ADDITION OF LITHIATED METHOXYALLENE TO AZIRIDINES – A NOVEL ACCESS TO ENANTIOPURE PIPERIDINE AND β-AMINO ACID DERIVATIVES

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Dedicated to Dr. Alfred Bader on the occasion of his 85th birthday.

Addition of lithiated methoxyallene to aziridine derivatives provided the expected primary addition products. The less substituted carbon of the aziridine ring was attacked selectively. The primary adducts could be converted to enantiopure piperidine derivatives or β-amino acid derivatives. The unexpected reactions lead to a tricyclic sulfonamide and to alkynyl-substituted aminoethers. The efficient two-step conversion of a piperidone derivative to a benzomorphan demonstrates the potential of this approach to biologically active compounds.

Keywords: Allenes; Aziridines; Alkynes; Piperidones; Benzomorphan; β-Amino ester.

Alkoxyallenes are highly versatile C3 building blocks in organic synthesis[1]. This has been demonstrated by the preparation of oxygen-containing and nitrogen-containing five-membered heterocycles employing lithiated alkoxyallenes and suitable electrophiles (Scheme 1)[2,3]. Very often high stereoselectivities have been achieved and numerous applications to the synthesis of natural products or their analogues have been reported[4]. The reaction of lithiated alkoxyallenes with nitrones occurs as a [3+3] cyclization affording 1,2-oxazine derivatives with high diastereoselectivity[5]. These six-membered heterocycles are particularly versatile intermediates for the stereoselective synthesis of aminopolyols and related acyclic or cyclic compounds[6]. Herein we describe our attempts to convert alkoxyallenes and aziridines in an overall [3+3] cyclization process to piperidine derivatives. It is well known that suitably substituted aziridine derivatives can serve as electrophiles in reactions with organometallic reagents[7].

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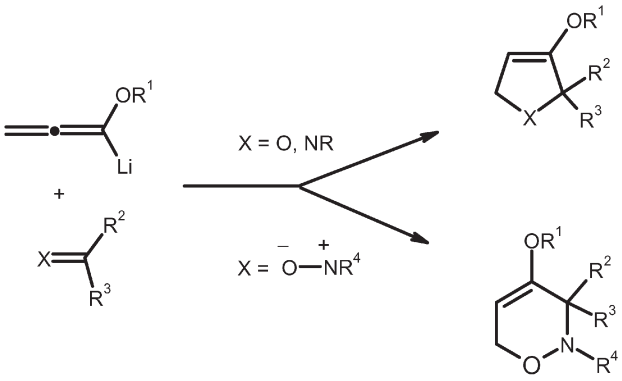
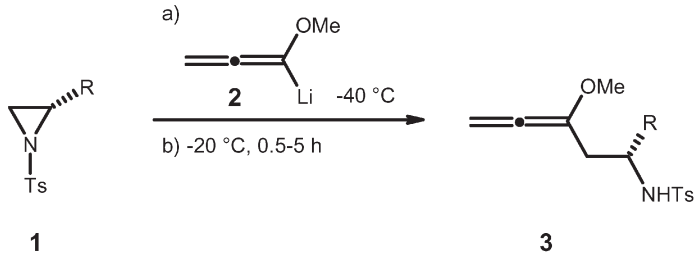
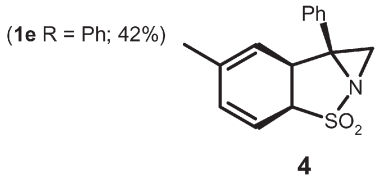


SCHEME 1

N-Tosyl-substituted aziridines **1a**–**1e** were easily obtained according to literature procedures – in the case of **1b**–**1e** in enantiopure form[8]. The reaction of **1a**–**1d** with an excess of lithiated methoxyallene **2** at –20 °C (Scheme 2) afforded the expected primary adducts **3a**–**3d** quantitatively. Purification of these moderately stable compounds gave **3b** in a low and **3d** in a good yield. The attack of the lithiated species regioselectively occurred at the less substituted aziridine carbon. Surprisingly, aziridine derivative **1e** (R = Ph) furnished tricyclic compound **4**, which is apparently the result of



