Synthesis of Six-Membered Cyclic Sulfonimidamides

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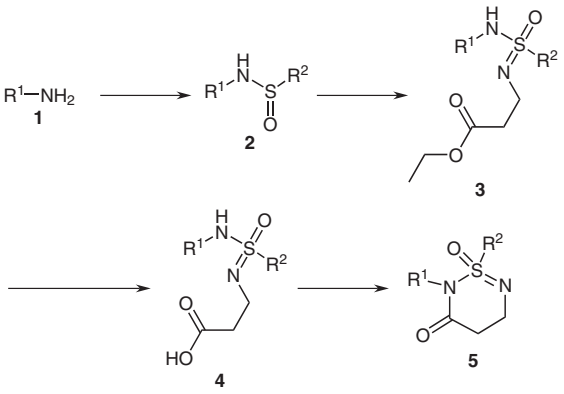
Abstract: A general synthetic route to six-membered cyclic *N*-aryl- and *N*-alkyl-substituted sulfonimidamides via an intramolecular ring closure of suitably functionalised acyclic sulfonimidamides is described. The structure of this new ring system was confirmed by various analytical methods and in one example by X-ray structural analysis.

Key words: sulfonimidamide, heterocycles, cyclisation, sulfur, intramolecular

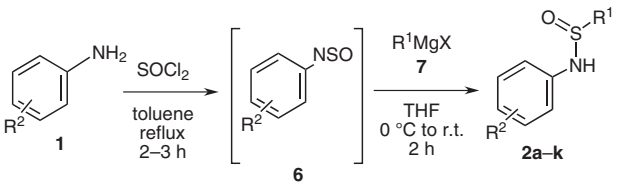
Sulfonimidamides are derivatives of sulfonic acid and analogues of sulfonamides. They are known since early 1960 when the first report was published by Levchenko et al.[1] Although known for sometime, the attention given to sulfonimidamides has been modest until recently; early reports described the preparation[2] and exploration of the chemistry of such systems.[3] Most of the recent reports describe the use of sulfonimidamides as reagents in organic synthesis such as a source of nitrogen for metal-catalysed nitrene transfer reactions,[4] aziridination of olefins,[5] as chiral organocatalysts,[6] or as ligands for transition metal-catalysed asymmetric synthesis.[7] There are also reports which describe the use of sulfonimidamides as potential pharmaceutical[8] or as potential crop protecting agents.[9] Constraining this functionality within a ring system via the N–S–N system has received little attention with only two reports of five-membered ring systems being published.[10,11] The most recent publication[11] has prompted us to report our own research into such ring systems, and we now describe our investigations into six-membered cyclic sulfonimidamides **5**.

Our strategy focused on the construction of the ring system by an intramolecular ring closure, via nitrogen, of suitably functionalised acyclic sulfonimidamides. The latter could be obtained from the reaction of sulfonimidoyl chlorides (prepared in situ) with a β-amino ester (Scheme 1). We were keen to prepare such rings containing the amide functionality, as this would hopefully enable further derivatisation of these rings.

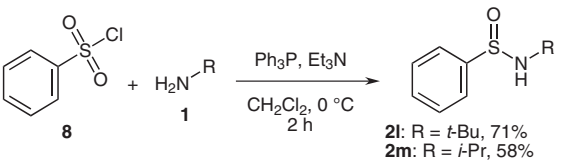
The synthesis of intermediate *N*-aryl sulfinamides **2a**–**k** was achieved by the addition of a Grignard reagent **7** to *N*-thionylanilines **6**,[12] which were conveniently prepared from the reaction of anilines with thionyl chloride as shown in Scheme 2[13] (Table 1). For the synthesis of *N*-alkyl derivatives a different strategy was used to prepare sulfinamides **2**. Sulfinamides **2l**–**m** were prepared from phenylsulfonyl chloride by the method,[14] which involves in situ reduction of the sulfonyl chloride to sulfinyl chloride and coupling with amines **1** (Scheme 3).



Scheme 1 General scheme for the synthesis of cyclic sulfonimidamides



Scheme 2 Synthesis of *N*-aryl sulfinamides (Table 1)



Scheme 3 Synthesis of *N*-alkyl sulfinamides

The synthesis of cyclic sulfonimidamides **5** is shown in Scheme 4 (Table 2). Oxidative chlorination using *tert*-butyl hypochlorite (*t*-BuOCl) of sulfinamides **2** generates

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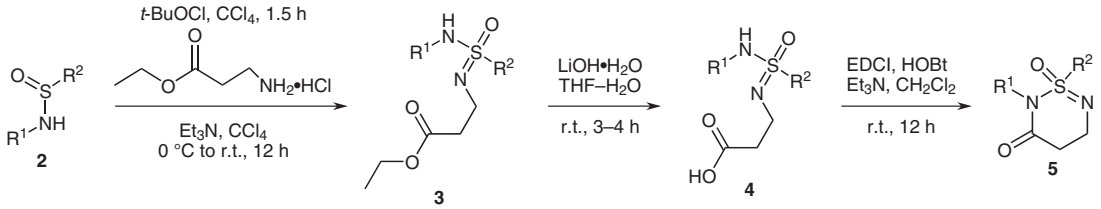
Table 1 Substrate Scope for *N*-Aryl Sulfinamides **2a–k**

Entry	R^1	R^2	Yield of **2** (%)[a]
1	Et	H	**2a**, 83
2	Et	4-Br	**2b**, 88
3	Et	4-Me	**2c**, 80
4	Et	4-OMe	**2d**, 95
5	Et	2-Me	**2e**, 95
6	Et	2,6-Me_2	**2f**, 82
7	*c*-C_3H_5	H	**2g**, 86
8	CH(Me)Et	4-F	**2h**, 75
9	CH(Me)Et	2-OMe	**2i**, 53
10	*i*-Pr	H	**2j**, 95
11	Bn	H	**2k**, 80

[a] Isolated yields by CombiFlash chromatography over two steps.

the sulfonimidoyl chlorides, which are further treated without isolation with β-alanine ethyl ester HCl salt in the presence of base to give the sulfonimidamides **3** in 35–66% yields.[15] Attempted cyclisation of sulfonimidamides **3** under a variety of conditions[16] failed to give **5**. We next turned our attention to obtain the cyclic sulfonimidamides **5** via the corresponding acids **4**; these compounds were prepared by basic hydrolysis of esters **3** in good to excellent yields (Table 2). The cyclisation of acids **4** was then investigated. Treatment of **4a** with Mukaiyama's reagent indeed led to the formation of the six-membered ring **5a**; however, separation of **5a** from the by-product proved tedious. We were then pleased to find that when acids **4** were subjected to intramolecular cyclisation using 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDCI) and 1-hydroxybenzotriazole hydrate (HOBt), the cyclised products **5** were formed and could be readily isolated by chromatography (Table 2). The yields in the final cyclisation step illustrate the impact of steric effects, that is, when R^1 = *tert*-butyl, it was not possible to isolate any cyclised product; however, with R^1 = isopropyl, the cyclisation proceeded in 55% yield.



