# Synthesis of 2-*exo*-acryloyloxy-*N*-(1-adamantyl)bornane-10-sulfonamide diastereomers as chiral scaffolds

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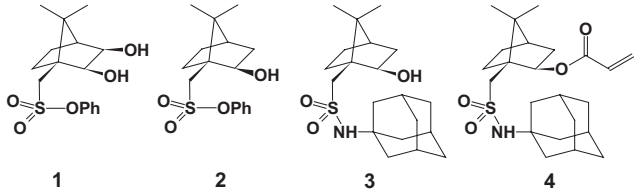
Routes to the synthesis of 2-*exo*- and 2-*endo*-acryloyloxy-*N*-(1-adamantyl)bornane-10-sulfonamide have been developed, and preliminary applications of the former as a chiral Baylis–Hillman substrate have been explored.

**Keywords:** asymmetric synthesis, *N*-(1-adamantyl)-2-hydroxybornane-10-sulfonamides, 2-acryloyloxy-*N*-(1-adamantyl)-bornane-10-sulfonamides, Baylis–Hillman substrates.

Camphor derivatives have found wide application as chiral auxiliaries.[1] Notable examples include the use by Oppolzer's group of 2-*exo*-hydroxybornane-10-sulfonamide esters as substrates in the efficient asymmetric synthesis of β-substituted carboxylic acids[2] and, perhaps most significantly, in their applications of enantiomeric bornane-10,2-sultams in a range of asymmetric transformations.[3] In our own research programme, we have used camphor-derived chiral auxiliaries for the diastereoselective benzylation of carboxylic esters,[4] Simmons–Smith cyclopropanation of acetals of α,β-unsaturated aldehydes[5] and Baylis–Hillman reactions.[6]

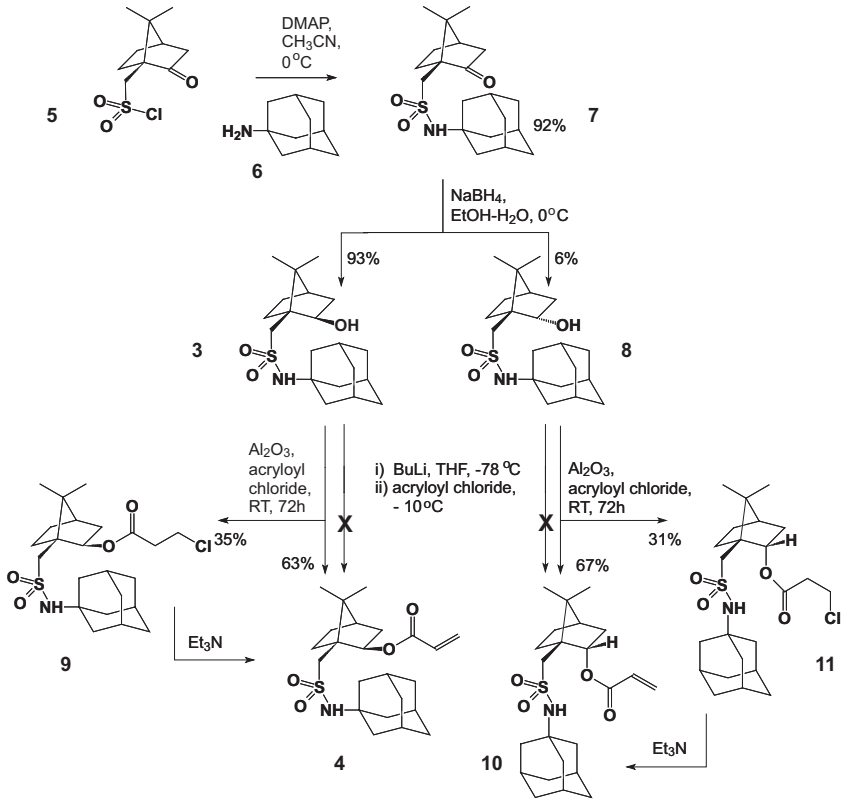
Recent applications of Baylis–Hillman methodology abound[7] and successful asymmetric transformations have also been reported.[8] In an attempt to improve on the low diastereomeric excesses (<35%) that we have obtained in such reactions,[6] we decided to focus attention on the development of analogues of the diol **1**, α,β-unsaturated aldehyde acetals of which gave excellent stereoselectivity (>99% d.e.) in Simmons–Smith cyclopropanation reactions.[5] The phenyl sulfonate analogue **2** was initially targeted as a chiral auxiliary, but its formation is complicated by facile intramolecular trans-esterification to



**1** **2** **3** **4**

afford the corresponding sultone.[9] Attention was consequently turned to the *N*-adamantylsulfonamide **3**, the rationale being that the sulfonamide would be more resistant to intramolecular substitution[10] than the sulfonate ester **2** and that the bulky adamantyl group could promote diastereofacial selectivity.[11] While the resulting acrylate ester **4** was expected to serve as a chiral Baylis–Hillman substrate, it could also prove to be a useful chiral scaffold for various asymmetric transformations.