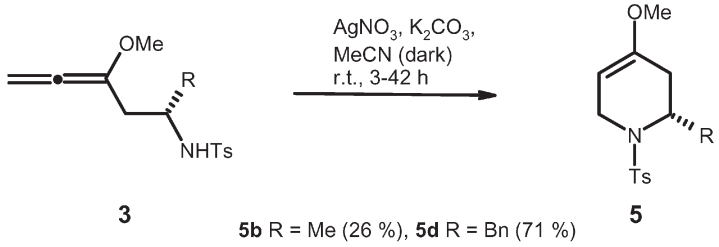
R = **a**: H (100 %), **b**: Me (100 %) [39 %], **c**: *i*Pr (100 %), **d**: Bn (100 %) [65 %]



SCHEME 2
Addition of lithiated methoxyallene to aziridines

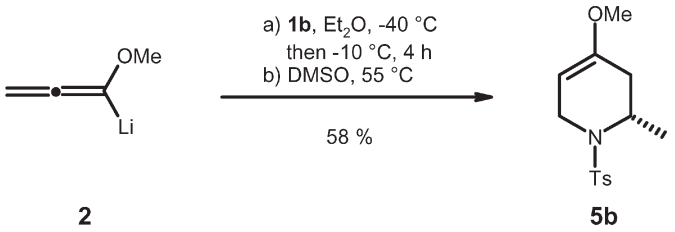
deprotonation at the benzylic position next to the aziridine nitrogen and subsequent intramolecular attack of the resulting lithiated species on the *ortho*-position of the *N*-tosyl group. The protonation proceeded regio- and stereoselectively to give product **4**. We suggest that lithiated methoxyallene **2** serves as the base for deprotonation of **1e** [9,10].

The purified primary products **3b** and **3d** were cyclized to the desired piperidine derivatives **5b** and **5d** in moderate to good yields employing silver nitrate in the presence of potassium carbonate in acetonitrile (Scheme 3). After a number of alternative methods, we found that these conditions are the most reliable, but we did not check gold catalysis which recently gave excellent results in other cyclizations[11,2j].



SCHEME 3
Cyclization of allene precursor **3**

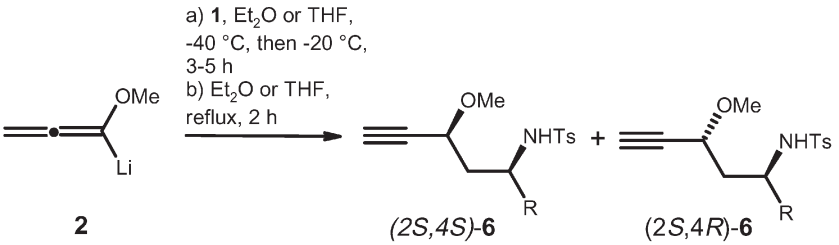
For the preparation of **5b**, we developed a second protocol. Reaction of lithiated methoxyallene **2** in diethyl ether with aziridine derivative **1b** was performed as above. Without aqueous work-up, the solvent was evaporated and replaced by dry DMSO. Subsequent heating of the dissolved lithium salt of the primary adduct **3b** to 55 °C furnished the cyclization product **5b** in a good overall yield, but only moderate purity[12] (Eq. (*1*)). A full analytical characterization of tetrahydropyridine **5b** was not possible due to its instability during storage.



(*1*)

One-step reaction giving piperidine **5b**

An interesting alternative reaction pathway was discovered when the primary addition products of lithiated methoxyallene **2** and aziridines **1b**, **1c**, and **1d** were directly heated without exchange of the solvent. Reflux in diethyl ether or THF induced a rearrangement to provide alkynyl-substituted aminoethers **6** as mixtures of *syn*/*anti*-isomers in 20–35% yields after aqueous work-up and purification (Scheme 4). The constitution and configuration of *anti*-**6b** was proven by an X-ray analysis (Fig. 1) which allowed configurational assignment of all compounds[13]. Although the yields and diastereoselectivities were quite low (only for **6d** a moderate *syn*-selectivity was observed), this unexpected process is quite intriguing since it shows an entirely new facet of alkoxyallene reactivity[14].