Scheme 4 Synthesis and cyclisation of sulfonimidamides (Table 2)

Table 2 Substrate Scope for Alkyl and Aryl Sulfonimidamides

Entry	R^1	R^2	Yield of **3** (%)[a]	Yield of **4** (%)[b]	Yield of **5** (%)[a]	**5** Mp (°C)
1	Ph	Et	**3a**, 55	**4a**, 85	**5a**, 76	103–105
2	4-BrC_6H_4	Et	**3b**, 56	**4b**, 90	**5b**, 65	114–116
3	4-MeC_6H_4	Et	**3c**, 35	**4c**, 92	**5c**, 60	88–90
4	4-MeOC_6H_4	Et	**3d**, 35	**4d**, 90	**5d**, 60	80–82
5	2-MeC_6H_4	Et	**3e**, 35	**4e**, 90	**5e**, 55	oil
6	2,6-$Me_2C_6H_3$	Et	**3f**, 57	**4f**, 70	**5f**, 45	oil
7	Ph	*c*-C_3H_5	**3g**, 58	**4g**, 85	**5g**, 60	126–128
8	4-FC_6H_4	CH(Me)Et	**3h**, 60	**4h**, 85	**5h**, 55	167–169
9	2-MeOC_6H_4	CH(Me)Et	**3i**, 66	**4i**, 90	**5i**, 50	oil
10	Ph	*i*-Pr	**3j**, 40	**4j**, 72	**5j**, 71	144–146
11	Ph	Bn	**3k**, 46	**4k**, 84	**5k**, 70	184–186
12	*t*-Bu	Ph	**3l**, 66	**4l**, 70	**5l**, 0	–
13	*i*-Pr	Ph	**3m**, 56	**4m**, 90	**5m**, 55	81–83

[a] Isolated yields by CombiFlash chromatography.
[b] Isolated yields by acid-base workup.

The synthesis of these ring systems using a substituted β-amino ester was also investigated. Reaction of sulfinamide **2c** with *t*-BuOCl gave the sulfonimidoyl chloride, which was treated with racemic ethyl 3-aminobutyrate. After hydrolysis and ring closure as described above, a 1:1 mixture of diastereomers **5n** and **5o** (Figure 1) was obtained, which could be readily separated by chromatography. The absolute configurations of these structures have not been assigned.

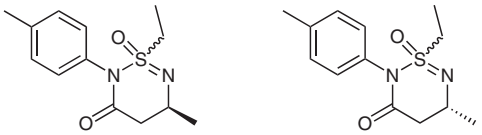


Figure 1 Products **5n** and **5o**

The geometry of the six-membered ring was confirmed by X-ray structure analysis of **5j**. This showed the ring to have an envelope shape, with five atoms (C12, C10, N3, S1, and N14) co-planar, and one atom C13 significantly out of the plane (Figure 2). The phenyl ring is perpendicular to the plane of the ring. Bond distances for the S=N and S–N bonds are in agreement with values observed in similar compounds reported in the Cambridge Crystallographic Database (Table 3).

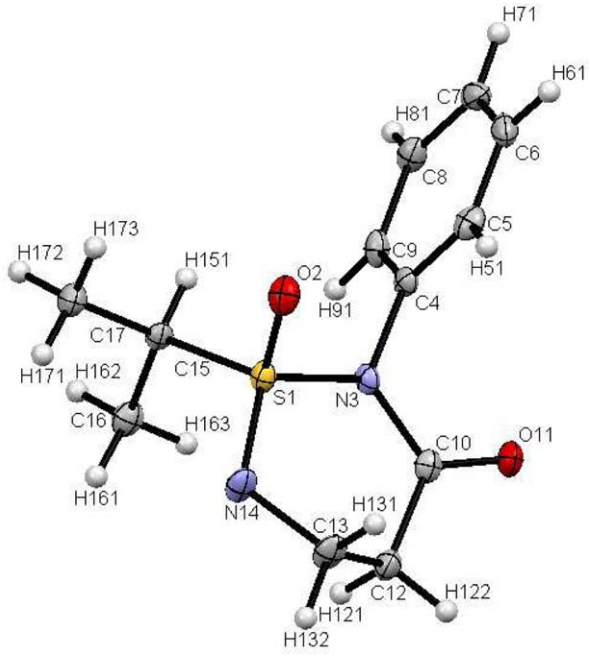


Figure 2 Crystal structure of **5j** ORTEP-style diagram with non-hydrogen atoms shown at 50% probability, atom numbering is arbitrary

In summary, we have developed a general and straightforward route to access six membered cyclic sulfonimidamides. The structures of these molecules have been fully characterised; X-ray crystallographic data of one of the molecules **5j** revealed a nonplanar geometry of the heterocyclic ring. Currently, we are exploring the chemistry of such ring systems, and in addition investigating the synthesis of five- and seven-membered ring systems.

Table 3 Comparison of Bond Lengths and Angles Around the Sulfur in **5j**

	CSD[a]	**5j**
Bond length S_1–N_3	1.67 ± 0.04 Å	1.705 Å
Bond length S_1=N_{14}	1.54 ± 0.04 Å	1.510 Å
Bond angle S_1=N_{14}–C_{13}	117.0 ± 4.4°	116.96°

[a] The median values from 6 structures in the Cambridge Structure Database containing the acyclic N–S=N fragment is provided for comparison.

All the chemical reagents were purchased and used as received, unless otherwise indicated. Grignard reagent used was EtMgBr (3.40 M solution in Et_2O, Aldrich), unless otherwise noted. ^1H and ^{13}C NMR spectra were recorded on a Bruker Avance II-400 spectrometer and all chemical shift values refer to $\delta_{TMS} = 0.00$ or $CDCl_3$ $\delta_H = 7.26$; δ_C, 77.1. The HRMS analyses were performed on an Agilent QTOF 6520 mass spectrometer and LCMS on THERMO MSQ PLUS mass spectrometer. IR spectra were recorded on Shimadzu DRS Prestige 21 spectrophotometer. Column chromatographic purifications were performed on a CombiFlash Rf (Teledyne Isco) with silica gel using the indicated mobile phase.

***N*-Phenylethanesulfinamide (2a);[17a] Typical Procedure**

Method A: To a stirred solution of aniline (**1a**; 2.00 g, 21.5 mmol) in anhydrous toluene (10 mL) at r.t. was added a solution of $SOCl_2$ (3.29 g, 2.00 mL, 27.9 mmol) in anhydrous toluene (10 mL). This suspension was refluxed for 2–3 h under N_2 atmosphere, whereupon a clear solution was observed. All the volatiles were removed by reducing under pressure to afford the crude *N*-thionylaniline **6a**, which was dissolved in anhydrous THF (10 mL). To this solution was added at 0 °C commercial EtMgBr solution in Et_2O (9.47 mL, 32.2 mmol, 3.40 M) under N_2 atmosphere. The reaction mixture was stirred at 0 °C for 1 h, and then at r.t. for 1 h, under N_2 atmosphere. The mixture was quenched by sat. aq NH_4Cl (50 mL) and extracted with EtOAc (3 × 100 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated under reduced pressure. The crude product was purified by CombiFlash chromatography (silica gel, *n*-hexane–EtOAc, 4:1) to afford the desired sulfinamide **2a**; yield: 3.00 g (83%); sticky yellow solid.