A solution of adamantylamine **6** and DMAP in acetonitrile was treated with camphor-10-sulfonyl chloride **5**, as the limiting reagent to minimise the possibility of disulfonylation. Work-up and purification afforded the *N*-adamantylsulfonamide **7** in 92% yield (Scheme 1). Reduction of the ketone




**Scheme 1**

* Correspondent.

functionality was achieved in excellent overall yield (99%) using $NaBH_4$ in $EtOH/H_2O$ (5:1), radial chromatography affording the isomeric *exo*- and *endo*-alcohols, **3** (93%) and **8** (6%), respectively. There was no evidence of the kind of intramolecular cyclisation observed in the preparation of the phenyl sulfonate analogue **2**.[9]

Attempted acylation of the chiral alcohols (**3** and **8**) using BuLi at –78°C followed by acryloyl chloride at –10°C failed to afford any of the desired products, and attention was turned to the use of $Al_2O_3$ as an acylation catalyst[12] – an approach that had proved successful in the preparation of the acrylate ester of the phenyl sulfonate analogue **2**.[9] The epimeric alcohols **3** and **8** were thus each added to neutral $Al_2O_3$ and, following the addition of acryloyl chloride, the resulting mixtures were stirred at room temperature for 72 h. Work-up and purification of the crude reaction mixtures afforded the acrylate esters **4** and **10**, accompanied, in each case, by the corresponding hydrochlorinated derivatives **9** and **11**. The overall yields of the α,β-unsaturated esters **4** and **10** were increased by efficient triethylamine-mediated dehydrohalogenation of compounds **9** and **11**, as described in our earlier study.[9]

Having established efficient synthetic access to 2-*exo*-acryloyloxy-*N*-(1-adamantyl)bornane-10-sulfonamide **4**, attention could be given to its application as a substrate for asymmetric Baylis–Hillman reactions. The rate-determining step for such reactions is considered to involve interaction between an adehyde and a zwitterionic enolate intermediate (generated, in the present case, by conjugate addition of the catalyst, DABCO, to the acrylate ester **4**).[13] Computer modelling of the the zwitterionic enolate (Fig. 1) indicates a favoured conformation and the anticipated direction of approach of the electrophilic aldehyde. With the bulky adamantyl moiety effectively blocking access from the "front", the diastereocontrol is presumed to depend on the *re*- or *si*-facial orientation of the aldehyde.

Baylis–Hillman reactions are, typically, very slow – sometimes requiring several weeks to afford acceptable yields! However, highly electrophilic aldehydes, such as pyridinecarbaldehydes, have been shown to react more rapidly.[14] Consequently, in a series of preliminary, small-scale reactions, 2-*exo*-acryloyloxy-*N*-(1-adamantyl)-bornane-10-sulfonamide **4** was reacted with a range of pyridinecarbaldehydes **12a–d** and 2-nitrobenzaldehyde **12e**, using DABCO as the Baylis–Hillman catalyst (Scheme 2). The disappearance of the 2'-H and 3'-$CH_2$ vinylic signals of the acrylate ester **4** was accompanied by the appearance of the 3'-H, 3'-OH and vinylic methylene signals characteristic of the Baylis–Hillman products **13a–e**.

The reaction with 6-methyl-2-pyridinecarbaldehyde **12d** proceeded in excellent overall yield (95%) and stereoslectivity (95% d.e.).[15] However, while the yields for the remaining reactions were also very good (89–99%), the stereoselectivities were disappointing (22–60% d.e.), and it seems that the additional bulk provided by the 6-methyl group in compound **12d** plays a role in controlling diastereofacial selectivity.

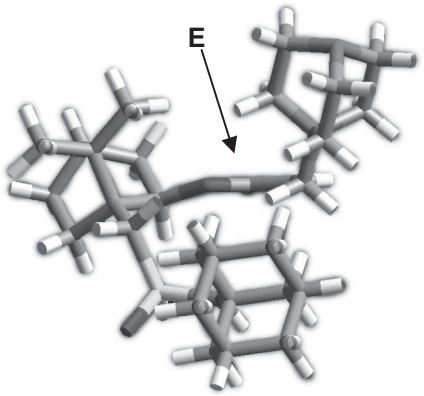


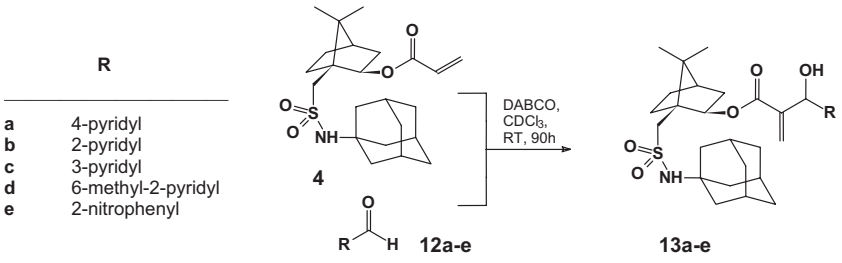

**Fig. 1** Computer-modelled structure of the putative, zwitterionic, Baylis–Hillman intermediate showing expected direction of approach by the aldehyde (E).