6	R	Yield	(2*S*,4*S*) : (2*S*,4*R*)
b	Me	35 %	46 : 54
c	*i*Pr	25 %	56 : 44
d	Bn	20 %	65 : 35

SCHEME 4
Conversion to alkynes **6**

Since the efficacy of the conversion of compounds **3** into piperidine derivatives **5** was not fully satisfactory, we were looking for more efficient methods. For this purpose, we checked proton sources and NBS as ring-closure-inducing electrophiles. One equivalent of trifluoroacetic acid[15] converted **3a**–**3d** (unpurified) to the expected piperidin-4-one derivatives **7a**–**7d** in varying yields (Scheme 5). Again, the benzyl-substituted derivative **7d** was isolated in the highest yield making the overall transformation of the L-phenylalanine derived aziridine **1d** to enantiopure six-membered heterocycle **7d** quite efficient. We assume that all the compounds derived from the chiral aziridine derivatives **1b**–**1d** are enantiopure since the stereogenic centres of all compounds are located in positions where racemizations during the subsequent steps are hardly conceivable. Another

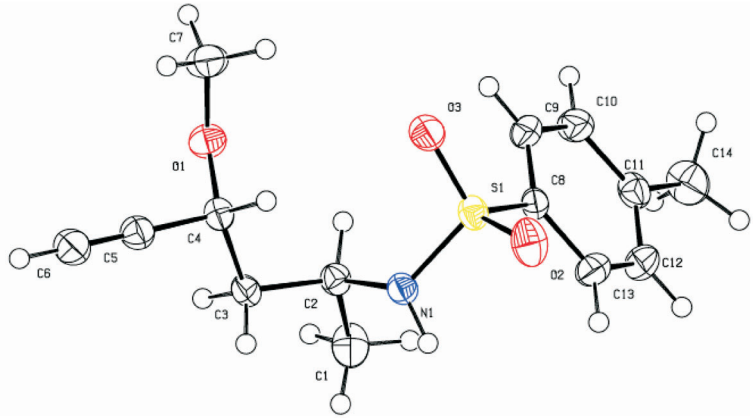
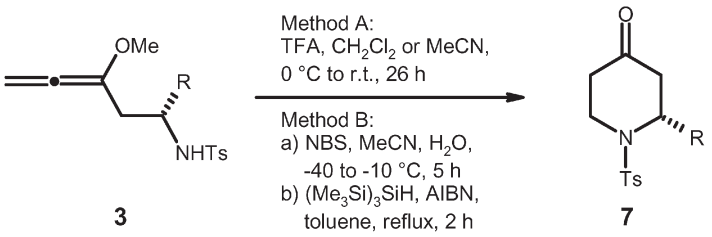


FIG. 1
ORTEP representation of the X-ray crystal structure of alkyne *anti*-**6b**



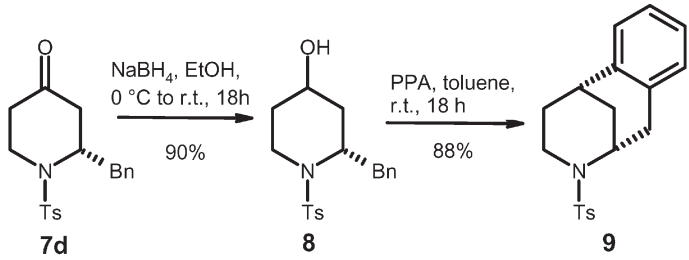
Method A: **7a** R = H (37 %), **7b** R = Me (32 %),
7c R = *i*Pr (17 %), **7d** R = Bn (69 %)
Method B: **7d** R = Bn (50 %)

SCHEME 5
Cyclization of unpurified adducts **3** to piperidinones **7**

method for converting primary adduct **3d** into **7d** consisted in bromination with NBS [16] to provide a 5-bromo-4-piperidone intermediate (3:1 mixture of diastereomers) which was converted to **7d** with tris(trimethylsilyl)silane under radical conditions[17].