IR (KBr): 3153, 1598, 1490, 1411, 1232, 1060, 1022, 885, 750, 696, 516 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.25 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.87–2.99 (m, 2 H, SCH_2), 6.50 (br s, 1 H, NH), 6.90–7.00 (m, 3 H, ArH), 7.17–7.22 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.7, 49.4, 117.8, 120.2, 122.9, 129.5, 141.4.

ESI-MS: *m*/*z* = 170.06 $[M + H]^+$.

***N*-(4-Bromophenyl)ethanesulfinamide (2b)**

From 4-bromoaniline (3.67 g, 21.5 mmol); yield: 4.60 g (88%); yellow solid; mp 65–68 °C.

IR (KBr): 3136, 1589, 1489, 1381, 1298, 1176, 1116, 821 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.28 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.92–2.94 (m, 2 H, SCH_2), 6.86–6.90 (m, 2 H, ArH), 7.05 (br s, 1 H, NH), 7.30–7.34 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.6, 49.5, 115.5, 119.7, 132.3, 140.6.

ESI-MS: *m*/*z* = 245.87, 247.87 ([M – H]$^+$ for ^{79}Br and ^{81}Br).

***N*-(*p*-Tolyl)ethanesulfinamide (2c)**[17b]
From *p*-toluidine (2.30 g, 21.5 mmol); yield: 3.20 g (80%); white solid; mp 65–68 °C.

IR (KBr): 3134, 2933, 1612, 1514, 1284, 1236, 1055, 896, 808, 671, 522 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.30 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.28 (s, 2 H, ArC*H*$_3$), 2.88–3.04 (m, 2 H, SCH_2), 6.54 (br s, 1 H, NH), 6.92–6.97 (m, 2 H, ArH), 7.04–7.06 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.5, 20.6, 49.4, 119.1, 129.8, 132.9, 138.4.

ESI-MS: *m*/*z* = 183.89 [M + H]$^+$.

***N*-(4-Methoxyphenyl)ethanesulfinamide (2d)**
From *p*-anisidine (2.64 g, 21.5 mmol); yield: 4.10 g (95%); yellow solid; mp 77–79 °C.

IR (KBr): 3122, 1508, 1456, 1303, 1240, 1110, 1035, 898, 823, 684 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.29 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.84–3.01 (m, 2 H, SCH_2), 3.75 (s, 3 H, OCH_3), 6.54 (br s, 1 H, NH), 6.71–6.81 (m, 2 H, ArH), 6.98–7.02 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.6, 49.3, 55.5, 114.6, 121.9, 133.8, 156.4.

ESI-MS: *m*/*z* = 200.06 [M + H]$^+$.

***N*-(*o*-Tolyl)ethanesulfinamide (2e)**
From *o*-toluidine (2.30 g, 21.5 mmol); yield: 3.80 g (95%); yellow oil.

IR (film): 3184, 1495, 1242, 1064, 1030, 891, 748 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.31 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.24 (s, 3 H, ArC*H*$_3$), 2.99–3.02 (m, 2 H, SCH_2), 6.18 (br s, 1 H, NH), 6.98–7.00 (m, 1 H, ArH), 7.14–7.16 (m, 2 H, ArH), 7.25–7.26 (m, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.5, 17.8, 49.8, 119.5, 123.9, 127.0, 128.3, 130.9, 139.3.

ESI-MS: *m*/*z* = 184.20 [M + H]$^+$.

***N*-(2,6-Dimethylphenyl)ethanesulfinamide (2f)**
From 2,6-dimethylaniline (2.60 g, 21.5 mmol); yield: 3.50 g (82%); white solid; mp 68–70 °C.

IR (KBr): 3180, 1478, 1401, 1197, 1042, 880, 780, 636 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.35 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.26 (s, 6 H, 2 × ArC*H*$_3$), 2.89–2.97 (m, 2 H, SCH_2), 5.40 (br s, 1 H, NH), 6.89–6.98 (m, 3 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.5, 17.6, 19.1, 50.6, 126.0, 128.4, 126.0, 128.4, 128.8, 133.6, 137.3, 137.5.

ESI-MS: *m*/*z* = 198.13 [M + H]$^+$.

***N*-Phenylcyclopropanesulfinamide (2g)**
From aniline (2.00 g, 21.5 mmol) and cyclopropylmagnesium bromide (64.4 mL, 32.2 mmol, 0.50 M in THF); yield: 3.40 g (86%); white solid; mp 84–86 °C.

IR (KBr): 3153, 1598, 1498, 1400, 1232, 1064, 889, 698 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88–0.94, 1.33–1.36 (m, 4 H, 2 × cyclopropyl CH_2), 2.34–2.38 (m, 1 H, SCH), 5.99 (br s, 1 H, NH), 7.02–7.08 (m, 3 H, ArH), 7.26–7.30 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 0.0, 4.5, 32.2, 119.8, 124.4, 130.6, 142.0.

ESI-MS: *m*/*z* = 182.15 [M + H]$^+$.

***N*-(4-Fluorophenyl)butane-2-sulfinamide (2h)**
From 4-fluoroaniline (2.38 g, 21.5 mmol) and Me_2CHCH_2MgCl (16.1 mL, 32.2 mmol, 2.00 M in THF); yield: 3.50 g (75%); white solid; mp 78–80 °C.

IR (KBr): 3454, 1645, 1511, 1216, 1080, 1047, 895, 821, 759 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.02–1.04 (m, 3 H, CH_3), 1.07–1.09 (m, 3 H, CH_3), 2.10–2.16 (m, 1 H, SCH), 2.78–2.91 (m, 2 H, CH_2), 6.89–6.99 (m, 4 H, ArH), 7.00 (br s, 1 H, NH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.8, 22.3, 24.6, 64.6, 115.9, 116.1, 120.5, 137.2, 157.9, 160.3.

ESI-MS: *m*/*z* = 216.08 [M + H]$^+$.

***N*-(2-Methoxyphenyl)butane-2-sulfinamide (2i)**
From *o*-anisidine (2.64 g, 21.5 mmol) and Me_2CHCH_2MgCl (16.1 mL, 32.2 mmol, 2.00 M in THF); yield: 2.60 g (53%); yellow solid; mp 78–80 °C.

IR (KBr): 3772, 1596, 1495, 1250, 1048, 882, 742, 562 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.02–1.04 (m, 6 H, 2 × CH_3), 2.08–2.15 (m, 1 H, SCH), 2.73–2.84 (m, 2 H, CH_2), 3.75 (s, 3 H, OCH_3), 6.36 (br s, 1 H, NH), 6.76–6.79 (m, 1 H, ArH), 6.81–6.92 (m, 2 H, ArH), 7.16–7.19 (dd, *J* = 1.6, 8.0 Hz, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.9, 22.5, 24.5, 55.7, 65.3, 110.9, 117.0, 121.2, 123.0, 130.7, 148.7.

ESI-MS: *m*/*z* = 227.81 [M + H]$^+$.

***N*-Phenylpropane-2-sulfinamide (2j)**[17c]
From aniline (2.00 g, 21.5 mmol) and $Me_2CHMgCl$ (16.1 mL, 32.2 mmol, 2.00 M in THF); yield: 3.73 g (95%); white solid; mp 65–67 °C.