The results clearly indicate the potential of 2-*exo*-acryloyloxy-*N*-(1-adamantyl)bornane-10-sulfonamide **4** as a chiral auxiliary and future research is expected to focus on further applications.

## Experimental

Melting points were determined using a Kofler hot-stage apparatus and are uncorrected. NMR spectra were recorded on Bruker AMX400 or AVANCE 400 MHz spectrometers at 303 K in $CDCl_3$, and calibrated using solvent signals. IR spectra were recorded on a Perkin Elmer FT-IR spectrum 2000 spectrometer. Low-resolution (EI) mass spectra were obtained on a Finnigan-Mat GCQ mass spectrometer and high-resolution (EI) mass spectra on a VG70-SEQ double-focusing magnetic sector spectrometer (Cape Technikon Mass Spectrometry unit or Department of Chemistry, University of the Witwatersrand). Optical rotations were measured on a Perkin Elmer 141 polarimeter using a 1 dm cell, with concentrations cited in g/100 ml. Computer modelling was conducted at the molecular mechanics level using the Accelrys Cerius$^2$ software package on an SGI $O^2$ computer. Optically pure compounds were derived from commercially available, homochiral, (1*R*)-(+)-camphor.

N-*(1-Adamantyl)camphor-10-sulfonamide* **7**: A solution of camphor-10-sulfonyl chloride (2.52 g, 10.0 mmol) in acetonitrile (20 ml) was added dropwise under $N_2$ to a stirred solution of adamantylamine **6** (3.22 g, 21.3 mmol) and dimethylaminopyridine (0.26 g, 2.1 mmol) in acetonitrile (10 ml) at 0°C, and the solution was stirred for 1 h. The reaction mixture was then hydrolysed with water (10 ml) followed by 10% aqueous HCl (2 ml), and the resulting mixture was extracted into EtOAc (3 × 25 ml). The organic layers were combined, washed with 5% aqueous NaOH (5 ml) and dried over anhydrous $MgSO_4$. The solvent was removed *in vacuo* to afford N-(*1-adamantyl)camphor-10-sulfonamide* **7** as white crystals (3.51 g, 92%), m.p. 193–195°C (Found: $M^+$, 365.20387. $C_{20}H_{31}NO_3S$ requires *M*, 365.20247); $\delta_H$ (400 MHz; $CDCl_3$) 0.90 (3H, s, 9-Me), 1.04 (3H, s, 8-Me), 1.41, 1.86, 2.02 and 2.32 (4H, series of multiplets, 5- and 6-$CH_2$), 1.66 and 2.00 (12H, 2 × m, adamantyl-$CH_2$), 1.92 and 2.38 (2H, 2 × m, 3-$CH_2$), 2.09 (3H, m, adamantyl-CH), 2.10 (1H, m, 4-H), 2.99 and 3.49 (2H, 2 × d, $J$ = 15.0 Hz, 10-$CH_2$) and 4.95 (1H, s, NH); $\delta_C$ (100 MHz; $CDCl_3$) 19.7 (C-8), 19.9 (C-9), 26.3 and 27.0 (C-5 and C-6), 29.7 (3 × adamantyl-CH), 36.0 and 43.2 (6 × adamantyl-$CH_2$), 42.8 (C-4), 42.9 (C-3), 48.5 and 55.4 (C-1 and C-7), 54.5 (C-10), 59.4 (C-11) and 216.7 (C-2); *m/z* 365 ($M^+$, 30.0%) and 135 (100).




**Scheme 2**

N-*(1-Adamantyl)-2*-exo-*hydroxybornane-10-sulfonamide* **3** *and* N-*(1-adamantyl)-2*-endo-*hydroxybornane-10-sulfonamide* **8**: A solution of *N*-(1-adamantyl)bornane-10-sulfonamide **7** (3.07 g, 8.4 mmol) in THF–$H_2O$ (2 ml:1 ml) was added dropwise to a stirred solution of $NaBH_4$ (3.27 g, 86.3 mmol) in a solution of THF–$H_2O$ (2 ml:1 ml) at –15°C over 20 min. The solution was stirred vigorously and allowed to warm to room temperature overnight. The reaction was then quenched with 5% HCl (2 ml) and the resulting mixture extracted into EtOAc (3 × 1 ml). The organic layers were combined, washed with 5% brine (3 ml) and dried over anhydrous $MgSO_4$. Solvent was removed *in vacuo* to give an oil, which was chromatographed [radial chromatography on silica gel, 1 mm plate; elution with hexane–EtOAc (8:2)] to afford two products:

N-*(1-adamantyl)-2*-exo-*hydroxybornane-10-sulfonamide* **3**: Transparent crystals (2.87 g, 93%), m.p. 191–194°C (Found: $M^+$, 367.21993. $C_{20}H_{33}NO_3S$ requires *M*, 367.21812); $[\alpha]^{20}_D$ = –40.98° (*c* 2.45, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.82 and 1.06 (6H, 2 × s, 8- and 9-Me), 1.12, 1.49, 1.68, 1,71 and 1.76 (6H, series of multiplets, 3-, 5- and 6-$CH_2$), 1.66 and 1.96 (12H, 2 × m, adamantyl-$CH_2$), 1.72 (1H, m 4-H), 2.11 (3H, m, adamantyl-CH), 2.92 and 3.49 (2H, 2 × d, *J* = 13.8 Hz, 10-$CH_2$), 3.32 (1H, d, *J* = 2.1 Hz, 2-OH), 4.06 (1H, m, 2-H) and 4.20 (1H, br s, NH); $\delta_C$ (400 MHz; $CDCl_3$) 19.9 and 20.6 (C-8 and C-9), 27.4, 30.7 and 38.9 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.3 (6 × adamantyl-$CH_2$), 44.4 (C-4), 48.6 and 50.8 (C-1 and C-7), 55.3 (C-11), 57.0 (C-10) and 76.4 (C-2); *m/z* 367 ($M^+$, 0.6%) and 151 (100); and

N-*(1-adamantyl)-2*-endo-*hydroxybornane-10-sulfonamide* **8**: Transparent crystals (0.17 g, 5.6%), m.p. 156–158°C (Found: $M^+$, 367.21706. $C_{20}H_{33}NO_3S$ requires *M*, 367.21812); $[\alpha]^{20}_D$ = + 4.64° (*c* 0.56, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.89 and 0.90 (6H, 2 × s, 8- and 9-Me), 1.08, 1.38, 1.54, 1.79, 2.30 and 2.40 (6H, series of multiplets, 3-, 5- and 6-$CH_2$), 1.63 (1H, t, *J* = 4.5 Hz, 4-H), 1.66 and 1.95 (12H, 2 × m, adamantyl-$CH_2$), 2.10 (adamantyl-CH), 3.09 and 3.15 (2H, 2 × d, *J* = 14.1 Hz, 10-$CH_2$), 3.48 (1H, d, *J* = 2.5 Hz, 2-OH), 4.23 (1H, br s, NH) and 4.33 (1H, ddd, *J* = 2.6, 5.2 and 10.0 Hz, 2-H); $\delta_C$ (100 MHz; $CDCl_3$) 18.9 and 20.5 (C-8 and C-9), 23.9, 28.3 and 38.3 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.3 (6 × adamantyl-$CH_2$), 43.9 (C-4), 51.3 and 51.5 (C-1 and C-7), 55.5 (C-11), 60.6 (C-10) and 75.2 (C-2); *m/z* 367 ($M^+$, 0.5%) and 151 (100).

N-*(1-Adamantyl)-2*-exo-*acryloyloxybornane-10-sulfonamide* **4** and N-*(1-adamantyl)-2*-exo-*(3-chloropropanoyloxy)bornane-10-sulfonamide* **9**: Neutral $Al_2O_3$ (0.47 g, 4.6 mmol) was added to the alcohol **3** (1.10 g, 3.0 mmol) and acryloyl chloride (0.56 g, 6.2 mmol) was then added. The resulting dispersion was sealed and kept unstirred at 25°C for 72 h. The residue was taken up in EtOAc (3 × 1 ml), filtered and dried over anhydrous $MgSO_4$. Solvent was removed *in vacuo* and the residue was chromatographed [HPLC; elution with hexane–EtOAc (8:2)] to afford two products:

N-*(1-adamantyl)-2*-exo-*acryloyloxybornane-10-sulfonamide* **4**: Transparent crystals, (0.80 g, 63%), m.p. 173–176°C (Found: $M^+$, 421.22844. $C_{23}H_{35}NO_4S$ requires *M*, 421.22868); $[\alpha]^{20}_D$ = –51.26° (*c* 4.06, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.89 and 1.02 (6H, 2 × s, 8- and 9-Me), 1.18, 1.59, 1.75, 1.99 (6H, series of multiplets, 3-, 5- and 6-$CH_2$), 1.61 and 1.90 (12H, 2 × m, adamantyl-$CH_2$), 1.77 (1H, m, 4-H), 2.05 (3H, m, adamantyl-CH), 2.90 and 3.54 (2H, 2 × d, *J* = 13.9 Hz, 10-$CH_2$), 4.11 (1H, s, NH), 5.03 (1H, m, 2-CH), 5.77 (1H, dd, *J* = 1.0 and 10.4 Hz, 3'-$H_Z$), 6.08 (1H, dd, *J* = 10.4 and 17.3 Hz, 2'-H) and 6.33 (1H, dd, *J* = 1.0 and 17.3 Hz, 3'-$H_E$); $\delta_C$ (100 MHz; $CDCl_3$) 20.0 and 20.4 (C-8 and C-9), 27.0, 29.9 and 39.5 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.2 (6 × adamantyl-$CH_2$), 44.4 (C-4), 49.3 and 49.5 (C-1 and C-7), 55.1 (C-11), 55.3 (C-10), 78.0 (C-2), 129.0 (C-2'), 130.0 (C-3') and 164.6 (C-1'); *m/z* 421 ($M^+$, 2.8%) and 135 (100); and

N-*(1-adamantyl)-2*-exo-*(3-chloropropanoyloxy)bornane-10-sulfonamide* **9**: (0.48 g, 35%) (Found: $M^+$, 457.21058. $C_{23}H_{36}NO_4SCl$ requires *M*, 457.20536); $[\alpha]^{20}_D$ = –13.64° (*c* 0.22, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.89 and 1.01 (6H, 2 × s, 8- and 9-Me), 1.16–2.02 (6H, series of multiplets, 3-,5- and 6-$CH_2$), 1.66 and 1.94 (12H, 2 × m, adamantyl-$CH_2$), 1.78 (1H, m, 4-H), 2.10 (3H, m, adamantyl-CH), 2.77 (2H, t, *J* = 6.8 Hz, 2'-$CH_2$), 3.21 (2H, 2 × d, *J* = 13.9 Hz, 10-$CH_2$), 3.74 (2H, m, 3'-$CH_2$), 4.00 (1H, s, NH) and 4.99 (1H, dd, *J* = 2.4 and 7.8 Hz, 2-CH); $\delta_C$ (100 MHz; $CDCl_3$) 20.0 and 20.4 (C-8 and C-9), 27.1, 30.1 and 39.5 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.4 (6 × adamantyl-$CH_2$), 37.9 (C-2'), 39.2 (C-3'), 44.4 (C-4), 49.3 and 49.4 (C-1 and C-7), 55.1 (C-11), 55.5 (C-10), 78.7(C-2) and 168.8 (C-1'); *m/z* 457 ($M^+$, 3.3%) and 135 (100).

*Conversion of the 3-chloropropanoyloxy analogue* **9** *to the acrylate ester* **4**: Triethylamine (0.32 g, 3.1 mmol) was added to a mixture of *N*-(1-adamantyl)-2-*exo*-acryloyloxybornane-10-sulfonamide **4** and *N*-(1-adamantyl)-2-*exo*-(3-chloropropanoyloxy)bornane-10-sulfonamide **9** [1.68 g (0.80 g, 1.7 mmol of **9**)]. The reaction mixture was stirred under $N_2$ at 25°C for 1 h and then taken up in EtOAc (5 ml), washed with brine and dried over anhydrous $MgSO_4$. Solvent was removed *in vacuo* to give transparent crystals of *N*-(1-adamantyl)-2-exo-acryloyl-oxybornane-10-sulfonamide **4** (0.67 g, 92%).

N-*(1-Adamantyl)-2*-endo-*acryloyloxybornane-10-sulfonamide* **10** *and* N-*(1-adaman-tyl)-2*-endo-*(3-chloropropanoyloxy)bornane-10-sulfonamide* **11**: The experimental procedure employed for the synthesis of 2-*exo*-analogues **4** and **9** was followed, using neutral $Al_2O_3$ (0.08 g, 0.8 mmol), *N*-(1-adamantyl)-2-*endo*-hydroxybornane-10-sulfonamide **8** (0.19 g, 0.5 mmol) and acryloyl chloride (0.16 g, 1.8 mmol). Work-up and purification [HPLC; elution with hexane–EtOAc (8:2)] afforded two products:

N-*(1-adamantyl)-2*-endo-*acryloyloxybornane-10-sulfonamide* **10**: White crystals (0.15 g, 67.1%), m.p. 120–122°C (Found: $M^+$, 421.22485. $C_{23}H_{35}NO_4S$ requires *M*, 421.22868); $[\alpha]^{20}_D$ = –32.50° (*c* 1.24, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.93 and 0.97 (6H, 2 × s, 8- and 9-Me), 1.08, 1.36, 1.68, 1.84, 2.49 and 2.57 (6H, series of multiplets, 3-, 5- and 6-$CH_2$), 1.63 and 1.90 (12H, 2 × m, adamantyl-$CH_2$), 1.72 (1H, m, 4-H), 2.07 (3H, m, adamantyl-CH), 3.10 and 3.14 (2H, 2 × d, *J* = 14.3 Hz, 10-$CH_2$), 3.97 (1H, s, NH), 5.23 (1H, d, *J* = 9.6 Hz, 2-H), 5.85 (1H, dd, *J* = 1.0 and 10.4 Hz, 3'-$H_Z$), 6.14 (1H, dd, *J* = 10.5 and 17.4 Hz, 2'-H) and 6.46 (1H, dd, *J* = 1.0 and 17.3 Hz, 3'-$H_E$); $\delta_C$ (100 MHz; $CDCl_3$) 19.2 and 19.9 (C-8 and C-9), 25.6, 28.0 and 37.7 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.3 (6 × adamantyl-$CH_2$), 44.0 (C-4), 50.2 and 50.6 (C-1 and C-7), 55.0 (C-11), 59.6 (C-10), 77.3 (C-2), 128.9 (C-2'), 130.9 (C-3') and 165.9 (C-1'); *m/z* 421 ($M^+$, 4.2%) and 135 (100); and

N-*(1-adamantyl)-2*-endo-*(3-chloropropanoyloxy)bornane-10-sulfonamide* **11**: Oil (0.07 g, 31%) (Found: $M^+$, 457.21295. $C_{23}H_{36}NO_4SCl$ requires *M*, 457.20536); $[\alpha]^{20}_D$ = + 24.52° (*c* 0.42, $CHCl_3$); $\delta_H$ (400 MHz; $CDCl_3$) 0.92 and 0.95 (6H, 2 × s, 8- and 9-Me), 1.08, 1.36, 1.65, 1.85, 2.45 and 2.49 (6H, series of multiplets, 3-, 5- and 6-$CH_2$), 1.65 and 1.92 (12H, 2 × m, adamantyl-$CH_2$), 1.73 (1H, m, 4-H), 2.10 (3H, m, adamantyl-CH), 2.84 (2H, dd, *J* = 6.8 and 12.3 Hz, 2'-$CH_2$), 3.06 and 3.14 (2H, 2 × d, *J* = 14.0 Hz, 10-$CH_2$), 3.79 (2H, t, *J* = 6.9 Hz, 3'-$CH_2$), 4.07 (1H, s, NH) and 5.26 (1H, d, *J* = 9.7 Hz, 2-CH); $\delta_C$ (100 MHz; $CDCl_3$) 19.2 and 19.9 (C-8 and C-9), 25.5, 28.0 and 37.5 (C-3, C-5 and C-6), 29.6 (3 × adamantyl-CH), 35.9 and 43.3 (6 × adamantyl-$CH_2$), 37.9 (C-2'), 39.3 (C-3'), 43.9 (C-4), 50.3 and 50.7 (C-1 and C-7), 55.0 (C-11), 59.9 (C-10), 77.2 (C-2) and 170.2 (C-1'); *m/z* 457 ($M^+$, 3.7%) and 135 (100).

*Conversion of the 3-chloropropanoyloxy analogue* **11** *to the acrylate ester* **10**: The experimental procedure employed for the conversion of the 3-chloropropanoyloxy analogue **9** to the acrylate ester **4** was followed, using triethylamine (0.01 g, 0.1 mmol) and a mixture of *N*-(1-adamantyl)-2-*endo*-acryloyloxybornane-10-sulfonamide **10** and *N*-(1-adamantyl)-2-endo-(3-chloropropanoyloxy) bornane-10-sulfonamide **11** [0.50 g (0.04 g, 0.08 mmol of **11**)]. Work-up afforded *N*-(1-adamantyl)-2-*endo*-acryl-oyloxybornane-10-sulfonamide **10** (0.03 g, 79.7%).

*Preliminary Baylis–Hillman reactions of aldehydes* **12a–e** *with* N-*(1-adamantyl)-2*-exo-*acryloyloxybornane-10-sulfonamide* **4**: The aldehyde **12** (0.27 mmol) and DABCO (0.02 mmol) were added to a solution of *N*-(1-adamantyl)-2-*exo*-acryloyloxybornane-10-sulfonamide **4** (0.24 mmol) in $CDCl_3$ (0.40 ml). After stirring at room temperature for 90 h, the solution was concentrated *in vacuo* and the residue was purified by washing with a minimal volume of cold $Et_2O$ to afford a mixture of the diastereomeric products **13**. Separation of the diastereomeric components was not attempted, but the $^1H$ and $^{13}C$ NMR data (detailed below) were used to characterise both isomers. $^1H$ NMR spectroscopy was also used to determine the %-transformation (and, hence, the crude yield of the products **13a–e**). The diastereomeric excess (% d.e.) was determined, in each case, from a comparison of the $^1H$ NMR integral ratios for several signals (typically C*H*OH, C=$CH_2$ and 8- and 9-Me) corresponding to the diastereomeric components.[15]