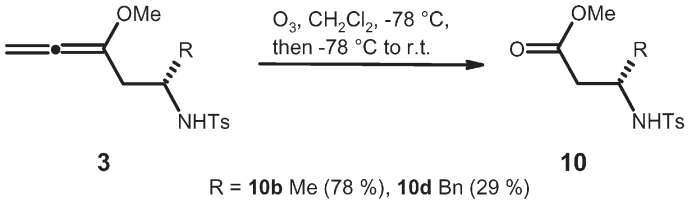
With easily available enantiopure compound **7d**, we demonstrated that 4-piperidone derivatives of this type are suitable precursors of benzomorphans[18]. Reduction with sodium borohydride afforded secondary alcohol **8** as a mixture of diastereomers in an excellent yield (Scheme 6). Subsequent treatment with polyphosphoric acid provided the desired

tricyclic compound **9** in a very good yield[19]. We assume that a range of analogues of **9** can be prepared in a similar fashion employing alkoxyallenes as the key C3 building blocks for the piperidine moiety.



SCHEME 6
Preparation of an enantiopure benzomorphan derivative

Finally, we could prove that primary adducts **3** are also suitable precursors of enantiopure β-amino acid derivatives[20]. To achieve this transformation, we performed ozonolysis of **3b** and **3d**, which provided the desired enantiopure protected β-amino acids **10b** and **10d** (Scheme 7). These transformations show again[21] that lithiated methoxyallene is an excellent synthetic equivalent of a formate ester anion[22].



SCHEME 7
Ozonolysis of unpurified allene adducts **3**

In summary, we could demonstrate that enantiopure aziridine derivatives are suitable electrophiles in addition reactions with lithiated alkoxyallenes such as **2**. Primary adducts **3** can be oxidatively cleaved to provide enantiopure β-amino acids but, more importantly, they open routes to functionalized piperidine derivatives[23]. The preparation of benzomorphan **9** shows the potential of these intermediates for the synthesis of biologically active compounds.

EXPERIMENTAL

All reactions were performed in argon atmosphere in flame-dried flasks; the components were added with syringes. All solvents were dried by standard methods. IR spectra (ν, cm^{-1}) were measured with a Perkin–Elmer 205 or Perkin–Elmer FT-IR spectrometer Nicolet 5 SXC. MS spectra were recorded with a Varian MAT 711 spectrometer. ^1H and ^{13}C NMR spectra (δ, ppm; *J*, Hz) were recorded on a Bruker (AC 500, AC 250) or Jeol Eclipse 500 instrument in $CDCl_3$ solution. The chemical shifts are given in relative to the TMS or to the $CDCl_3$ signal (δ_H 7.27, δ_C 77.0). Higher-order NMR spectra were approximately interpreted as first-order spectra if possible. Missing signals of minor isomers are overlapped by those of major isomers, or they could not be unambiguously identified due to low intensity. Neutral alumina (activity III, Merck) or silica gel 60 (0.04–0.063 mm, Merck–Schuchardt) was used for column chromatography. Melting points (uncorrected) were measured with a Büchi apparatus (SMP-20). Optical rotations were determined in a 1-ml cell with a pathlength of 10 cm using a Perkin–Elmer 241 polarimeter (Na D-line). The $[\alpha]_D$ values were measured at room temperature and are given in 10^{-1} deg cm^2 g^{-1} and the concentrations are given in g/100 cm^3.

N-[(2*S*)-4-Methoxy-1-phenylhexa-4,5-dien-2-yl]-4-methylbenzene-1-sulfonamide (**3d**). Typical Procedure

