers 21.4 (2 × q), 36.4 (q), 37.1 (q), 38.7 (t), 39.0 (t), 128.8 (2 × d), 129.5 (2 × d), 129.7 (2 × d), 130.0 (2 × d), 130.8 (s), 132.4 (s), 136.6 (s), 137.6 (s), 166.3 (s), and 173.1 (s); *m/z* EI 179.0952 (M^+, $C_{10}H_{13}NO_2$ requires 179.0946), 179 (M^+, 50%), 132 (34), 105 (100), 91 (5), and 77 (12).

***N*-Hydroxy-*N*-methyl-2-(4-methoxyphenyl)acetamide 20b.** Yield 86%; white crystalline solid, mp 71–72 °C (from hexane); mixture of two rotomers (Found: C, 61.25; H, 6.7; N, 6.7. $C_{10}H_{13}NO_3$ requires C, 61.2; H, 6.7; N, 7.2%); ν_{max}(Nujol)/cm^{-1} 3150, 2921, 1614, 1512, and 1476; δ_H(300 MHz; $CDCl_3$) 3.18 (3H, s, NMe, minor rotomer), 3.33 (3H, s, NMe, major rotomer), 3.62 (2H, br s, CH_2, major rotomer), 3.64 (2H, br s, CH_2, minor rotomer), 3.68 (3H, s, OMe, major and minor rotomer), 6.86 (2H, m, major and minor Ar), 7.15 (2H, m, major and minor Ar), and 8.40 (1H, br s, OH); δ_C(75.5 MHz; $CDCl_3$) for major rotomer 36.6 (q), 37.9 (t), 55.7 (q), 114.7 (2 × d), 130.1 (2 × d), 127.5 (s), 158.7 (s), and 173.0 (s); *m/z* EI 195.0901 (M^+, $C_{10}H_{13}NO_3$ requires 195.0896), 195 (M^+, 50%), 180 (6), 149 (5), 121 (100), and 91 (14).

***N*-Hydroxy-*N*-methyl-2-(4-chlorophenyl)acetamide 20c.** Yield 71%; white crystalline solid, mp 70–71 °C (from hexane); mixture of two rotomers (Found: C, 54.3; H, 5.0; N, 6.7. $C_9H_{10}NO_2Cl$ requires C, 54.1; H, 5.0; N, 7.0%); ν_{max}(Nujol)/cm^{-1} 3150, 3019, 1628, 1521, and 1476; δ_H(300 MHz; $CDCl_3$) 3.15 (3H, s, NMe, minor rotomer), 3.33 (3H, s, NMe, major rotomer), 3.63 (2H, br s, CH_2, major rotomer), 3.68 (2H, br s, CH_2, minor rotomer), 7.07–7.22 (4H, m, Ar), and 8.80 (1H, br s, OH); δ_C(75.5 MHz; $CDCl_3$) for major rotomer 36.3 (q), 38.6 (t), 128.9 (2 × d), 131.2 (2 × d), 133.0 (s), 133.8 (s), and 172.3 (s); *m/z* EI 199 (M^+, 3%), 183 (30), 126 (95), 91 (65), and 58 (100).

***N*-Hydroxy-*N*-methyl-2-(2-thienyl)acetamide 20d.** Yield 80%; white crystalline solid, mp 80–81 °C (from hexane) (Found: C, 48.9; H, 5.25; N, 8.05. $C_{17}H_{17}NO_2$ requires C, 49.1; H, 5.3; N, 8.2%); ν_{max}(Nujol)/cm^{-1} 3130, 3015, 1626, and 1209; δ_H(250 MHz; $CDCl_3$) 3.15 (2H, br s, CH_2), 3.93 (3H, br s, NMe), 6.85–6.92 (2H, m, Ar), and 7.16 (1H, br d, *J* 4.9), OH not observed; δ_C(75.5 MHz; $CDCl_3$) 33.5 (t), 36.5 (q), 125.3 (d), 127.2 (d), 127.3 (d), 136.5 (s), and 171.6 (s); *m/z* CI 171.0345 (M^+, $C_7H_9NO_2S$ requires 171.0354), 171 (M^+, 43%), 156 (35), 124 (26), 111 (42), and 97 (100).

***N*-Hydroxy-*N*-methylbut-3-enamide 20e.** Yield 55%; white crystalline solid, mp 168–170 °C (from hexane); mixture of two rotomers; ν_{max}(Nujol)/cm^{-1} 3500–2500, 2922, 1628, and 1473; δ_H(250 MHz; $CDCl_3$) 3.05–3.23 (5H, br m, CH_2, NMe), 5.08–5.14 (2H, br m, CH=CH_2), 5.78–5.89 (1H, br m, CH=CH_2), and 7.51 (1H, br s, OH); *m/z* EI 115.0640 (M^+, $C_5H_9NO_2$ requires 115.0633), 115 (M^+, 22%), 101 (60), 85 (91), 69 (90), and 58 (100).

***N*-Hydroxy-*N*-methylhexanamide 20f.** Yield 98%; yellow oil; ν_{max}(neat)/cm^{-1} 3172, 2922, and 1622; δ_H(400 MHz; $CDCl_3$) 0.73 (3H, br t, *J* 7.0, Me), 1.20–1.24 (4H, br m, 2 × CH_2), 1.55 (2H, br m, CH_2), 2.24 (2H, br m, $COCH_2$), 3.10 (3H, s, NMe), and 3.22 (1H, br s, OH); δ_C(100.6 MHz; $CDCl_3$) 13.7 (q), 22.2 (t), 24.4 (t), 31.2 (t), 32.4 (t), 35.1 (q), and 174.9 (s); *m/z* CI 145.1104 (M^+, $C_7H_{15}NO_2$ requires 145.1103), 146 (MH^+, 5%), 130 (100), 128 (2), and 117 (3).

***N*-Hydroxy-*N*-methyl-2-(1-naphthyl)acetamide 20g.** Yield 87%; white crystalline solid, mp 115–120 °C (from hexane) (Found: C, 72.45; H, 6.1; N, 6.6. $C_{13}H_{13}NO_2$ requires C, 72.5; H, 6.1; N, 6.5%); ν_{max}(Nujol)/cm^{-1} 3008, 2922, and 1600; δ_H(400 MHz; DMSO-d_6) 3.60 (3H, s, NMe), 4.20 (2H, s, CH_2), 7.40–8.00 (7H, m, Ar), and 10.21 (1H, br s, OH); δ_C(100.6 MHz; DMSO-d_6) 36.0 (q), 36.2 (t), 124.4 (s), 125.6 (d), 125.7 (d), 126.0 (d), 127.1 (d), 128.1 (s), 128.5 (s), 132.3 (d), 132.7 (d), 133.4 (d), and 171.0 (s); *m/z* EI 215.0897 (M^+, $C_{13}H_{13}NO_2$ requires 215.0946), 216 (MH^+, 12%), 199 (18), 141 (100), 115 (25), 105 (10), and 89 (5).

***N*-Hydroxy-*N*-methyl-2-(2-naphthyloxy)acetamide 20h.** Yield 96%; white crystalline solid, mp 180–190 °C (from hexane); ν_{max}($CHCl_3$)/cm^{-1} 3426, 2962, and 1657; δ_H(400 MHz; DMSO-d_6) 3.20 (3H, s, NMe), 5.00 (2H, s, CH_2), 7.20–7.44 (7H, m, Ar), 10.21 (1H, br s, OH); δ_C(100.6 MHz; DMSO-d_6) 35.8 (q), 64.8 (t), 107.0 (s), 118.3 (s), 123.5 (d), 123.7 (d), 126.0 (d), 126.5 (d), 127.3 (s), 129.0 (s), 135.0 (d), 156.0 (s), and 168.0 (s); *m/z* EI 231.0851 (M^+, $C_{13}H_{13}NO_3$ requires 231.0895), 231 (M^+, 10%), 215 (90), 144 (100), 127 (80), 115 (73), and 86 (20).