IR (KBr): 3169, 1598, 1498, 1475, 1402, 1280, 1226, 1049, 873, 754, 696, 509 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.35 (m, 6 H, 2 × CH_3), 2.96–3.03 (m, 1 H, SCH), 5.90 (br s, 1 H, NH), 7.00–7.04 (m, 3 H, ArH), 7.24–7.28 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 15.8, 16.2, 54.4, 117.9, 122.5, 129.0, 142.1.

ESI-MS: *m*/*z* = 184.06 [M + H]$^+$.

***N*,1-Diphenylmethanesulfinamide (2k)**[17d]
From aniline (915 mg, 9.84 mmol) and BnMgCl (7.38 mL, 14.7 mmol, 2.00 M in THF); yield: 1.82 g (80%); white solid; mp 138–140 °C.

IR (KBr): 3219, 3059, 1598, 1496, 1444, 1419, 1157, 1055, 985, 746, 696 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 3.80–3.85 (dd, *J* = 7.2, 13.2 Hz, 1 H, SCH_2), 4.16–4.20 (dd, *J* = 5.2, 13.2 Hz, 1 H, SCH_2), 4.26 (br s, 1 H, NH), 7.18–7.26 (m, 3 H, ArH), 7.40–7.47 (m, 3 H, ArH), 7.69–7.72 (dd, *J* = 1.6, 8.0 Hz, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 44.7, 126.0, 127.7, 128.3, 128.7, 128.9, 131.0, 137.7, 144.0.

ESI-MS: *m*/*z* = 232.07 [M + H]$^+$.

***N*-*tert*-Butylbenzenesulfinamide (2l);**[14a] **Typical Procedure**
Method B: To a stirred solution of benzenesulfonyl chloride (5.00 g, 28.4 mmol) and Et_3N (5.73 g, 7.86 mL, 56.8 mmol) in CH_2Cl_2 (75 mL) at 0 °C under N_2 atmosphere was added a solution of Ph_3P (7.44 g, 28.4 mmol) and *tert*-butylamine (2.07 g, 2.98 mL, 28.4 mmol) in CH_2Cl_2 (75 mL) using a syringe pump over a period of 1 h. The reaction mixture was stirred under N_2 atmosphere for 1 h and monitored by TLC (eluent: hexane–EtOAc, 3:2). After completion, the reaction mixture was concentrated under reduced pressure. The crude product was purified by CombiFlash chromatography (silica gel, *n*-hexane–EtOAc, 4:1) to afford the desired sulfinamide **2l**; yield: 4.00 g (71%); white solid; mp 55–58 °C.

IR (KBr): 3178, 2972, 1473, 1444, 1234, 1082, 1047, 744, 686 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.41 [s, 9 H, $C(CH_3)_3$], 3.85 (br s, 1 H, NH), 7.46–7.48 (m, 3 H, ArH), 7.68–7.70 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 31.1, 54.3, 125.6, 128.7, 130.9, 146.6.

ESI-MS: *m*/*z* = 198.45 $[M + H]^+$.

_N_-Isopropylbenzenesulfinamide (2m)[14b]
From benzenesulfonyl chloride (4.97 g, 28.2 mmol) and isopropylamine (1.66 g, 2.30 mL, 28.2 mmol); yield: 3.00 g (58%); yellow oil.

IR (film): 3202, 2968, 1444, 1244, 1086, 1051, 874, 751, 697 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.06 (d, *J* = 6.4 Hz, 3 H, CH_3), 1.28 (d, *J* = 6.4 Hz, 3 H, CH_3), 3.55–3.64 (m, 1 H, SCH), 3.88 (br s, 1 H, NH), 7.45–7.50 (m, 3 H, ArH), 7.68–7.84 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 24.5, 24.8, 46.2, 125.7, 128.7, 130.7, 145.3.

ESI-MS: *m*/*z* = 183.9 $[M + H]^+$.

Ethyl 3-[(Anilineethyloxo-1λ^6-sulfanylidene)amino]propanoate (3a); Typical Procedure
To a stirred solution of the sulfinamide **2a** (2.00 g, 11.8 mmol) in CCl_4 (20 mL) cooled to 0 °C in an round-bottomed flask covered with aluminum foil was added dropwise *tert*-butyl hypochlorite[17e] (1.91 g, 17.7 mmol) in CCl_4 (5 mL) and the reaction mixture was stirred for 1.5 h at 0 °C under N_2 atmosphere. The mixture was then concentrated under reduced pressure, maintaining an atmosphere of N_2 and the residue dissolved in CCl_4 (25 mL). To this solution was added β-alanine ethyl ester hydrochloride (4.51 g, 29.5 mmol), Et_3N (8.36 g, 11.4 mL, 82.8 mmol) in CCl_4 (20 mL) at 10–15 °C. The mixture was stirred at r.t. for 12 h under N_2 atmosphere, diluted with H_2O (50 mL), and extracted with EtOAc (3 × 70 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated under reduced pressure. The crude product was purified by Combi-Flash chromatography (silica gel, *n*-hexane–EtOAc, 7:3) to afford the desired product **3a**; yield: 1.85 g (55%); yellow oil.

IR (film): 3271, 2981, 2939, 1732, 1595, 1489, 1305, 1186, 1055, 912, 758, 731, 694 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.20 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.42 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.40–2.45 (m, 2 H, NCH_2), 3.20–3.24 (m, 2 H, SCH_2), 3.31–3.34 (m, 2 H, $COCH_2$), 4.07–4.11 (m, 2 H, CO_2CH_2), 6.93–6.97 (m, 1 H, ArH), 7.09–7.11 (m, 2 H, ArH), 7.18–7.25 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.2, 13.1, 33.6, 38.2, 48.1, 59.9, 121.0, 122.4, 128.0, 142.7, 171.1.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{20}N_2O_3S$: 285.1267; found: 285.1261.

Ethyl 3-{[(4-Bromoanilino)ethyloxo-1λ^6-sulfanylidene]amino}propanoate (3b)
From **2b** (1.57 g, 6.40 mmol); yield: 1.30 g (56%); yellow oil.

IR (film): 3273, 2980, 1732, 1485, 1305, 1188, 1053, 831 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.22 (t, *J* = 7.6 Hz, 3 H, CH_3), 1.40 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.38–2.45 (m, 2 H, NCH_2), 3.20–3.29 (m, 2 H, SCH_2), 3.30–3.35 (m, 2 H, $COCH_2$), 4.06–4.14 (m, 2 H, CO_2CH_2), 6.95–6.99 (m, 2 H, ArH), 7.25–7.30 (m, 2 H, ArH),

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.2, 13.1, 33.6, 38.2, 48.1, 60.5, 113.6, 124.1, 130.8, 142.1, 171.0.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{19}BrN_2O_3S$: 363.0373; found: 363.0369.

Ethyl 3-{[Ethyl(4-methylanilino)oxo-1λ^6-sulfanylidene]amino}propanoate (3c)
From **2c** (1.75 g, 9.56 mmol); yield: 1.00 g (35%); yellow oil.