Methoxyallene (1.05 g, 15.0 mmol) was dissolved in dry THF (30 ml) and treated with butyllithium (2.5 M in hexanes; 5.4 ml, 13.5 mmol) at –40 °C under argon atmosphere. After 5 min the solution of **2** was warmed to –20 °C and a solution of aziridine **1d** (432 mg, 1.50 mmol) dissolved in THF (6 ml) was added within 5 min. The reaction mixture was stirred for 30 min and quenched with saturated aqueous NH_4Cl solution (18 ml). Warming to room temperature was followed by extraction with diethyl ether and drying (anhydrous Na_2SO_4). Purification of the crude product by column chromatography (neutral Al_2O_3, hexane–ethyl acetate 4:1) gives **3d** (349 mg, 65%) as a brown viscous oil. $[\alpha]_D$ –1.94 (*c* 0.98, $CHCl_3$). ^1H NMR ($CDCl_3$, 250 MHz): 2.09–2.30 (m, 2 H, CH_2), 2.38 (s, 3 H, Ar**Me**), 2.83 (m_c, 2 H, C**H**$_2$Ph), 3.22 (s, 3 H, OMe), 3.55–3.67 (m, 1 H, NCH), 5.01 (d, *J* = 7.4, 1 H, NH), 5.33 (m_c, 2 H, $=CH_2$), 6.96–7.29 (m, 7 H, Ph, Ar), 7.66 (d, *J* = 8.3, 2 H, Ar). ^{13}C NMR ($CDCl_3$, 62.9 MHz): 21.4 (q, Ar**Me**), 36.2 (t, CH_2), 41.0 (t, CH_2Ph), 53.4 (q, OMe), 56.0 (d, CHN), 90.2 (t, $=CH_2$), 126.4 (s, =C), 127.0, 128.3, 129.4, 129.6, 137.3, 144.3 (4 d, 2 s, Ph, Ar), 199.3 (s, =C=). IR (neat): 3085–2830 (=C–H, C–H), 1955 (C=C=C), 1330 (SO_2N). For $C_{20}H_{23}NO_3S$ (357.4) calculated: 67.20% C, 6.49% H, 3.92% N; found: 67.27% C, 6.42% H, 3.50% N.

(2*S*)-2-Benzyl-4-methoxy-1-tosyl-1,2,3,6-tetrahydropyridine (**5d**). Typical Procedure

To a solution of allene adduct **3d** (285 mg, 0.80 mmol) in acetonitrile (3.6 ml) was added K_2CO_3 (221 mg, 1.60 mmol) and $AgNO_3$ (27 mg, 0.16 mmol), and the mixture was stirred with exclusion of light at room temperature for 42 h. The mixture was filtered through a Celite pad and the filter was washed with ethyl acetate. The resulting solution was concentrated in vacuo and the residue was purified by column chromatography (neutral Al_2O_3, hexane–ethyl acetate 4:1) to yield **5d** (201 mg, 71%) as a pale yellow viscous oil. $[\alpha]_D$ +18.8 (*c* 1.22, $CHCl_3$). ^1H NMR ($CDCl_3$, 250 MHz): 1.78–1.89 (m, 1 H, 3-H), 2.15–2.27 (m, 1 H, 3-H), 2.36 (s, 3 H, Ar**Me**), 2.68 (d, *J* = 7.4, 2 H, C**H**$_2$Ph), 3.49 (s, 3 H, OMe), 3.45–3.76 (m, 1 H, 6-H), 4.21 (ddd, *J* = 2.1, 4.5, 16.5, 1 H, 6-H), 4.38 (q, *J* = 7.4, 1 H, 2-H), 4.53–4.58 (m, 1 H, 5-H), 6.99–7.32 (m, 7 H, Ph, Ar), 7.59 (d, *J* = 8.4, 2 H, Ar). ^{13}C NMR ($CDCl_3$, 62.9 MHz): 21.1

(q, Ar**Me**), 29.6 (t, C-3), 37.4 (t, CH_2Ph), 39.6 (t, C-6), 52.7 (d, C-2), 88.9 (d, C-5), 126.4, 126.9, 128.4, 129.2, 129.5, 134.4, 138.1, 143.0 (5 d, 3 s, Ph, Ar), 152.2 (s, C-4). IR (neat): 3060–2850 (=C–H, C–H), 1680 (C=C), 1340 (SO_2N). For $C_{20}H_{23}NO_3S$ (357.4) calculated: 67.20% C, 6.49% H, 3.92% N; found: 66.25% C, 6.48% H, 3.48% N. HRMS (80 eV): for $C_{20}H_{21}NO_3S$ (M^+ – 2 H) calculated 355.1242, found 355.1253.

N-[(2*S*,4*S*)- and (2*S*,4*R*)-4-Methoxyhex-5-yn-2-yl]-4-methylbenzene-1-sulfonamide (**6b**). Typical Procedure

To a solution of methoxyallene (0.664 g, 9.47 mmol) in diethyl ether (8 ml) was added dropwise butyllithium (2.5 M in hexanes; 3.4 ml, 8.5 mmol) at –40 °C. After 15 min a solution of aziridine **1b** (0.200 g, 0.95 mmol) in diethyl ether (2 ml) was added and the mixture was stirred at –20 °C for 5 h, and then heated to reflux for an additional 2 h. The reaction mixture was quenched with saturated aqueous NH_4Cl solution. After separation of the phases, the aqueous phase was extracted with diethyl ether. The combined organic extracts were washed with brine and dried (anhydrous Na_2SO_4). The crude product was purified by column chromatography (silica gel, hexane–ethyl acetate 4:1) to yield (2*S*,4*S*)-**6b** (41 mg, 16%) as a yellowish oil and (2*S*,4*R*)-**6b** (50 mg, 19%) as colorless crystals, m.p. 103–104 °C.