***N*-Hydroxy-*N*-methyl-2,2-diphenylacetamide 20i.**[19b] Yield 26%; white crystalline solid, mp 87.8–88.9 °C (from hexane); mixture of two rotomers; ν_{max}($CHCl_3$)/cm^{-1} 3416, 2927, 1704, and 1605; δ_H(250 MHz; $CDCl_3$) 3.22 (3H, s, NMe, minor rotomer), 3.35 (3H, s, NMe, major rotomer), 5.11 (1H, br s, CH, major rotomer), 5.62 (1H, br s, CH, minor rotomer), 7.28–7.35 (10H, m, 2 × Ar), 9.09 (1H, br s, OH); *m/z* CI 242.1171 (MH^+, $C_{15}H_{16}NO_2$ requires 242.1182), 241 (M^+, 15%), 212 (25), 167 (100), and 152 (46).

***N*-Benzoyloxy-*N*-methyl-4-phenylbut-3-enamide 3b.** Yield 54%; clear oil; ν_{max}(neat)/cm^{-1} 1763, 1710, and 1248; δ_H(250 MHz; $CDCl_3$) 3.30 (2H, d, *J* 6.0, CH_2CO), 3.44 (3H, s, NMe), 6.29 (1H, dt, *J* 16.0 and 6.0, C*H*=CHPh), 6.40 (1H, d, *J* 16.0, CH=C*H*Ph), 7.15–7.34 (5H, m, Ar), 7.51 (2H, m, Ar), 7.68 (1H, m, Ar), and 8.09 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 35.7 (q), 36.9 (t), 121.5 (d), 126.2 (d), 126.6 (2 × d), 127.4 (d), 128.4 (2 × d), 128.9 (2 × d), 129.9 (2 × d), 133.3 (s), 134.5 (d), 136.7 (s), 164.2 (s), and 171.1 (s); *m/z* CI 296.1287 (MH^+, $C_{18}H_{18}NO_3$ requires 296.1287), CI 296 (MH^+, 21%), 176 (100), and 105 (27).

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***N*-Benzyl-*N*-benzoyloxy-4-phenylbut-3-enamide 3c.** Yield 95%; clear oil; ν_{max}(neat)/cm^{-1} 1766, and 1682; δ_H(250 MHz; $CDCl_3$) 3.36 (2H, d, *J* 5.2, CH_2CO), 5.08 (2H, s, NCH_2), 6.30–6.46 (2H, m, CH=CH), 7.21–7.52 (10H, m, Ar), 7.40 (2H, m, Ar), 7.65 (1H, m, Ar), and 8.02 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 37.1 (t), 51.7 (t), 121.8 (d), 126.2 (d), 126.5 (2 × d), 127.4 (d), 127.9 (2 × d), 128.4 (2 × d), 128.6 (2 × d), 128.8 (2 × d), 129.7 (2 × d), 129.9 (d), 133.6 (s), 134.5 (d), 135.0 (s), 136.7 (s), 164.8 (s), and 171.33 (s); *m*/*z* CI 372.1602 (MH^+, $C_{24}H_{21}NO_3$ requires 372.1601), CI 372 (MH^+, 61%), 266 (14), 250 (71), 105 (100), and 91 (37).

***N*-Acetoxy-*N*-methyl-2-phenylacetamide 21a.** Yield 80%; white crystalline solid, mp 40.1–41.2 °C (from hexane) (Found: C, 63.5; H, 6.25; N, 6.4. $C_{11}H_{13}NO_3$ requires C, 63.75; H, 6.3; N, 6.8%); ν_{max}($CHCl_3$)/cm^{-1} 1792, 1674, and 1600; δ_H(300 MHz; $CDCl_3$) 1.95 (3H, s, Me), 3.17 (3H, s, NMe), 3.53 (2H, s, CH_2), and 7.10–7.22 (5H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 18.7 (q), 35.9 (br q), 40.1 (t), 127.4 (2 × d), 129.0 (2 × d), 129.5 (d), 134.3 (s), 168.5 (s), and 171.9 (br s); *m*/*z* EI 207.0894 (M^+, $C_{11}H_{13}NO_3$ requires 207.0895), 207 (M^+, 55%), 148 (77), 118 (80), and 91 (100).

***N*-Pivaloyloxy-*N*-methyl-2-phenylacetamide 21b.** Yield 72%; colourless oil; ν_{max}(neat)/cm^{-1} 1762, 1676 and 1599; δ_H(250 MHz; $CDCl_3$) 1.28 (9H, s, t-Bu), 3.24 (3H, s, NMe), 3.56 (2H, s, CH_2), and 7.21–7.28 (5H, m, Ph); δ_C(100.6 MHz; $CDCl_3$) 26.3 (q), 26.7 (q), 26.9 (q), 27.0 (s), 35.0 (q), 38.2 (t), 126.8 (d), 128.7 (2 × d), 128.7 (2 × d), 133.3 (s), 168.1 (s), and 170.7 (s); *m*/*z* EI 249.1368 (M^+, $C_{14}H_{19}NO_3$ requires 249.1365), CI 250 (MH^+, 20%), 166 (5), 150 (15), 118 (18), 91 (100), and 85 (70).

***N*-(4-Nitrobenzoyloxy)-*N*-methyl-2-phenylacetamide 21c.** Yield 51%; yellow solid, mp 135–138 °C; ν_{max}(Nujol)/cm^{-1} 1770, 1677, and 1600; δ_H(250 MHz; $CDCl_3$) 3.34 (3H, s, NMe), 3.63 (2H, s, CH_2), 7.10–7.20 (5H, m, Ar), and 8.09–8.22 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 36.7 (q), 40.5 (t), 124.2 (d), 127.5 (2 × d), 128.8 (2 × d), 129.4 (2 × d), 131.5 (2 × d), 132.5 (s), 133.8 (s), 151.6 (s), 162.8 (s), and 171.7 (s); *m*/*z* EI 314.0908 (M^+, $C_{16}H_{14}N_2O_5$ requires 314.0903), CI 315 (MH^+, 20%), 150 (100), 120 (30), 92 (70), and 66 (20).

***N*-Acetoxy-*N*-methyl-2-(4-methoxyphenyl)acetamide 21e.** Yield 80%; white crystalline solid, mp 46–47 °C (from hexane) (Found: C, 60.65; H, 6.4; N, 5.6. $C_{12}H_{15}NO_4$ requires C, 60.7; H, 6.4; N, 5.9%); ν_{max}($CHCl_3$)/cm^{-1} 1793, 1670, and 1611; δ_H(300 MHz; $CDCl_3$) 2.12 (3H, s, Me), 3.26 (3H, s, NMe), 3.53 (2H, s, CH_2), 3.75 (3H, s, OMe), 6.81 (2H, d, *J* 8.5, Ar), and 7.11 (2H, d, *J* 8.5, Ar); δ_C(100.6 MHz; $CDCl_3$) 18.8 (q), 22.5 (q), 39.2 (t), 55.6 (q), 114.4 (2 × d), 126.2 (s), 130.5 (2 × d), 159.0 (s), and 168.5 (s), signals for NMe and CO not observed; *m*/*z* CI 237.1009 (M^+, $C_{12}H_{15}NO_4$ requires 237.1002), 238 (MH^+, 100%), 210 (45), 148 (62), and 121 (76).