IR (film): 3336, 2981, 2939, 1732, 1506, 1309, 1186, 1055, 786 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.24 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.41 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.21 (s, 3 H, ArCH_3), 2.41–2.45 (m, 2 H, CH_2), 3.19–3.23 (m, 2 H, CH_2), 3.30–3.36 (m, 2 H, CH_2), 4.06–4.10 (m, 2 H, CO_2CH_2), 6.94–6.97 (m, 4 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.5, 13.1, 40.4, 40.6, 45.6, 48.9, 59.6, 122.0, 122.2, 128.5, 130.3, 140.1, 170.3.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{14}H_{22}N_2O_3S$: 299.1420; found: 299.1423.

Ethyl 3-{[Ethyl(4-methoxyanilino)oxo-1λ^6-sulfanylidene]amino}propanoate (3d)
From **2d** (915 mg, 4.60 mmol); yield: 500 mg (35%); yellow oil.

IR (film): 3273, 2982, 1729, 1505, 1313, 1237, 1053, 835 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.22 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.40 (t, *J* = 6.2 Hz, 3 H, CH_3), 2.40–2.44 (m, 2 H, SCH_2), 3.16–3.23 (m, 2 H, NCH_2), 3.29–3.32 (m, 2 H, $COCH_2$), 3.47 (s, 3 H, OCH_3), 4.05–4.11 (m, 2 H, CO_2CH_2), 6.75–6.77 (m, 2 H, ArH), 7.01–7.03 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.2, 14.2, 34.8, 39.3, 48.8, 55.4, 60.9, 114.3, 124.5, 136.6, 155.1, 172.1.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{14}H_{22}N_2O_4S$: 315.1372; found: 315.1367.

Ethyl 3-{[Ethyl(2-methylanilino)oxo-1λ^6-sulfanylidene]amino}propanoate (3e)
From **2e** (3.00 g, 16.3 mmol); yield: 1.70 g (35%); yellow oil.

IR (film): 3286, 2980, 1732, 1489, 1311, 1188, 1056, 759 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.24 (t, *J* = 7.6 Hz, 3 H, CH_3), 1.44 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.25 (s, 3 H, ArCH_3), 2.42–2.46 (m, 2 H, NCH_2), 3.20–3.25 (m, 2 H, SCH_2), 3.28–3.33 (m, 2 H, $COCH_2$), 4.06–4.12 (m, 2 H, CO_2CH_2), 4.65 (br s, 1 H, NH), 6.85–6.89 (m, 1 H, ArH), 7.01–7.05 (m, 1 H, ArH), 7.10–7.12 (m, 1 H, ArH), 7.21–7.23 (m, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.7, 14.1, 18.4, 34.7, 39.3, 49.5, 60.9, 122.0, 122.3, 126.2, 130.3, 132.2, 142.2, 172.2.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{14}H_{22}N_2O_3S$: 299.1423; found: 299.1419.

Ethyl 3-{[(2,6-Dimethylanilino)ethyloxo-1λ^6-sulfanylidene]amino}propanoate (3f)
From **2f** (1.61 g, 8.21 mmol); yield: 1.46 g (57%); yellow oil.

IR (film): 2980, 1729, 1471, 1301, 1203, 1184, 1104s, 1058, 767 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.22 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.49 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.33 (s, 6 H, 2 × ArCH_3), 2.38–2.41 (m, 2 H, NCH_2), 3.24–3.30 (m, 4 H, SCH_2, $COCH_2$), 4.02–4.14 (m, 2 H, CO_2CH_2), 4.58 (br s, 1 H, NH), 6.82–6.86 (m, 1 H, ArH), 6.96–6.99 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 9.2, 14.2, 19.6, 35.0, 39.5, 49.8, 60.8, 123.0, 128.1, 133.7, 139.7, 172.4.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{15}H_{24}N_2O_3S$: 313.1580; found: 313.1577.

Ethyl 3-[(Anilinocyclopropyloxo-1λ^6-sulfanylidene)amino]propanoate (3g)
From **2g** (1.31 g, 7.22 mmol); yield: 1.24 g (58%); yellow oil.

IR (film): 3280, 1732, 1489, 1271, 1188, 1049, 891 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 0.96–1.09, 1.22–1.35 (m, 4 H, 2 × cyclopropyl CH_2), 1.22 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.42–2.47 (m, 2 H, NCH_2), 2.60–2.64 (m, 1 H, SCH), 3.34–3.37 (m, 2 H, $COCH_2$), 4.06–4.12 (m, 2 H, CO_2CH_2), 4.80 (br s, 1 H, NH), 6.91–6.96 (m, 1 H, ArH), 7.08–7.12 (m, 2 H, ArH), 7.17–7.21 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 4.9, 6.4, 14.1, 32.4, 34.7, 39.2, 60.9, 121.9, 123.5, 128.9, 143.7, 172.1.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{14}H_{20}N_2O_3S$: 297.1267; found: 297.1269.

Ethyl 3-{[(4-Fluoroanilino)oxo-*sec*-butyl-1λ^6-sulfanylidene]amino}propanoate (3h)
From **2h** (1.50 g, 7.07 mmol); yield: 1.40 g (60%); yellow oil.

IR (film): 3286, 2963, 1733, 1501, 1304, 1213, 1046, 837, 723 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.15 (m, 6 H, 2 × CH_3), 1.23 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.35–2.43 (m, 3 H, CH_2, SCH), 2.92–2.98 (m, 1 H, $COCH_2$), 3.11–3.17 (m, 1 H, $COCH_2$), 3.28–3.32 (m, 2 H, NCH_2), 4.05–4.11 (m, 2 H, CO_2CH_2), 4.75 (br s, 1 H, NH), 6.85–6.90 (m, 2 H, ArH), 7.01–7.04 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.0, 21.4, 21.6, 24.0, 33.6, 38.4, 59.9, 61.4, 114.3, 114.5, 123.6, 123.7, 138.8, 156.2, 158.6, 171.0.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{15}H_{23}FN_2O_3S$: 331.1486; found: 331.1481.

Ethyl 3-{[(2-Methoxyanilino)oxo-*sec*-butyl-1λ^6-sulfanylidene]amino}propanoate (3i)
From **2i** (1.30 g, 5.76 mmol); yield: 1.30 g (66%); yellow solid; mp 60–62 °C.

IR (KBr): 3066, 1728, 1585, 1494, 1286, 1222, 1174, 1024, 765, 628, 524 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.12–1.14 (m, 6 H, 2 × CH_3), 1.21 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.38–2.43 (m, 3 H, CH_2, SCH), 3.05–3.19 (m, 2 H, $COCH_2$), 3.30–3.36 (m, 2 H, NCH_2), 3.83 (s, 3 H, OCH_3), 4.06–4.11 (m, 2 H, CO_2CH_2), 6.83–6.88 (m, 2 H, ArH), 6.97–7.01 (m, 1 H, ArH), 7.21–7.23 (dd, *J* = 1.6, 7.6 Hz, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 12.5, 20.9, 23.6, 33.7, 37.2, 54.1, 59.0, 60.6, 109.6, 119.5, 122.1, 124.1, 129.6, 151.2, 170.5

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{16}H_{26}N_2O_4S$: 343.1686; found: 343.1679.