(2*S*,4*S*)-**6b**: $[\alpha]_D$ +26.9 (*c* 0.45, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): 1.13 (d, *J* = 6.5, 3 H, Me), 1.74 (ddd, *J* = 4.8, 5.3, 14.5, 1 H, 2-H), 1.86 (ddd, *J* = 7.6, 8.7, 14.5, 1 H, 2-H), 2.42 (s, 3 H, Ar**Me**), 2.43 (d, *J* = 2.1, 1 H, 5-H), 3.30 (s, 3 H, OMe), 3.44–3.47 (m, 1 H, 1-H), 3.85 (ddd, *J* = 2.1, 5.3, 7.6, 1 H, 3-H), 4.97 (d, *J* = 6.1, 1 H, NH), 7.29, 7.71 (2 d, *J* = 8.1 each, 2 H, Ar). ^{13}C NMR ($CDCl_3$, 62.9 MHz): 21.3 (q, Me), 21.8 (q, Ar**Me**), 42.3 (t, C-2), 47.8 (d, C-1), 56.1 (q, OMe), 68.7 (d, C-5), 74.5 (d, C-3), 81.4 (s, C-4), 126.9, 129.4, 137.8, 143.0 (2 d, 2 s, Ar). IR (neat): 3285–3260 (N–H), 3065–2825 (=C–H, C–H), 2110 (C≡C), 1305 (SO_2N). MS (EI, 80 eV, 90 °C), *m/z* (%): 281 (0.3) $[M]^+$, 155 (67) $[C_7H_7O_2S]^+$, 126 (12) $[M - C_7H_7O_2S]^+$, 91 (100) $[C_7H_7]^+$. For $C_{14}H_{19}NO_3S$ (281.1) calculated: 59.76% C, 6.81% H, 4.98% N; found: 58.97% C, 6.60% H, 4.54% N.

(2*S*,4*R*)-**6b**: $[\alpha]_D$ +46.3 (*c* 0.8, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): 1.10 (d, *J* = 6.3, 3 H, Me), 1.75 (m_c, 2 H, 2-H), 2.33 (d, *J* = 1.8, 1 H, 5-H), 2.42 (s, 3 H, Ar**Me**), 3.31 (s, 3 H, OMe), 3.49–3.65 (m, 1 H, 1-H), 4.05 (dt, *J* = 1.8, 6.0, 1 H, 3-H), 5.13 (d, *J* = 6.4, 1 H, NH), 7.29, 7.77 (2 d, *J* = 8.2 each, 2 H, Ar). ^{13}C NMR ($CDCl_3$, 62.9 MHz): 21.3 (q, Me), 21.6 (q, Ar**Me**), 42.3 (t, C-2), 46.9 (d, C-1), 56.5 (q, OMe), 67.9 (d, C-5), 74.0 (d, C-3), 81.4 (s, C-4), 127.0, 129.4, 137.8, 143.0 (2 d, 2 s, Ar). IR (KBr): 3330–3280 (N–H), 3000–2900 (=C–H, C–H), 2110 (C≡C), 1320 (SO_2N). MS (EI, 80 eV, 90 °C), *m/z* (%): 281 (0.1) $[M]^+$, 155 (53) $[C_7H_7O_2S]^+$, 126 (15) $[M - C_7H_7O_2S]^+$, 91 (100) $[C_7H_7]^+$. For $C_{14}H_{19}NO_3S$ (281.1) calculated: 59.76% C, 6.81% H, 4.98% N; found: 59.26% C, 6.65% H, 4.75% N.