*Baylis–Hillman products* **13a** (93%, 38% d.e.); $\delta_H$ (400 MHz; $CDCl_3$) 0.80/0.88 and 0.84/0.97 (6H, 2 × s, 8- and 9-Me), 1.14–1.99 (19H, series of multiplets, 3-$CH_2$, 4-H, 5-$CH_2$, 6-$CH_2$, adamantyl-$CH_2$), 2.05 (3H, br m, adamantyl-CH), 2.87 and 3.35/2.92 and 3.46 (2H, 2 × d, 10-$CH_2$), 4.27 (1H, s, NH), 5.01/5.05 (1H, dd, 2-H), 5.02 (1H, br s, CHO*H*), 5.52/5.57 (1H, s, C*H*OH), 5.93 and 5.99 (2H, 2 × s, C=$CH_2$), 7.33 (2H, t, Ar–H) and 8.54/8.55 (2H, s, Ar–H); $\delta_C$ (100 MHz; $CDCl_3$) 19.6/19.9 and 20.2/20.3 (C-8 and C-9),

27.0/27.1 (C-5), 29.57/29.58 (adamantyl-$CH_2$), 30.2/30.8 (C-6), 35.88/35.90 (NC*C*$H_2$), 39.4/39.6 (C-3), 43.3/43.4 (adamantyl-CH), 44.3/44.9 (C-4), 49.2/49.3 and 49.6/49.7 (C-1 and C-7), 55.2/55.7 (C-10), 55.7 (NHC), 71.4/72.6 (CHOH), 79.1/79.2 (C-2), 121.3/121.6 (Ar–C), 127.1/127.4 and 141.7/142.2 (C=$CH_2$), 149.69/149.70 and 150.4/150.7 (Ar–C) and 164.78/164.81 (C=O).

*Baylis–Hillman products* **13b** (99%; 22% d.e.); $\delta_H$ (400 MHz; $CDCl_3$) 0.66/0.88 and 0.82/1.01 (6H, 2 × s, 8- and 9-Me), 1.13–2.12 (22H, series of multiplets, 3-$CH_2$, 4-H, 5-$CH_2$, 6-$CH_2$, adamantyl-CH and -$CH_2$), 2.82/2.85 and 3.46/3.49 (2H, 2 × d, 10-$CH_2$), 4.13/4.44 (1H, s, NH), 4.98/5.07 (1H, br s, CHO*H*), 5.02/5.10 (1H, dd, 2-H), 5.54/5.71 (1H, s, C*H*OH), 5.90 and 6.36/5.80 and 6.23 (2H, 2 × s, C=$CH_2$), 7.17–7.23 (1H, m, Ar–H), 7.41/7.47 (1H, d, Ar–H), 7.65–7.70 (1H, m, Ar–H) and 8.50/8.55 (1H, d, Ar–H); $\delta_C$ (100 MHz; $CDCl_3$) 19.5/20.0 and 20.3/20.4 (C-8 and C-9), 27.0/27.1 (C-5), 29.5/29.7 (adamantyl-$CH_2$), 35.7/35.8 (C-6), 35.8/36.0 (NC*C*$H_2$), 39.3/39.4 (C-3), 43.3/43.4 (adamantyl-CH), 44.3/44.5 (C-4), 49.2/49.5 and 49.3/49.6 (C-1 and C-7), 55.0/55.3 (C-10), 55.1/55.3 (NHC), 70.9/73.0 (CHOH), 78.7/79.0 (C-2), 120.9/121.7 (C-5'), 122.65/122.68 (C-7'), 125.6/128.0 and 142.9/143.1 (C=$CH_2$), 137.0/137.1, 147.8/148.2 and 151.8/152.0 (C-4') and 169.3/169.9 (C=O).