***N*-Acetoxy-*N*-methyl-2-(4-methylphenyl)acetamide 21f.** Yield 89%; white crystalline solid, mp 48–49 °C (Found: C, 65.0; H, 6.8; N, 6.2. $C_{12}H_{15}NO_3$ requires C, 65.1; H, 6.85; N, 6.3%); ν_{max}($CHCl_3$)/cm^{-1} 1794, 1669, and 1601; δ_H(300 MHz; $CDCl_3$) 2.07 (3H, s, Me), 2.22 (3H, s, Me), 3.20 (3H, s, NMe), 3.50 (2H, s, CH_2), and 7.01 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 18.8 (q), 21.4 (q), 39.8 (t), 129.3 (2 × d), 129.7 (2 × d), 131.1 (s), 137.0 (s), and 168.5 (s), signals for NMe and CO not observed; *m*/*z* EI 221.1056 (M^+, $C_{12}H_{15}NO_3$ requires 221.1053), 221 (M^+, 12%), 179 (17), 132 (60), 105 (100), and 91 (10).

***N*-Acetoxy-*N*-methyl-2-(4-chlorophenyl)acetamide 21g.** Yield 74%; yellow oil (Found: C, 54.3; H, 5.0; N, 5.6. $C_{11}H_{12}NO_3Cl$ requires C, 54.6; H, 5.0; N, 5.8%); ν_{max}(neat)/cm^{-1} 1792, 1675, and 1598; δ_H(300 MHz; $CDCl_3$) 2.15 (3H, s, Me), 3.26 (3H, s, NMe), 3.55 (2H, s, CH_2), 7.12 (2H, d, *J* 9.8, Ar), and 7.25 (2H, d, *J* 9.8, Ar); δ_C(100.6 MHz; $CDCl_3$) 18.2 (q), 38.5 (t), 128.5 (2 × d), 130.4 (2 × d), 132.0 (s), 132.8 (s), and 167.8 (s), signals for NMe and CO not observed; *m*/*z* EI 241.0504 (M^+, $C_{11}H_{12}NO_3Cl$ requires 241.0506), 241 (M^+, 16%), 184 (25), 152 (70), 125 (100), and 89 (55).

***N*-Propanoyloxy-*N*-methyl-2-(4-methylphenyl)acetamide 21h.** Yield 90%; clear oil (Found: C, 65.7; H, 7.3; N, 5.9. $C_{13}H_{17}NO_3$ requires C, 66.3; H, 7.3; N, 5.95%); ν_{max}(neat)/cm^{-1} 1787, and 1677; δ_H(250 MHz; $CDCl_3$) 1.19 (3H, t, *J* 7.5, CH_2CH_3), 2.24 (3H, s, Me), 2.36 (2H, q, *J* 7.5, CH_2CH_3), 3.21 (3H, s, NMe), 3.50 (2H, s, CH_2), and 7.03 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 9.0 (q), 21.4 (q), 25.6 (t), 39.7 (t), 129.3 (2 × d), 129. 7 (2 × d), 131.1 (s), 136.9 (s), 163.9 (s), and 172.1 (s), the NMe signal was too broad to be observed; *m*/*z* EI 235.1208 (M^+, $C_{13}H_{17}NO_3$ requires 235.1205), EI 235 (M^+, 11%), 163 (11), 132 (52), 105 (100), and 91 (20).

***N*-Acetoxy-*N*-methyl-4-phenylbut-3-enamide 21i.** Yield 75%; clear oil; ν_{max}(neat)/cm^{-1} 1778, and 1673; δ_H(400 MHz; $CDCl_3$) 2.12 (3H, s, Me), 3.16 (2H, d, *J* 6.6, CH_2), 3.25 (3H, s, NMe), 6.22 (1H, dt, *J* 16.0 and 6.8, CH_2CH=CH), 6.40 (1H, d, *J* 16.0, CH_2CH=C*H*), and 7.31 (5H, m, Ph); δ_C(100.6 MHz; $CDCl_3$) 18.4 (q), 35.4 (t), 36.8 (q), 121.7 (d), 122.7 (d), 126.3 (d), 127.6 (2 × d), 128.5 (2 × d), 133.5 (s), 168.3 (s), and 171.0 (s); *m*/*z* EI 233.1010 (M^+, $C_{13}H_{15}NO_3$ requires 233.1052), 233 (M^+, 11%), 191 (100), 144 (60), 117 (60), and 91 (40).

***N*-Pivaloyloxy-*N*-methyl-4-phenylbut-3-enamide 21j.** Yield 29%; clear oil; ν_{max}(neat)/cm^{-1} 1789, 1698, and 1620; δ_H(400 MHz; $CDCl_3$) 1.31 (9H, s, t-Bu), 3.16 (2H, d, *J* 5.5, CH_2), 3.27 (3H, s, NMe), 6.20 (1H, dt, *J* 15.9 and 6.8, CH_2CH=CH), 6.50 (1H, d, *J* 15.9, CH_2CH=C*H*), and 7.20–7.31 (5H, m, Ph); δ_C(100.6 MHz; $CDCl_3$) 26.4 (q), 27.0 (q), 27.0 (s), 27.1 (q), 35.3 (q), 36.7 (t), 121.7 (d), 121.6 (d), 126.3 (d), 127.6 (2 × d), 128.5 (2 × d), 136.9 (s), 171.2 (s), and 175.6 (s); *m*/*z* EI 275.1523 (M^+, $C_{16}H_{21}NO_3$ requires 275.1522), CI 276 (MH^+, 35%), 234 (20), 174 (100), 117 (60), and 91 (20).

***N*-Benzoyloxy-*N*-methyl-2-(2-thienyl)acetamide 21k.** Yield 82%; yellow oil (Found: C, 61.4; H, 4.7; N, 5.0. $C_{14}H_{13}NO_3S$ requires C, 61.1; H, 4.75; N, 5.1%); ν_{max}(neat)/cm^{-1} 1709, 1675, and 1579; δ_H(400 MHz; $CDCl_3$) 3.31 (3H, s, NMe), 3.76 (2H, s, CH_2), 6.78 (2H, m, thienyl), 7.07 (1H, dd, *J* 4.3 and 1.1, thienyl), and 7.15–7.60 (5H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 33.7 (t), 35.8 (br q), 125.0 (d), 126.5 (d), 126.7 (d), 128.9 (2 × d), 130.0 (2 × d), 135.8 (d), 134.9 (s), 163.3 (s), and 164.1 (s); *m*/*z* EI 275.0606 (M^+, $C_{14}H_{13}NO_3S$ requires 275.0616), EI 275 (M^+, 1%), 155 (4), 135 (25), 105 (100), and 97 (51).

***N*-(4-Nitrobenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 21l.** Yield 88%; white crystalline solid, mp 121–122 °C (from hexane) (Found: C, 52.2; H, 3.8; N, 8.1. $C_{14}H_{12}N_2O_5S$ requires C, 52.5; H, 3.8; N, 8.7%); ν_{max}(neat)/cm^{-1} 1774, 1683, and 1602; δ_H(300 MHz; $CDCl_3$) 3.46 (3H, s, NMe), 3.89 (2H, s, CH_2), 6.87 (1H, br s, thienyl), 6.92 (1H, dd, *J* 3.7 and 2.0, thienyl), 7.19 (1H, d, *J* 3.7, thienyl), 8.24 (2H, d, *J* 7.1, Ar), and 8.35 (2H, d, *J* 7.1, Ar); δ_C(100.6 MHz; $CDCl_3$) 30.9 (q), 34.2 (t), 124.0 (2 × d), 125.2 (d), 126.8 (d), 126.9 (d), 131.3 (2 × d), 132.0 (s), 134.4 (s), 151.3 (s), and 162.4 (s), other CO not found at room temperature (found at 170.6 in d_8-toluene, −70 °C with 5 s relaxation delay); *m*/*z* EI 320.0470 (M^+, $C_{14}H_{12}N_2O_5S$ requires 320.0467), EI 320 (M^+, 1%), 266 (10), 150 (80), 97 (95), and 83 (100).