(2*S*)-2-Benzyl-1-tosyl-2,3,5,6-tetrahydropyridin-4-one (**7d**). Typical Procedure

To a solution of allene adduct **3d** (103 mg, 0.29 mmol) in dichloromethane (1 ml) was added dropwise CF_3CO_2H (21 µl, 0.29 mmol) dissolved in dichloromethane (0.5 ml) at 0 °C. The mixture was allowed to warm to room temperature and stirred for 26 h. It was then concentrated in vacuo and the residue was taken up in diethyl ether (5 ml), and neutralized with saturated aqueous $NaHCO_3$ solution (5 ml). After separation of the phases, the aqueous phase was extracted with diethyl ether (3 × 5 ml) and the combined organic extracts were dried (anhydrous Na_2SO_4). The crude product was purified by column chromatography (neu-

tral Al_2O_3, hexane–ethyl acetate 4:1) to yield **7d** (69 mg, 69%) as a pale yellow viscous oil, which slowly crystallized at 4 °C, m.p. 88 °C. $[\alpha]_D$ –32.5 (*c* 0.94, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): 2.30–2.32 (m, 1 H, 5-H), 2.33–2.36 (m, 1 H, 3-H), 2.39 (s, 3 H, Ar**Me**), 2.51–2.60 (m, 2 H, 3-H, 5-H), 2.63–2.73 (m, 2 H, C**H**$_2$Ph), 3.39 (m_c, 1 H, 6-H), 4.05 (m_c, 1 H, 6-H), 4.64 (m_c, 1 H, 2-H), 7.06–7.10, 7.19–7.28 (2 m, 2 H, 5 H, Ph, Ar), 7.53 (d, *J* = 8.5, 2 H, Ar). ^{13}C NMR ($CDCl_3$, 125.8 MHz): 21.4 (q, Ar**Me**), 38.7 (t, C**H**$_2$Ph), 40.47, 40.53 (2 t, C-3, C-6), 44.1 (t, C-5), 56.1 (d, C-2), 126.8, 127.1, 128.6, 129.1, 129.8, 136.7, 136.8, 143.6 (5 d, 3 s, Ph, Ar), 206.5 (s, C-4). IR (KBr): 3080, 2970–2860 (=C–H, C–H), 1720 (C=O), 1340 (SO_2N). For $C_{19}H_{21}NO_3S$ (343.5) calculated: 66.45% C, 6.16% H, 4.08% N; found: 66.31% C, 5.85% H, 3.78% N.

(1*S*,6*R*)-3-Tosyl-1,2,3,4,5,6-hexahydro-2,6-methano[3]benzazocine (**9**)

A solution of piperidone **7d** (558 mg, 1.62 mmol) dissolved in ethanol (10 ml) was cooled to 0 °C and $NaBH_4$ (184 mg, 4.88 mmol) was added. The resulting mixture was stirred at room temperature for 18 h. The mixture was quenched with 2 M HCl and the mixture was extracted with diethyl ether. The combined organic phases were washed with saturated aqueous $NaHCO_3$ solution, dried (anhydrous Na_2SO_4), and concentrated in vacuo. The crude product was filtered through a short column (silica gel, pentane–ethyl acetate 1:1) to yield **8** (506 mg, 90%, two diastereomers). Alcohol **8** (108 mg, 0.31 mmol) was dissolved in toluene (20 ml), polyphosphoric acid (2 g) was added and the mixture was stirred at room temperature for 18 h. The mixture was quenched with saturated aqueous $NaHCO_3$ solution. The phases were separated and the aqueous phase was extracted with ethyl acetate. The combined organic layers were washed with brine, dried (anhydrous $MgSO_4$) and concentrated in vacuo. The crude product was purified by column chromatography (silica gel, hexane–ethyl acetate 4:1, then 1:1) to yield **9** (88 mg, 88%) as a colorless solid, m.p. 111–112 °C. $[\alpha]_D$ –6.5 (*c* 0.15, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): 1.80 (m_c, 2 H, 12-H), 1.90 (m_c, 2 H, 13-H), 2.43 (s, 3 H, Ar**Me**), 2.64 (d, *J* = 18.4, 1 H, 8-H), 2.75 (td, *J* = 3.1, 12.5, 1 H, 11-H), 2.98 (dd, *J* = 6.2, 18.4, 1 H, 8-H), 3.08 (m_c, 1 H, 1-H), 3.63 (dd, *J* = 4.7, 12.5, 1 H, 11-H), 4.48 (m_c, 1 H, 9-H), 7.06–7.11 (m, 4 H, Ar), 7.29, 7.71 (2 d, *J* = 8.0, 2 H each, Ar). ^{13}C NMR ($CDCl_3$, 125.8 MHz): 21.5 (q, Ar**Me**), 30.6 (t, C-13), 31.8 (d, C-1), 32.1 (t, C-12), 33.2 (t, C-8), 38.0 (t, C-11), 47.6 (d, C-9), 126.1, 126.4, 127.0, 127.5, 128.9, 129.7, 135.6, 137.9, 138.8, 142.9 (6 d, 4 s, Ar). IR (KBr): 3060–2850 (=C–H, C–H), 1335 (SO_2N). For $C_{19}H_{12}NO_2S$ (327.1) calculated: 69.69% C, 6.46% H, 4.18% N; found: 69.62% C, 6.45% H, 4.19% N.