Ethyl 3-[(Anilinoisopropyloxo-1λ^6-sulfanylidene)amino]propanoate (3j)
From **2j** (1.70 g, 9.23 mmol); yield: 1.10 g (40%); yellow oil.

IR (film): 3257, 2981, 2937, 2252, 1728, 1597, 1489, 1307, 1269, 1201, 1045, 910, 732, 495 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.21 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.42–1.47 (m, 6 H, 2 × CH_3), 2.38–2.43 (m, 2 H, NCH_2), 3.31–3.35 (m, 3 H, $COCH_2$, SCH), 4.03–4.09 (m, 2 H, CO_2CH_2), 6.91–6.95 (m, 1 H, ArH), 7.09–7.11 (m, 2 H, ArH), 7.17–7.25 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.0, 15.5, 15.8, 33.9, 38.5, 54.3, 59.8, 120.9, 122.5, 127.9, 142.9, 171.1.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{14}H_{22}N_2O_3S$: 299.1423; found: 299.1418.

Ethyl 3-[(Anilinobenzyloxo-1λ^6-sulfanylidene)amino]propanoate (3k)
From **2k** (1.45 g, 6.28 mmol), yield: 1.00 g (46%); yellow oil.

IR (film): 3282, 2981, 1730, 1595, 1489, 1301, 1271, 1184, 1051, 786 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.10 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.17–2.22 (m, 2 H, NCH_2), 3.01–3.04 (m, 2 H, $COCH_2$), 3.92–3.96 (m, 2 H, CO_2CH_2), 4.30–4.39 (m, 2 H, SCH_2), 6.83–6.87 (m, 1 H, ArH), 6.99–7.12 (m, 2 H, ArH), 7.08–7.13 (m, 2 H, ArH), 7.27–7.31 (m, 3 H, ArH), 7.34–7.39 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 13.0, 29.8, 33.7, 59.7, 121.0, 122.4, 127.2, 127.8, 128.2, 128.3, 130.2, 142.9, 170.9.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{18}H_{22}N_2O_3S$: 347.1423; found: 347.1417.

Ethyl 3-{[(*tert*-Butylamino)oxophenyl-1λ^6-sulfanylidene]amino}propanoate (3l)
From **2l** (3.80 g, 19.4 mmol); yield: 4.00 g (66%); yellow oil.

IR (film): 3284, 2972, 1730, 1445, 1287, 1139, 1091, 755, 690, 605 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.23 (t, *J* = 7.2 Hz, 3 H, CH_3), 1.29 (s, 9 H, C $(CH_3)_3$), 2.46–2.54 (m, 2 H, NCH_2), 3.16–3.22 (m, 1 H, $COCH_2$), 3.36–3.40 (m, 1 H, $COCH_2$), 4.10–4.17 (m, 2 H, CO_2CH_2), 7.40–7.46 (m, 3 H, ArH), 7.87–7.89 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.2, 31.5, 35.6, 38.7, 54.4, 60.6, 127.0, 128.6, 131.4, 143.6, 173.2.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{15}H_{24}N_2O_3S$: 313.1580; found: 313.1582.

Ethyl 3-{[(Isopropylamino)oxophenyl-1λ^6-sulfanylidene]amino}propanoate (3m)
From **2m** (3.30 g, 17.9 mmol); yield: 3.00 g (56%); yellow oil.

IR (film): 3272, 2975, 1728, 1446, 1259, 1139, 755, 690 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.00 (d, *J* = 6.4 Hz, 3 H, CH_3), 1.10 (d, *J* = 6.4 Hz, 3 H, CH_3), 1.22 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.49–2.54 (m, 2 H, CH_2), 3.23–3.26 (m, 1 H, CH_2), 3.36–3.38 (m, 1 H, CH_2), 3.47–3.50 (m, 1 H, NCH), 4.06–4.13 (m, 2 H, CO_2CH_2), 7.40–7.47 (m, 3 H, ArH), 7.86–7.88 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 12.2, 24.8, 25.0, 36.1, 38.3, 45.6, 60.5, 126.9, 128.8, 131.9, 141.5, 173.0.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{14}H_{22}N_2O_3S$: 299.1424; found: 299.1424.

Ethyl 3-{[Ethyl(4-methylanilino)oxo-1λ^6-sulfanylidene]amino}butanoate (3n)
From **2c** (1.67 g, 9.16 mmol); yield: 1.00 g (35%); yellow oil.

IR (film): 3336, 2980, 1734, 1506, 1301, 1188, 1055, 786 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.18–1.21 (m, 6 H, 2 × CH_3), 1.32 (t, *J* = 6.4 Hz, 3 H, CH_3), 2.19 (s, 3 H, ArCH_3), 2.26–2.27 (m, 1 H, $COCH_2$), 2.38–2.40 (m, 1 H, $COCH_2$), 3.08–3.18 (m, 2 H, SCH_2), 3.73–3.81 (m, 1 H, NCH), 3.97–4.08 (m, 2 H, CO_2CH_2), 6.90 (s, 4 H, ArH),

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.3, 13.1, 19.7, 33.7, 38.2, 48.0, 60.0, 122.3, 128.5, 130.3, 139.9, 171.1.

HRMS (EI): *m/z* $[M + H]^+$ calcd for $C_{18}H_{22}N_2O_3S$: 313.1579; found: 313.1581.

3-[(Anilinoethyloxo-1λ^6-sulfanylidene)amino]propanoic Acid (4a); Typical Procedure
To a stirred solution of sulfonimidamide ester **3a** (1.50 g, 5.28 mmol) in THF (8 mL) was added a solution of LiOH (664 mg, 15.8 mmol) in H_2O (3 mL) at r.t. The reaction mixture was refluxed for 3–4 h, with monitoring by TLC (eluent: hexane–EtOAc, 1:9) until completion. The mixture was concentrated under reduced pressure to remove THF, diluted with H_2O (10 mL), and extracted with EtOAc (50 mL) (this organic layer was discarded to remove impurities). The aqueous layer was then acidified with aq 10% HCl and extracted with EtOAc (3 × 50 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated under reduced pressure to afford the desired product **4a**; yield: 1.10 g (85%); yellow oil.

IR (film): 3271, 2533, 1714, 1593, 1489, 1286, 1265, 1184, 1051, 912, 806 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.30 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.46–2.58 (m, 2 H, NCH_2), 3.22–3.27 (m, 2 H, SCH_2), 3.38–3.42 (m, 2 H, $COCH_2$), 6.63 (br s, 2 H, NH), 6.98–7.02 (m, 1 H, ArH), 7.10–7.13 (m, 2 H, ArH), 7.21–7.25 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.1, 34.8, 38.2, 47.8, 122.9, 123.6, 129.2, 142.6, 175.9.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{11}H_{16}N_2O_3S$: 257.0954; found: 257.0955.

3-{[(4-Bromoanilino)ethyloxo-1λ^6- sulfanylidene]amino}propanoic Acid (4b)
From **3b** (1.20 g, 3.32 mmol); yield: 1.00 g (90%); yellow oil.