*Baylis–Hillman products* **13c**: (93%, 60% d.e.); $\delta_H$ (400 MHz; $CDCl_3$) 0.86/0.88 and 0.89/0.96 (6H, 2 × s, 8- and 9-Me), 1.14–1.97 (19H, series of multiplets, 3-$CH_2$, 4-H, 5-$CH_2$, 6-$CH_2$, adamantyl-$CH_2$), 2.06 (3H, br s, adamantyl-CH), 2.85/2.90 and 3.30/3.41 (2H, 2 × d, 10-$CH_2$), 4.31/4.45 (1H, s, NH), 5.04–5.08 (1H, m, 2-H), 5.05 (1H, br s, CHO*H*), 5.57/5.63 (1H, s, C*H*OH), 5.75/5.63 and 6.27/6.27 (2H, 2 × s, C=$CH_2$), 7.27/7.29 (1H, d, Ar–H), 7.73–7.77 (1H, m, Ar–H), 8.50–8.53 (1H, m, Ar–H) and 8.59/8.58 (1H, d, Ar–H); $\delta_C$ (100 MHz; $CDCl_3$) 19.9/20.0 and 20.3 (C-8 and C-9), 26.99/27.03 (C-5), 29.6 (adamantyl -$CH_2$), 30.1/30.2 (C-6), 35.9 (adamantyl-CH), 39.36/39.42 (C-3), 43.4 (NC*C*$H_2$), 44.3/44.4 (C-4), 49.25/49.32 and 49.6/49.7 (C-1 and C-7), 54.87/54.89 (NHC), 55.2/55.7 (C-10), 71.0/71.7 (CHOH), 78.9/79.0 (C-2), 123.38/123.42 (Ar–C), 126.3/126.4 and 142.5/142.9 (C=$CH_2$), 134.3/134.5, 148.3/148.5, 148.9/149.1 and 149.2/150.0 (Ar–C) and 164.8/164.9 (C=O).

*Baylis–Hillman* products **13d**: (98%, 95% d.e.); $\delta_H$ (400 MHz; $CDCl_3$) 0.88 and 1.01 (6H, 2 × s, 8- and 9-Me), 1.20–2.05 (22H, series of multiplets, 3-$CH_2$, 4-H, 5-$CH_2$, 6-$CH_2$, adamantyl-CH and -$CH_2$), 2.52 (3H, s, 9'-Me), 2.84 and 3.50 (2H, 2 × d, 10-$CH_2$), 4.17 (1H, s, NH), 5.11 (1H, dd, 2-H), 5.49 (1H, br s, CHO*H*), 5.68 (1H, s, C*H*OH), 5.79 and 6.22 (2H, 2 × s, C=$CH_2$), 7.03 (1H, d, Ar–H), 7.22 (1H, d, Ar–H) and 7.55 (1H, t, Ar–H); $\delta_C$ (100 MHz; $CDCl_3$) 20.0 and 20.4 (C-8 and C-9), 24.2 (Ar$CH_3$), 27.1 (C-5), 29.5 (adamantyl-$CH_2$), 30.0 (C-6), 35.8 (adamantyl-CH), 39.4 (C-3), 43.2 (NC*C*$H_2$), 44.4 (C-4), 49.3 and 49.6 (C-1 and C-7), 55.0 (NHC), 55.2 (C-10), 70.2 (CHOH), 78.7 (C-2), 118.6 and 122.1 (Ar–C), 125.4 and 143.2 (C=$CH_2$), 137.4, 156.6 and 157.9 (Ar–C) and 165.1 (C=O).

*Baylis–Hillman* products **13e**: (89%, 52% d.e.); $\delta_H$ (400 MHz; $CDCl_3$) 0.87/0.88 and 0.91/1.00 (6H, 2 × s, 8- and 9-Me), 1.14–2.12 (22H, series of multiplets, 3-$CH_2$, 4-H, 5-$CH_2$, 6-$CH_2$, adamantyl-CH and -$CH_2$), 2.94/2.86 and 3.36/3.47 (2H, 2 × d, 10-$CH_2$), 4.31/4.20 (1H, s, NH), 4.99–5.04/5.09–5.13 (1H, m, 2-H), 5.05 (1H, br s, CHO*H*), 5.47/5.48 and 6.28/6.22 (2H, 2 × s, C=$CH_2$), 6.22/6.19 (1H, s, C*H*OH), 7.43–7.49 (1H, m, Ar–H), 7.63–7.69 (1H, m, Ar–H), 7.72–7.96 (1H, m, Ar–H) and 8.00/8.11 (1H, dd, Ar–H); $\delta_C$ (100 MHz; $CDCl_3$) 19.7/19.9 and 20.29/20.31 (C-8 and C-9), 26.97/27.04 (C-6), 29.61/29.64 (adamantyl-$CH_2$), 30.0/30.3 (C-5), 35.9 (adamantyl -CH), 39.3/39.4 (C-3), 43.25/43.33 (NC*C*$H_2$), 44.37/44.41 (C-4), 49.19/49.29 and 49.31/49.8 (C-1 and C-7), 55.27/56.13 (C-10), 55.27/56.08 (NHC), 67.7/68.5 (CHOH), 78.7/79.1 (C-2), 124.9/126.0 (C-6'), 128.7/128.6 and 142.0/141.5 (C=$CH_2$), 128.9/129.0, 133.6/133.8, 134.0/134.1, 136.3/136.5 and 164.4/164.7 (Ar–C) and 171.5/171.6 (C=O).

The authors thank the National Research Foundation (NRF; GUN 2069255) and Rhodes University for generous financial support, and Dr Edith Antunes for obtaining melting points.

*Received 29 December 2006; accepted 25 February 2007*
*Paper 06/4378 doi:10.3184/030823407X196953*

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