***N*-(4-Methoxybenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 21m.** Yield 82%; yellow oil (Found: C, 58.5; H, 5.0; N, 4.3. $C_{15}H_{15}NO_4S$ requires C, 59.0; H, 4.95; N, 4.6%); ν_{max}($CHCl_3$)/cm^{-1} 1756, 1675, and 1605; δ_H(300 MHz; $CDCl_3$) 3.31 (3H, s,

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NMe), 3.75 (2H, s, CH_2), 3.78 (3H, s, OMe), 6.77–6.82 (2H, m, thienyl), 6.88 (2H, m, Ar), 7.07 (1H, dd, *J* 5.3 and 1.3, thienyl), and 7.94 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 34.1 (t), 36.1 (br q), 56.0 (q), 114.6 (2 × d), 118.9 (s), 125.4 (d), 127.1 (d), 127.2 (d), 132.7 (2 × d), 134.9 (s), 164.1 (s), 164.2 (s), and 165.1 (s); *m*/*z* CI 306.0798 (MH^+, $C_{15}H_{16}NO_4S$ requires 306.0800), CI 306 (MH^+, 100%), 170 (71), 156 (95), and 135 (82).

***N*-(4-Methylbenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 21n.** Yield 88%; yellow oil (Found: C, 62.25; H, 5.2; N, 4.1. $C_{15}H_{15}NO_3S$ requires C, 62.2; H, 5.2; N, 4.8%); ν_{max}($CHCl_3$)/cm^{-1} 1757, 1676, and 1608; δ_H(250 MHz; $CDCl_3$) 2.69 (3H, s, Me), 3.23 (3H, s, NMe), 3.67 (2H, s, CH_2), 6.68 (1H, br s, thienyl), 6.72 (1H, dd, *J* 4.2 and 3.0, thienyl), 6.98 (1H, dd, *J* 4.2 and 1.0, thienyl), 7.13 (2H, d, *J* 6.8, Ar), and 7.80 (2H, d, *J* 6.8, Ar); δ_C(100.6 MHz; $CDCl_3$) 22.2 (q), 34.1 (t), 36.1 (br q), 124.1 (s), 125.4 (d), 127.1 (d), 127.2 (d), 130.1 (2 × d), 130.5 (2 × d), 135.3 (s), 146.2 (s), and 164.5 (s), other C=O not found; *m*/*z* EI 289.0766 (M^+, $C_{15}H_{15}NO_3S$ requires 289.0772), EI 289 (M^+, 1%), 149 (4), 136 (6), 119 (100), and 91 (40).

***N*-(4-Chlorobenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 21o.** Yield 94%; white crystalline solid, mp 76–77 °C (Found: C, 54.7; H, 4.2; N, 4.1. $C_{14}H_{12}NO_3SCl$ requires C, 54.3; H, 3.9; N, 4.5%); ν_{max}($CHCl_3$)/cm^{-1} 1767, 1676, and 1595; δ_H(250 MHz; $CDCl_3$) 3.43 (3H, s, NMe), 3.86 (2H, s, CH_2), 6.68 (1H, br s, thienyl), 6.72 (1H, dd, *J* 4.2 and 3.0, thienyl), 7.19 (1H, d, *J* 3.0, thienyl), 7.50 (2H, m, Ar), and 8.01 (2H, m, Ar); *m*/*z* EI 309.0227 (M^+, $C_{14}H_{12}NO_3SCl^{35}$ requires 309.0226), CI 310 (MH^+, 40%), 156 (85), 139 (20), 97 (10), and 35 (100).

***N*-Acetoxy-*N*-methyl-2-(2-thienyl)acetamide 21p.** Yield 66%; yellow oil; ν_{max}(neat)/cm^{-1} 1794, 1673, and 1602; δ_H(300 MHz; $CDCl_3$) 2.15 (3H, s, Ac), 3.26 (3H, s, NMe), 3.77 (2H, s, CH_2), 6.88 (2H, m, thienyl), and 7.16 (1H, dd, *J* 5.2 and 1.2, thienyl); δ_C(100.6 MHz; $CDCl_3$) 18.7 (q), 34.2 (t), 36.1 (br q), 125.3 (d), 127.1 (d), 127.2 (d), 135.2 (s), and 168.4 (s), other CO not found at room temperature; *m*/*z* EI 213.0456 (M^+, $C_{19}H_{11}NO_3S$ requires 213.0459), EI 213 (M^+, 12%), 167 (16), 149 (52), 135 (86), and 113 (100).

***N*-(4-Nitrobenzoyloxy)-*N*-methylbut-3-enamide 21q.** Yield 70%; clear oil; ν_{max}(neat)/cm^{-1} 1773, and 1606; δ_H(400 MHz; $CDCl_3$) 3.17 (2H, d, *J* 6.4, CH_2), 3.46 (3H, s, NMe), 5.16 (2H, m, CH=CH_2), 6.92 (1H, m, C*H*=CH_2), and 8.21–8.36 (4H, m, Ar); *m*/*z* CI 265.0825 (M^+, $C_{12}H_{13}N_2O_5$ requires 265.0824), EI 179 (20), 167 (40), 150 (100), 104 (90), and 76 (87).

***N*-(4-Nitrobenzoyloxy)-*N*-methylhexanamide 21r.** Yield 77%; white crystalline solid, mp 215–220 °C (from hexane); ν_{max}(neat)/cm^{-1} 1771, 1677, and 1606; δ_H(400 MHz; $CDCl_3$) 0.80 (3H, br t, *J* 4.0, Me), 1.20–1.31 (4H, br m, CH_2CH_2), 1.52–1.70 (2H, br m, CH_2), 2.23 (2H, br t, *J* 6.0, C(O)CH_2), 3.40 (3H, s, NMe), and 8.20–8.31 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 13.9 (q), 22.3 (t), 24.0 (t), 31.3 (t), 34.0 (t), 36.2 (q), 124.0 (2 × d), 131.2 (2 × d), 132.2 (s), 151.2 (s), 162.6 (s), and 171.2 (s); *m*/*z* CI 294.1219 (M^+, $C_{14}H_{18}N_2O_5$ requires 294.1216), CI 295 (MH^+, 50%), 244 (23), 150 (60), 150 (60), 130 (100), and 120 (68).

***N*-(4-Nitrobenzoyloxy)-*N*-methyl(1-naphthyl)acetamide 21s.** Yield 98%; white crystalline solid, mp 215–220 °C (from hexane) (Found: C, 65.4; H, 4.55; N, 7.3. $C_{20}H_{16}N_2O_5$ requires C, 65.9; H, 4.4; N, 7.7%); ν_{max}($CHCl_3$)/cm^{-1} 1772, 1677, and 1607; δ_H(400 MHz; $CDCl_3$) 3.50 (3H, s, NMe), 4.20 (2H, s, CH_2), and 7.31–8.30 (11H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 36.3 (q), 37.0 (t), 123.5 (d), 123.8 (2 × d), 125.4 (d), 125.9 (d), 126.5 (d), 127.4 (s), 128.1 (s), 128.8 (d), 129.9 (s), 130.3 (d), 131.1 (2 × d), 132.0 (s), 133.8 (d), 151.1 (s), 162.5 (s), and 175.5 (s); *m*/*z* EI 364.1008 (M^+, $C_{20}H_{16}N_2O_5$ requires 364.1059), EI 364 (MH^+, 25%), 168 (23), 150 (80), 141 (100), and 115 (35).