IR (film): 3234, 3018, 1712, 1485, 1280, 1215, 1051 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.34 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.44–2.60 (m, 2 H, NCH_2), 3.20–3.25 (m, 2 H, SCH_2), 3.30–3.40 (m, 2 H, $COCH_2$), 6.88 (br s, 1 H, NH), 7.12–7.14 (m, 2 H, ArH), 7.37–7.39 (m, 2 H, ArH),

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.0, 33.5, 35.1, 47.3, 114.3, 124.1, 131.0, 141.3, 175.4.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{11}H_{15}BrN_2O_3S$: 335.0060; found: 335.0053.

3-{[Ethyl(4-methylanilino)oxo-1λ^6-sulfanylidene]amino}propanoic Acid (4c)
From **3c** (900 mg, 3.02 mmol); yield: 750 mg (92%); yellow oil.

IR (film): 3224, 3001, 1715, 1475, 1285, 1212, 1042, 742 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.30 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.21 (s, 3 H, ArCH_3), 2.44–2.55 (m, 2 H, NCH_2), 3.26–3.27 (m, 2 H, SCH_2), 3.29–3.38 (m, 2 H, $COCH_2$), 6.10 (br s, 1 H, NH), 7.01 (s, 4 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 6.9, 19.7, 28.6, 33.7, 37.0, 46.7, 122.7, 128.9, 132.5, 136.9, 174.5.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{18}N_2O_3S$: 271.1111; found: 271.1108.

3-{[Ethyl(4-methoxyanilino)oxo-1λ^6-sulfanylidene]amino}propanoic Acid (4d)
From **3d** (500 mg, 1.59 mmol); yield: 410 mg (90%); yellow oil.

IR (film): 3447, 2934, 1717, 1506, 1254, 1212, 1033, 836 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.28 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.50–2.61 (m, 2 H, CH_2), 3.45–3.47 (m, 2 H, CH_2), 3.57–3.59 (m, 2 H, CH_2), 3.77 (s, 3 H, OCH_3), 6.80–6.82 (m, 2 H, ArH), 7.20–7.26 (m, 2 H, ArH), 7.40 (br s, 1 H, NH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.2, 35.4, 48.0, 55.5, 60.4, 114.7, 126.2, 128.8, 129.6, 130.9, 157.6, 175.3.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{18}N_2O_4S$: 287.1060; found: 287.1056.

3-{[Ethyl(2-methylanilino)oxo-1λ^6-sulfanylidene]amino}propanoic Acid (4e)
From **3e** (795 mg, 2.67 mmol); yield: 650 mg (90%); yellow oil.

IR (film): 3269, 2939, 1712, 1489, 1286, 1215, 1056, 758 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.42 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.25 (s, 3 H, ArCH_3), 2.46–2.54 (m, 2 H, NCH_2), 3.20–3.25 (m, 2 H, SCH_2), 3.33–3.37 (m, 2 H, $COCH_2$), 6.57 (br s, 1 H, NH), 6.89–6.93 (m, 1 H, ArH), 7.04–7.07 (m, 1 H, ArH), 7.12–7.14 (m, 1 H, ArH), 7.21–7.23 (m, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.4, 17.3, 33.6, 37.5, 47.7, 121.7, 122.0, 125.3, 129.5, 131.6, 140.2, 175.3.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{18}N_2O_3S$: 271.1111; found: 271.1108.

3-{[(2,6-Dimethylanilino)ethyloxo-1λ^6-sulfanylidene]amino}propanoic Acid (4f)
From **3f** (100 mg, 0.32 mmol); yield: 64 mg (70%); yellow oil.

IR (film): 3200, 2933, 1711, 1473, 1281, 1203, 1103, 1053, 773 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.43 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.35 (s, 6 H, 2 × ArCH_3), 2.51–2.60 (m, 2 H, CH_2), 3.36–3.43 (m, 2 H, CH_2), 3.73–3.76 (m, 2 H, CH_2), 6.59 (br s, 1 H, NH), 6.93–7.01 (m, 3 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 9.2, 21.9, 37.6, 41.2, 48.0, 125.3, 127.6, 134.6, 134.9, 174.2.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{13}H_{20}N_2O_3S$: 285.1267; found: 285.1262.

3-[(Anilinocyclopropyloxo-1λ^6-sulfanylidene)amino]propanoic Acid (4g)
From **3g** (1.04 g, 3.51 mmol); yield: 800 mg (85%); yellow oil.

IR (film): 3018, 2358, 1714, 1489, 1288, 1215, 1049, 891 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.00–1.02, 1.24–1.27 (m, 4 H, 2 × cyclopropyl CH_2), 2.50–2.70 (m, 3 H, CH_2, SCH), 3.39–3.46 (m, 2 H, CH_2), 6.58 (br s, 1 H, NH), 6.90–7.04 (m, 1 H, ArH), 7.11–7.15 (m, 2 H, ArH), 7.20–7.26 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 4.9, 6.3, 31.7, 34.5, 38.3, 123.1, 124.0, 129.1, 142.0, 175.8.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{16}N_2O_3S$: 269.0955; found: 269.0950.

3-{[(4-Fluoroanilino)oxo-*sec*-butyl-1λ^6-sulfanylidene]amino}propanoic Acid (4h)
From **3h** (835 mg, 2.53 mmol); yield: 650 mg (85%); yellow oil.

IR (film): 3528, 2965, 1716, 1501, 1307, 1214, 1090, 1043, 837 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.11–1.19 (m, 6 H, 2 × CH_3), 2.31–2.39 (m, 1 H, SCH), 2.43–2.59 (m, 2 H, CH_2), 2.99–3.04 (dd, *J* = 6.4, 14.0 Hz, 1 H, CH_2), 3.14–3.19 (dd, *J* = 6.0, 14.0 Hz, 1 H, CH_2), 3.32–3.40 (m, 2 H, CH_2), 6.88–6.92 (m, 2 H, ArH), 7.02–7.07 (m, 2 H, ArH), 7.77 (br s, 1 H, NH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 20.0, 21.4, 24.0, 33.5, 37.3, 59.4, 114.5, 114.8, 123.8, 123.9, 137.4, 156.7, 159.1, 170.3.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{13}H_{19}FN_2O_3S$: 303.1173; found: 303.1170.

3-{[(2-Methoxyanilino)oxo-*sec*-butyl-1λ^6-sulfanylidene]amino}propanoic Acid (4i)
From **3i** (1.28 g, 3.75 mmol); yield: 1.06 g (90%); solid; mp 83–85 °C.

IR (KBr): 3259, 2953, 1712, 1494, 1240, 1217, 1029, 827, 748 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.02–1.06 (m, 6 H, 2 × CH_3), 2.28–2.33 (m, 1 H, SCH), 2.40–2.43 (m, 2 H, CH_2), 3.03–3.05 (m, 1 H, CH_2), 3.08–3.14 (m, 1 H, CH_2), 3.27–3.35 (m, 2 H, CH_2), 3.73 (s, 3 H, OCH_3), 6.40 (br s, 1 H, NH), 6.77–6.80 (m, 2 H, ArH), 6.92–6.94 (m, 1 H, ArH), 7.17–7.19 (m, 1 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 19.7, 21.4, 21.5, 24.3, 34.0, 37.2, 54.6, 60.6, 110.3, 120.1, 123.0, 123.8, 129.4, 151.4, 175.1.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{14}H_{22}N_2O_4S$: 315.1373; found: 315.1373.