Methyl (3*S*)-3-(4-Methylbenzene-1-sulfonamido)butanoate (**10b**)

A solution of unpurified allene adduct **3b** (200 mg, 0.71 mmol) in dry methanol (10 ml) was cooled to –78 °C and ozone was bubbled into the solution until a blue color persisted. Then, the excess of ozone was purged out with oxygen. Removing the solvent yielded the crude product, which was recrystallized from a mixture of hexane–ethyl acetate to give **10b** (153 mg, 78%) as a colorless solid, m.p. 77–78 °C. $[\alpha]_D$ –23.7 (*c* 0.24, $CHCl_3$); ref.[24] m.p. 77–78 °C, $[\alpha]_D$ –22.4 (*c* 1.16, $CHCl_3$). ^{1}H NMR ($CDCl_3$, 500 MHz): 1.14 (d, *J* = 6.7, 3 H, 4-H), 2.43 (s, 3 H, Ar**Me**), 2.44 (m_c, 2 H, 2-H), 3.62 (s, 3 H, OMe), 3.68 (m_c, 1 H, 3-H), 5.26 (d, *J* = 8.4, 1 H, NH), 7.30, 7.76 (2 d, *J* = 8.1, 2 H each, Ar). ^{13}C NMR ($CDCl_3$, 125.8 MHz): 21.0, 21.4 (2 q, C-4, Ar**Me**), 40.6 (t, C-2), 46.5 (d, C-3), 51.7 (q, OMe), 127.0, 129.7, 137.9, 143.3 (2 d, 2 s, Ar), 171.6 (s, CO).

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13. Crystal data of *anti*-**6b**: $C_{14}H_{19}NO_3S$, M_r = 281.4; T = 173(2) K; crystal size: 0.5 × 0.2 × 0.1 mm; monoclinic, space group $P2(1)$, a = 10.204(3) Å, b = 7.750(2) Å, c = 10.287(3) Å; Z = 2; D_c = 1.261 Mg m^{-3}; $F(000)$ = 300; μ(MoKα) = 0.222 mm^{-1}; θ range for data collection: 2.17 to 30.58°; index ranges: $-14 \le h \le 10$, $-11 \le k \le 11$, $-14 \le l \le 9$; reflections collected/unique: 6556/4187 (R_{int} = 0.0158); final R indices ($I > 2\sigma(I)$): $R1$ = 0.0352, $wR2$ = 0.0840. For structure solution and refinement, the programs SHELXS97 and SHELXL97 were used[25]. CCDC 720141 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/conts/retrieving.html (or from the Cambridge Crystallographic Data Centre, 12, Union Road, Cambridge, CB2 1EZ, UK; fax: +44 1223 336033; or deposit@ccdc.cam.ac.uk).
14. This rearrangement may be caused by excess lithiated methoxyallene present or its presumed thermal decomposition product lithium methoxide. The process requires deprotonation at the terminal allene carbon and reprotonation in position 3 to generate the alkyne moiety. The overall driving force could be the subsequent deprotonation of the fairly acidic alkyne proton to afford the dianions of compounds **6**. The fairly low yields indicate that considerable decomposition is occurring under these reaction conditions. For the formation of similar compounds by an alternative approach, see: Alouane N., Vrancken E., Mangeney P.: *Synthesis* **2007**, 1261.
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