***N*-(4-Nitrobenzoyloxy)-*N*-methyl-2-(2-naphthyloxy)acetamide 21t.** Yield 82%; white crystalline solid, mp 158–160 °C (from hexane) (Found: C, 62.95; H, 4.2; N, 7.2. $C_{20}H_{16}N_2O_6$ requires C, 63.1; H, 4.2; N, 7.4%); ν_{max}(Nujol)/cm^{-1} 1776, 1695, and 1602; δ_H(400 MHz; $CDCl_3$) 3.50 (3H, s, NMe), 4.80 (2H, s, CH_2), 7.02–7.42 (7H, m, Ar), and 8.21–8.32 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 36.4 (q), 66.0 (t), 107.3 (s), 118.21 (s), 123.7 (d), 124.1 (2 × d), 126.5 (d), 126.8 (d), 127.5 (d), 129.2 (d), 129.6 (d), 131.5 (2 × d), 131.6 (s), 134.1 (d), 151.0 (s), 157.0 (s), 160.2 (s), and 162.5 (s); *m*/*z* EI 380.0961 (M^+, $C_{20}H_{16}N_2O_6$ requires 380.1008), CI 381 (MH^+, 25%), 215 (55), 144 (65), 127 (100), 120 (85), and 99 (45).

***N*-Acetoxy-*N*-methyl-2,2-diphenylacetamide 21u.** Yield 56%; white crystalline solid, mp 79.5–80.4 °C (from hexane) (Found: C, 72.1; H, 6.1; N, 4.9. $C_{17}H_{17}NO_3$ requires C, 72.1; H, 6.05; N, 4.9%); ν_{max}(neat)/cm^{-1} 1787, and 1651; δ_H(250 MHz; $CDCl_3$) 2.04 (3H, s, Ac), 3.36 (3H, s, NMe), 5.14 (1H, s, CH), and 7.25–7.37 (10H, m, 2 × Ar); δ_C(100.6 MHz; $CDCl_3$) 18.0 (q), 54.2 (d), 127.1 (2 × d), 128.3 (4 × d), 128.7 (4 × d), 138.0 (2 × s), and 167.5 (s), one C=O and the NMe too broad to be observed; *m*/*z* EI 284.1289 (M^+, $C_{17}H_{17}NO_3$ requires 284.1287), CI 284 (MH^+, 50%), 226 (38), 167 (15), and 35 (100).

***N*-Benzyloxy-*N*-butyl-4-phenylbut-3-enamide 3a.** Method 2: Dibenzoyl peroxide (2.43 g, 13.4 mmol) in dichloromethane (15 cm^3) was added dropwise to *n*-butylamine (0.69 cm^3, 6.92 mmol) and sodium carbonate (3.13 g, 23 mmol) in dichloromethane (15 cm^3). The reaction was stirred at room temperature for 2 hours and then a solution of (*E*)-styrylacetyl chloride (1.25 g 13.4 mmol) was added and the mixture stirred for another 1 hour. Water was added and the product extracted with dichloromethane (3 × 30 cm^3). The combined extracts were washed with water, dried over $MgSO_4$ and the solvent removed *in vacuo*. Purification by column chromatography (5 : 1 gradient to 2 : 1 petroleum ether–ethyl acetate) furnished the butenamide **3a** in 54% yield; yellow oil; ν_{max}(neat)/cm^{-1} 1766, 1674, and 1600; δ_H(250 MHz; $CDCl_3$) 0.92 (3H, t, *J* 7.3, Me), 1.39 (2H, sextet, *J* 7.4, CH_2Me), 1.65 (2H, quintet, *J* 7.4, CH_2), 3.27 (2H, d, *J* 5.2, CH_2CO), 3.85 (2H, t, *J* 7.4, NCH_2), 6.24–6.47 (2H, m, CH=CHPh), 7.12–7.22 (5H, m, Ar), 7.48 (2H, m, Ar), 7.64 (1H, m, Ar), and 8.09 (2H, m, Ar); *m*/*z* CI 338.1756 (MH^+, $C_{21}H_{23}NO_3$ requires 338.1756), CI 338 (MH^+, 0.5%), 217 (12), 118 (100), 105 (99), and 57 (97).

General procedure for thermal rearrangement

A solution of the hydroxamic acid derivative (**3a**–**c**, 0.15 mmol) in toluene (2.5 cm^3) was heated at 140 °C in a sealed tube for 1–3 days. The solvent was then removed *in vacuo* and the residue purified by chromatography (2 : 1 petroleum ether–ethyl acetate).

2-Benzoyloxy-*N*-butyl-4-phenylbut-3-enamide 6a. Yield 85%; colourless oil; ν_{max}(neat)/cm^{-1} 1723, 1665, and 1600; δ_H(250 MHz; $CDCl_3$) 0.90 (3H, t, *J* 7.2, Me), 1.25–1.57 (4H, m, CH_2CH_2Me), 3.31 (2H, dt, *J* 7.2 and 6.0, NCH_2), 6.00 (1H, dd, *J* 6.7 and 1.2, CH), 6.20 (1H, br s, NH), 6.41 (1H, dd, *J* 15.9 and 6.7, C*H*=CHPh), 6.81 (1H, dd, *J* 15.9 and 1.2, CH=C*H*Ph), 7.26–7.88 (8H, m, Ar), and 8.12 (2H, m, Ar); *m*/*z* EI 337.1672 (M^+, $C_{21}H_{23}NO_3$ requires 337.1679), EI 337 (M^+, 3%), 238 (50), 115 (36), and 105 (100).

2-Benzoyloxy-*N*-methyl-4-phenylbut-3-enamide 6b. Yield 95%; colourless oil; ν_{max}(neat)/cm^{-1} 1722, 1668, and 1600; δ_H(250 MHz; $CDCl_3$) 2.89 (3H, d, *J* 5.0, NMe), 6.04 (1H, dd,

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J 6.7 and 1.2, CH), 6.29 (1H, br s, NH), 6.42 (1H, dd, *J* 16.0 and 6.7, C*H*=CHPh), 6.82 (1H, dd, *J* 16.0 and 1.2, CH=C*H*Ph), 7.26–7.88 (8H, m, Ar), and 8.12 (2H, m, Ar); *m/z* EI 295.1208 (M^+, $C_{18}H_{17}NO_3$ requires 295.1209), EI 295 (M^+, 6%), 238 (19), 115 (53), and 105 (100).

2-Benzoyloxy-*N*-benzyl-4-phenylbut-3-enamide 6c. Yield 80%; colourless oil; ν_{max}(neat)/cm^{-1} 1711, 1655, and 1600; δ_H(250 MHz; $CDCl_3$) 4.50 (1H, dd, *J* 14.9 and 5.8, C*H*HPh), 4.57 (1H, dd, *J* 14.9 and 5.8, C*H*HPh), 6.07 (1H, dd, *J* 6.7 and 1.3, CH), 6.45 (2H, br m, NH and C*H*=CHPh), 6.84 (1H, dd, *J* 15.9 and 1.3, CH=C*H*Ph), 7.23–7.65 (13H, m, Ar), and 8.10 (2H, m, Ar); *m/z* EI 371.1529 (M^+, $C_{24}H_{21}NO_3$ requires 371.1522), EI 371 (M^+, 2%), 238 (34), 105 (100), 91 (64), and 77 (57).

General procedure for triethylamine catalysed rearrangement

Method A: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.015 mmol) in toluene (2.5 cm^3) was heated at 110 °C. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

Method B: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.15 mmol) in toluene (2.5 cm^3) was heated at 63 °C. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

Method C: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.15 mmol) in dichloromethane (2.5 cm^3) was heated at 40 °C. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

Method D: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.09 mmol) in CH_2Cl_2 (2.5 cm^3) at room temperature. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

Method E: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.03 mmol) in CH_2Cl_2 (2.5 cm^3) was heated at 40 °C in a sealed tube. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

Method F: A solution of the hydroxamic acid derivative (**21a**–**t**, 0.15 mmol) and triethylamine (0.15 mmol) in toluene (2.5 cm^3) was heated at 160 °C in a sealed tube. The volatiles were then removed *in vacuo* and the residue purified by chromatography (2:1 petroleum ether–ethyl acetate).

2-Acetoxy-*N*-methyl-2-phenylacetamide 22a. Yield 75%; colourless oil; ν_{max}(neat)/cm^{-1} 3360, 1789, and 1666 (Found: C, 63.8; H, 6.5; N, 6.95. $C_{11}H_{13}NO_3$ requires C, 63.75; H, 6.3; N, 6.8%); δ_H(250 MHz; $CDCl_3$) 2.18 (3H, s, Me), 2.83 (3H, d, *J* 5.0, NMe), 6.07 (1H, s, CH), 6.24 (1H, br s, NH), and 7.26–7.37 (5H, m, Ph); δ_C(100.6 MHz; $CDCl_3$) 18.2 (q), 35.4 (q), 74.4 (d), 127.3 (2 × d), 128.8 (2 × d), 129.3 (d), 134.0 (s), 167.9 (s), and 168.6 (s); *m/z* EI 207.0891 (M^+, $C_{11}H_{13}NO_3$ requires 207.0895), CI 208 (MH^+, 23%), 166 (5), 150 (30), 118 (42), and 91 (100).

2-Pivaloyloxy-*N*-methyl-2-phenylacetamide 22b. Yield 65%; colourless oil; ν_{max}(neat)/cm^{-1} 3300, 1776, and 1680; δ_H(250 MHz; $CDCl_3$) 1.30 (9H, s, t-Bu), 2.84 (3H, d, *J* 4.9, NMe), 6.05 (1H, s, CH), and 7.33–7.41 (6H, m, Ph, NH); δ_C(100.6 MHz; $CDCl_3$) 26.1 (q), 26.3 (q), 27.3 (s), 31.5 (q), 39.8 (q), 75.6 (s), 125.4 (2 × d), 128.3 (2 × d), 129.1 (d), 137.7 (s), 169.6 (s), and 176.9 (s); *m/z* EI 249.1361 (M^+, $C_{14}H_{19}NO_3$ requires 249.1365), CI 250 (MH^+, 100%), 148 (70), 116 (15), and 91 (40).

2-(4-Nitrobenzoyloxy)-*N*-methyl-2-phenylacetamide 22c. Yield 99%; white crystalline solid, mp 140–143 °C; ν_{max}($CHCl_3$)/cm^{-1} 3450, 1734, 1690, and 1602 (Found: C, 60.6; H, 4.6; N, 8.55. $C_{11}H_{13}NO_3$ requires C, 61.1; H, 4.5; N, 8.9%); δ_H(250 MHz; $CDCl_3$) 2.73 (3H, d, *J* 5.0, NMe), 6.19 (1H, s, CH), 6.76 (1H, br s, NH), and 7.30–8.20 (9H, m, Ar); *m/z* EI 314.0903 (M^+, $C_{16}H_{14}N_2O_5$ requires 314.0900), CI 315 (MH^+, 10%), 257 (20), 150 (50), 120 (100), and 91 (30).

2-(1′,1′,1′-Trichloroacetoxy)-*N*-methyl-4-phenylbut-3-enamide 22d. Yield 10%; clear oil; ν_{max}($CHCl_3$)/cm^{-1} 3022, 1745, and 1688; δ_H(400 MHz; $CDCl_3$) 2.83 (3H, d, *J* 4.9, NMe), 5.73 (1H, d, *J* 7.0, CH), 6.23 (1H, dd, *J* 16.0 and 7.0, C*H*=CHPh), 6.33 (1H, br s, NH), 6.70 (1H, d, *J* 16.0, CH=C*H*Ph), and 7.20–7.42 (5H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 26.2 (q), 68.2 (d), 80.0 (s), 118.0 (d), 118.6 (d), 127.0 (d), 128.8 (2 × d), 129.1 (2 × d), 136.3 (s), 155.3 (s) and 171.2 (s); *m/z* CI No MH^+ observed 190 ($M^+ - COCCl_3$, 2%), 172 (15), 131 (100), 115 (30), 105 (55) and 91 (20).

2-Acetoxy-*N*-methyl-2-(4-methoxyphenyl)acetamide 22e. Yield 94%; colourless oil; ν_{max}(neat)/cm^{-1} 3314, 1740, 1664, and 1612; δ_H(250 MHz; $CDCl_3$) 2.12 (3H, s, Me), 2.78 (3H, d, *J* 5.4, NMe), 3.75 (3H, s, OMe), 5.99 (1H, s, CH), 6.48 (1H, br s, NH), 6.85 (2H, d, *J* 8.8, Ar), and 7.32 (2H, d, *J* 8.8, Ar); δ_C(100.6 MHz; $CDCl_3$) 21.4 (q), 26.5 (q), 55.6 (q), 75.6 (d), 114.5 (2 × d), 128.2 (s), 129.4 (2 × d), 160.4 (s), 169.6 (s), and 169.7 (s); *m/z* EI 237.1001 (M^+, $C_{12}H_{15}NO_4$ requires 237.1004), EI 237 (M^+, 16%), 179 (25), 149 (40), 137 (55), and 121 (100).

2-Acetoxy-*N*-methyl-2-(4-methylphenyl)acetamide 22f. Yield 94%; colourless oil; ν_{max}(neat)/cm^{-1} 3269, 1742, and 1656 (Found: C, 64.7; H, 6.9; N, 6.4. $C_{12}H_{15}NO_3$ requires C, 65.1; H, 6.85; N, 6.3%); δ_H(250 MHz; $CDCl_3$) 2.31 (3H, s, Me), 2.77 (3H, d, *J* 5.4, NMe), 6.01 (1H, s, CH), 6.52 (1H, br s, NH), 7.14 (2H, d, *J* 9.5, Ar), and 7.30 (2H, d, *J* 9.5, Ar); δ_C(100.6 MHz; $CDCl_3$) 21.4 (q), 21 5 (q), 26.5 (q), 75.8 (d), 127.8 (2 × d), 129.8 (2 × d), 133.1 (s), 139.2 (s), 169.5 (s), and 171.5 (s); *m/z* EI 221.1047 (M^+, $C_{12}H_{15}NO_3$ requires 221.1052), EI 221 (M^+, 10%), 163 (42), 121 (100), and 91 (40).

2-Acetoxy-*N*-methyl-2-(4-chlorophenyl)acetamide 22g. Yield 100%; clear oil; ν_{max}(neat)/cm^{-1} 3290, 1745, and 1665 (Found: C, 54.7; H, 5.3; N, 6.1. $C1_3H_{17}NO_3$ requires C, 54.65; H, 5.0; N, 5.8%); δ_H(250 MHz; $CDCl_3$) 2.18 (3H, s, Me), 2.84 (3H, d, *J* 4.9, NMe), 6.04 (1H, s, CH), 6.18 (1H, br s, NH), 7.25–7.38 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 21.4 (q), 26.6 (q), 75.1 (d), 129.2 (2 × d), 129.3 (2 × d), 134.5 (s), 135.3 (s), 169.0 (s), and 169.5 (s); *m/z* EI 241.0503 (M^+, $C_{11}H_{12}NO_3$ requires 241.0506), CI 242 (MH^+, 100%), 184 (95), and 102 (25).

2-Propanoyloxy-*N*-methyl-2-(4-methylphenyl)acetamide 22h. Yield 82%; white crystalline solid, mp 79.3–80.6 °C; ν_{max}(Nujol)/cm^{-1} 3267, 1744, and 1657; δ_H(250 MHz; $CDCl_3$) 1.17 (3H, t, *J* 7.5, CH_2CH_3), 2.34 (3H, s, Me), 2.45 (2H, m, CH_2CH_3), 2.85 (3H, d, *J* 4.9, NMe), 6.07 (1H, s, CH), 6.11 (1H, br s, NH), 7.17 (2H, d, *J* 8.0, Ar), and 7.30 (2H, d, *J* 8.0, Ar); δ_C(100.6 MHz; $CDCl_3$) 9.3 (q), 21.6 (q), 26.6 (q), 27.9 (t), 75.6 (d), 127.7 (2 × d), 129.8 (2 × d), 133.2 (s), 139.2 (s), 169.6 (s), and 173.1 (s); *m/z* CI 236.1294 (MH^+, $C_{13}H_{18}NO_3$ requires 236.1287), EI 235 (M^+, 10%), 178 (72), 121 (85), 91 (74), and 57 (100).

2-Acetoxy-*N*-methyl-4-phenylbut-3-enamide 22i. Yield 99%; colourless oil; ν_{max}(neat)/cm^{-1} 3378, 1735, and 1654; δ_H(400 MHz; $CDCl_3$) 2.20 (3H, d, *J* 4.9, NMe), 5.73 (1H, d, *J* 7.0, CH), 6.23 (1H, dd, *J* 16.0 and 7.0, C*H*=CHPh), 6.70 (1H, d, *J* 16.0, CH=C*H*Ph), 7.26–7.88 (6H, m, Ar and NH); δ_C(100.6 MHz; $CDCl_3$) 20.0 (q), 21.5 (q), 25.2 (q), 73.4 (d), 121.5 (d), 124.3 (d), 125.8 (d), 127.4 (2 × d), 127.8 (2 × d), 133.8 (s), 167.8 (s), and 168.3 (s); *m/z* EI 233.1009 (M^+, $C_{13}H_{15}NO_3$ requires 233.1052),

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CI 234 (MH^+, 2%), 191 (2), 176 (100), 161 (22), 115 (55), and 77 (35).

2-Pivaloyloxy-*N*-methyl-4-phenylbut-3-enamide 22j. Yield 82%; colourless oil; ν_{max}(neat)/cm^{-1} 3356, 1778, and 1672; δ_H(250 MHz; $CDCl_3$) 1.30 (9H, s, t-Bu), 2.84 (3H, d, *J* 4.8, NMe), 5.72 (1H, dd, *J* 6.7 and 1.0, CH), 6.10 (1H, br s, NH), 6.22 (1H, dd, *J* 16.0 and 6.7, C*H*=CHPh), 6.70 (1H, dd, *J* 16.0 and 1.0, CH=C*H*Ph), 7.26–7.88 (6H, m, Ar and NH); δ_C(100.6 MHz; $CDCl_3$) 26.3 (q), 26.9 (q), 27.1 (q), 27.2 (s), 31.1 (q), 74.1 (d), 121.6 (d), 122.8 (d), 126.8 (d), 128.3 (2 × d), 128.6 (2 × d), 135.7 (s), 169.3 (s), and 174.0 (s); *m*/*z* EI 275.1523 (M^+, $C_{13}H_{15}NO_3$ requires 275.1522), CI 276 (MH^+, 48%), 192 (10), 174 (100), 117 (30), and 85 (50).

2-Benzoyloxy-*N*-methyl-2-(2-thienyl)acetamide 22k. Yield 100%; white crystalline solid, mp 86–86 °C (from hexane); ν_{max}($CHCl_3$)/cm^{-1} 3455, 1724, 1684, and 1602 (Found: C, 61.3; H, 4.75; N, 4.6. $C_{14}H_{13}NO_3S$ requires C, 61.1; H, 4.75; N, 5.1%); δ_H(400 MHz; $CDCl_3$) 2.81 (3H, d, *J* 5.2, NMe), 6.32 (1H, br s, NH), 6.55 (1H, s, CH), 6.92 (1H, dd, *J* 4.9 and 3.4, thienyl), 7.17 (1H, m, thienyl), 7.25 (1H, dd, *J* 4.9 and 1.0, thienyl), 7.38 (2H, m, Ar), 7.52 (1H, m, Ar), and 8.02 (2H, dd, *J* 7.9 and 1.0, Ar); *m*/*z* EI 275.0610 (M^+, $C_{14}H_{13}NO_3S$ requires 275.0616), EI 275 (M^+, 3%), 218 (10), 122 (49), 105 (100), and 83 (82).

2-(4-Nitrobenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 22l. Yield 100%; white crystalline solid, mp 139–140 °C (from hexane); ν_{max}(neat)/cm^{-1} 3450, 1734, 1690, and 1602 (Found: C, 52.2; H, 4.0; N, 8.4. $C_{14}H_{12}N_2O_5S$ requires C, 52.5; H, 3.8; N, 8.8%); δ_H(250 MHz; $CDCl_3$) 2.78 (3H, d, *J* 4.9, NMe), 6.53 (1H, s, CH), 6.82 (1H, br q, *J* 4.9, NH), 6.97 (1H, dd, *J* 5.2 and 3.6, thienyl), 7.22 (1H, dd, *J* 3.6 and 1.0, thienyl), 7.33 (1H, dd, *J* 5.2 and 1.0, thienyl), and 8.19 (4H, s, Ar); δ_C(100.6 MHz; $CDCl_3$) 26.7 (q), 72.6 (d), 123.9 (2 × d), 127.4 (d), 127.8 (d), 128.7 (d), 131.5 (2 × d), 134.8 (s), 136.9 (s), 151.1 (s), 163.8 (s), and 168.2 (s); *m*/*z* EI 320.0472 (M^+, $C_{14}H_{12}N_2O_3S$ requires 320.0466), EI 320 (M^+, 6%), 263 (60), 150 (100), 104 (56), and 96 (61).

2-(4-Methoxybenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 22m. Yield 100%; yellow oil; ν_{max}(neat)/cm^{-1} 3464, 1757, 1672, and 1605 (Found: C, 58.7; H, 5.0; N, 4.1. $C_{15}H_{15}NO_5S$ requires C, 59.0; H, 5.0; N, 4.6%); δ_H(300 MHz; $CDCl_3$) 2.87 (3H, d, *J* 4.9, NMe), 3.86 (3H, s, OMe), 6.45 (1H, br s, NH), 6.58 (1H, s, CH), 6.86–7.01 (3H, m, thienyl + 2 Ar), 7.22 (1H, d, *J* 3.4, thienyl), 7.32 (1H, dd, *J* 5.2 and 1.1, thienyl), and 8.04 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 26.4 (q), 71.4 (d), 113.9 (2 × d), 121.2 (s), 126.6 (d), 126.8 (d), 127.5 (d), 132.1 (2 × d), 137.7 (s), 164.0 (s), 164.6 (s), and 168.4 (s); *m*/*z* EI 305.0724 (M^+, $C_{15}H_{15}NO_4S$ requires 305.0722), EI 305 (M^+, <0.5%), 152 (6), 135 (100), 107 (4), and 97 (30).

2-(4-Methylbenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 22n. Yield 100%; white crystalline solid, mp 103–105 °C (from hexane); ν_{max}($CHCl_3$)/cm^{-1} 3455, 1724, 1687, and 1611; δ_H(300 MHz; $CDCl_3$) 2.42 (3H, s, Me), 2.89 (3H, d, *J* 4.9, NMe), 6.26 (1H, br s, NH), 6.61 (1H, s, CH), 7.01 (1H, dd, *J* 5.1 and 3.4, thienyl), 7.23–7.35 (4H, m, 2 × thienyl, 2 × Ar), and 7.99 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 21.7 (q), 26.4 (q), 71.5 (d), 126.1 (s), 126.7 (d), 126.8 (d), 127.6 (d), 129.3 (2 × d), 129.9 (2 × d), 137.5 (s), 144.7 (s), 164.9 (s), and 168.3 (s); *m*/*z* EI 289.0771 (M^+, $C_{15}H_{15}NO_3S$ requires 289.0773), EI 289 (M^+, 10%), 258 (5), 232 (15), 136 (16), 119 (76), 91 (36), and 83 (200).

2-(4-Chlorobenzoyloxy)-*N*-methyl-2-(2-thienyl)acetamide 22o. Yield 100%; white crystalline solid, mp 55–58 °C (from hexane); ν_{max}($CHCl_3$)/cm^{-1} 3455, 1726, 1692, and 1594; δ_H(250 MHz; $CDCl_3$) 2.90 (3H, d, *J* 4.9, NMe), 6.15 (1H, br s, NH), 6.58 (1H, s, CH), 7.02 (1H, dd, *J* 5.2 and 3.6, thienyl), 7.23 (1H, br m, thienyl), 7.37 (1H, dd, *J* 5.1 and 1.0, thienyl), 7.44 (2H, m, Ar), and 8.03 (2H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 26.4 (q), 71.7 (d), 127.1 (d), 128.9 (2 × d), 131.3 (2 × d), 137.1 (s), 140.3 (s), 144.7 (s), 164.1 (s), and 167.9 (s); *m*/*z* EI 309.0225 (M^+, $C_{14}H_{12}NO_3SCl^{35}$ requires 309.0226), EI 309 (MH^+, <0.5%), 156 (16), 139 (44), and 83 (100).

2-Acetoxy-*N*-methyl-2-(2-thienyl)acetamide 22p. Yield 90%; white crystalline solid, mp 135–136 °C (from hexane); ν_{max}($CHCl_3$)/cm^{-1} 3455, 1740, 1686, and 1601 (Found: C, 50.5; H, 5.2; N, 6.3. $C_9H_{11}NO_3S$ requires C, 50.7; H, 5.2; N, 6.6%); δ_H(250 MHz; $CDCl_3$) 2.16 (3H, s, Ac), 2.86 (3H, d, *J* 4.9, NMe), 6.23 (1H, br s, NH), 6.33 (1H, s, CH), 6.97 (1H, dd, *J* 5.2 and 3.6, thienyl), 7.14 (1H, dd, *J* 3.6 and 0.9, thienyl), and 7.30 (1H, dd, *J* 5.2 and 0.9, thienyl); δ_C(100.6 MHz; $CDCl_3$) 21.3 (q), 26.7 (q), 71.4 (s), 127.3 (2 × d), 128.2 (d), 137.8 (s), 168.4 (s), and 169.5 (s); *m*/*z* EI 213.0472 (M^+, $C_9H_{11}NO_3S$ requires 213.0460), CI 14 (MH^+, 25%), 171 (81), 154 (100), 135 (60), and 114 (24).

2-(4-Nitrobenzoyloxy)-*N*-(methyl)but-3-enamide 22q. Yield 55%; colourless oil; ν_{max}(neat)/cm^{-1} 3450, 1734, 1686, and 1599; δ_H(300 MHz; $CDCl_3$) 2.86 (3H, d, *J* 4.9, NMe), 5.43 (1H, ddd, *J* 10.3, 1.0 and 1.0, C*H*H=CH), 5.53 (1H, ddd, *J* 17.1, 1.0 and 1.0, C*H*H=CH), 5.82 (1H, ddd, *J* 6.4, 1.0, and 1.0), 6.09 (1H, m, C*H*H=CH), and 8.28 (4H, m, Ar); δ_C(100.6 MHz; $CDCl_3$) 26.7 (q), 76.1 (d), 120.6 (t), 124.1 (2 × d), 131.4 (2 × d), 131.5 (d), 135.0 (s), 151.2 (s), 163.6 (s), and 168.2 (s); *m*/*z* EI 265.0826 (M^+, $C_{12}H_{12}N_2O_4$ requires 265.0824), CI 266 (MH^+, 20%), 181 (90), 138 (100), and 94 (15).

2-(4-Nitrobenzoyloxy)-*N*-methyl-2-(1-naphthyl)acetamide 22s. Yield 100%; colourless oil; ν_{max}(neat)/cm^{-1} 3368, 1772, 1677, and 1607; δ_H(250 MHz; $CDCl_3$) 2.80 (3H, d, *J* 4.6, NMe), 6.90 (1H, br s, NH), 7.00 (1H, s, CH), and 7.40–8.30 (11H, m, Ar); *m*/*z* EI 364.1014 (M^+, $C_{20}H_{16}N_2O_5$ requires 364.1059), CI 365 (MH^+, 10%), 307 (45), 150 (100), 141 (20), 120 (25), and 92 (10).

2-Hydroxy-*N*-methyl-2-phenylacetamide 23.[19b] To a solution of 2-acyloxy-*N*-methyl-2-phenylacetamide **22a** (0.27 g, 1.3 mmol) in MeOH–H_2O (4 cm^3, 1:1 v/v) was added potassium carbonate (0.18 g, 1.3 mmol). The mixture was stirred at room temperature for 30 minutes. The solvent was removed *in vacuo* and the residue taken up in ethyl acetate and extracted with water (2 × 5 cm^3). Drying with $MgSO_4$ and removal of the solvent *in vacuo* furnished the alcohol **23** (110 mg, 52% yield) as a clear oil.

Cross-over experiment with 21a and 21h

A mixture of **21a** (31.1 mg, 0.15 mmol) and **21h** (35.2 mg, 0.15 mmol) triethylamine (30 mg, 0.30 mmol) in toluene (5.0 cm^3) was heated at 110 °C for 5 days. The volatiles were then removed *in vacuo* and the residue analysed by GC–NMR to show a 1:1:1:1 mixture of **22a**:**22h**:**22f**:**22v**. 2-Acetoxy-*N*-methyl-2-phenylacetamide **22a**, 6.7 minutes; 2-acetoxy-*N*-methyl-2-(4-methylphenyl)acetamide **22f**, 9.3 minutes; 2-propanoyloxy-*N*-methyl-2-(4-methylphenyl)acetamide **22h**, 11.6 minutes; 2-propanoyloxy-*N*-methyl-2-phenylacetamide **22v**, 8.3 minutes.

2-Propanoyloxy-*N*-methyl-2-phenylacetamide 22v. From cross-over experiment, GC = 8.3 minutes; colourless oil; ν_{max}(Nujol)/cm^{-1} 3274, 1743, and 1657 (Found: C, 64.8; H, 6.8; N, 6.2. $C_{12}H_{16}NO_3$ requires C, 65.1; H, 6.8; N, 6.3%); δ_H(250 MHz; $CDCl_3$) 1.14 (3H, t, *J* 7.5, CH_2CH_3), 2.40 (2H, m, CH_2CH_3), 2.79 (3H, d, *J* 4.6, NMe), 6.03 (1H, s, CH), 6.32 (1H, br s, NH), and 7.27–7.35 (5H, m, Ph); δ_C(100.6 MHz; $CDCl_3$) 9.3 (q), 26.5 (q), 27.9 (t), 75.7 (d), 127.7 (2 × d), 129.1 (2 × d),

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129.7 (d), 136.2 (s), 169.4 (s), and 173.1 (s); *m/z* CI 222.1131 (MH^+, $C_{12}H_{16}NO_3$ requires 364.1130), CI 221 (MH^+, 50%), 164 (86), 152 (65), and 35 (100).

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