3-[(Anilinoisopropyloxo-1λ^6-sulfanylidene)amino]propanoic Acid (4j)
From **3j** (814 mg, 2.73 mmol); yield: 530 mg (72%); yellow oil.

IR (film): 3248, 2956, 1710, 1488, 1220, 1203, 1032, 837, 735 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.38 (d, *J* = 6.8 Hz, 3 H, CH_3), 1.44 (d, *J* = 6.8 Hz, 3 H, CH_3), 2.39–2.56 (m, 2 H, CH_2), 3.40–3.43 (m, 2 H, CH_2), 3.46–3.51 (m, 1 H, SCH), 6.97–7.01 (m, 1 H, ArH), 7.11–7.13 (m, 2 H, ArH), 7.20–7.25 (m, 2 H, ArH), 7.30 (br s, 1 H, NH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 16.4, 16.6, 35.0, 38.7, 54.8, 122.8, 123.5, 129.1, 142.6, 176.0.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{18}N_2O_3S$: 271.1111; found: 271.1108.

3-[(Anilinobenzyloxo-1λ^6-sulfanylidene)amino]propanoic Acid (4k)

From **3k** (906 mg, 2.62 mmol); yield: 700 mg (84%); yellow oil.

IR (film): 3205, 2975, 1710, 1460, 1350, 1250, 1140, 978, 805, 740, 602 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.04 (s, 2 H, SCH_2), 2.89–3.05 (m, 2 H, NCH_2), 4.15–4.32 (m, 2 H, $COCH_2$), 5.70 (br s, 1 H, NH), 6.82–6.99 (m, 3 H, ArH), 7.03–7.08 (m, 2 H, ArH), 7.14–7.15 (m, 2 H, ArH), 7.20–7.25 (m, 3 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 28.6, 36.0, 57.7, 127.3, 127.4, 128.0, 128.6, 130.2, 143.4, 177.5.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{16}H_{18}N_2O_3S$: 319.1111; found: 319.1112.

3-{[(*tert*-Butylamino)oxophenyl-1λ^6-sulfanylidene]amino}propanoic Acid (4l)

From **3l** (1.88 g, 6.03 mmol); yield: 1.20 g (70%); yellow oil.

IR (film): 3209, 2971, 1707, 1468, 1365, 1245, 1139, 981, 869, 811, 755, 598 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.23 [s, 9 H, $C(CH_3)_3$], 2.36–2.54 (m, 2 H, NCH_2), 3.01–3.08 (m, 1 H, $COCH_2$), 3.21–3.27 (m, 1 H, $COCH_2$), 7.26 (br s, 1 H, NH), 7.46–7.54 (m, 3 H, ArH), 7.92–7.94 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 31.4, 35.3, 37.5, 45.8, 55.4, 127.8, 129.0, 132.1, 142.4, 176.2.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{13}H_{20}N_2O_3S$: 285.1267; found: 285.1262.

3-{[(Isopropylamino)oxophenyl-1λ^6-sulfanylidene]amino}propanoic Acid (4m)

From **3m** (2.50 g, 8.40 mmol); yield: 2.04 g (90%); yellow oil.

IR (film): 3258, 2972, 1716, 1446, 1253, 1134, 755, 689, 559 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.92 (d, *J* = 6.4 Hz, 3 H, CH_3), 1.18 (d, *J* = 6.4 Hz, 3 H, CH_3), 2.43–2.44 (m, 1 H, CH_2), 2.55–2.58 (m, 1 H, CH_2), 3.08–3.10 (m, 1 H, NCH), 3.22–3.27 (m, 2 H, CH_2), 7.49–7.68 (m, 3 H, ArH), 7.68 (br s, 1 H, NH), 7.89–7.90 (m, 2 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 24.0, 25.7, 35.5, 37.1, 45.7, 128.3, 129.2, 132.5, 139.3, 176.7.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{18}N_2O_3S$: 271.1111; found: 271.1109.

3-{[Ethyl(4-methylanilino)oxo-1λ^6-sulfanylidene]amino}butanoic Acid (4n)

From **3n** (1.04 g, 3.33 mmol); yield: 900 mg (95%); yellow oil.

IR (film): 3363, 2978, 1714, 1506, 1286, 1053 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.25 (t, *J* = 7.6 Hz, 3 H, CH_3), 1.30–1.35 (m, 3 H, CH_3), 2.20 (s, 3 H, ArCH_3), 2.4–2.60 (m, 1 H, CH_2), 2.41–2.50 (m, 1 H, CH_2), 3.14–3.39 (m, 2 H, CH_2), 3.85–3.95 (m, 1 H, NCH), 7.01–7.05 (m, 4 H, ArH).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 7.0, 20.1, 21.0, 40.3, 45.8, 47.9, 122.6, 128.8, 132.7, 137.0, 173.6.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{13}H_{20}N_2O_3S$: 285.1267; found: 285.1269.

1-Ethyl-1-oxo-2-phenyl-1λ^6-thia-2,6-diazacyclohex-6-en-3-one (5a);[18] Typical Procedure

To a stirred solution of **4a** (990 mg, 3.90 mmol) in CH_2Cl_2 (10 mL) was added Et_3N (985 mg, 1.35 mL, 9.76 mmol) at r.t. To this mixture was then added EDCI (1.11 g, 5.85 mmol) and HOBt (895 mg, 5.85 mmol). The reaction mixture was stirred for 12 h at r.t. under N_2 atmosphere. The reaction mass was diluted with H_2O (10 mL) and extracted with CH_2Cl_2 (3 × 50 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated under reduced pressure. The crude product was purified by CombiFlash chromatography (silica gel, *n*-hexane–EtOAc, 7:3) to afford the desired product **5a**; yield: 700 mg (76%); white solid; mp 103–105 °C.

IR (KBr): 2997, 2870, 1697, 1485, 1303, 1134, 1022, 829, 759, 698, 524 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.39 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.69–2.87 (m, 2 H, NCH_2), 3.03–3.25 (m, 2 H, SCH_2), 3.49–3.57 (ddd, *J* = 3.4, 5.6, 13.1 Hz, 1 H, $COCH_2$), 3.82–3.92 (m, 1 H, $COCH_2$), 7.27–7.35 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.39–7.51 (m, 3 H, 2 × *m*-$CH_{Ar}N$, *p*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 9.0, 34.9, 38.7, 46.9, 129.5, 129.6, 129.8, 133.5, 170.7.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{11}H_{14}N_2O_2S$: 239.0850; found: 239.0854.

2-(4-Bromophenyl)-1-ethyl-1-oxo-1λ^6-thia-2,6-diazacyclohex-6-en-3-one (5b)

From **4b** (815 mg, 2.44 mmol); yield: 500 mg (65%); white solid; mp 114–116 °C.

IR (KBr): 2974, 2947, 2854, 1701, 1485, 1307, 1130, 1022, 829, 736, 659, 555, 520 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.39 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.69–2.86 (m, 2 H, NCH_2), 2.99–3.25 (m, 2 H, SCH_2), 3.48–3.58 (m, 1 H, $COCH_2$), 3.82–3.89 (ddd, *J* = 4.3, 10.5, 13.1 Hz, 1 H, $COCH_2$), 7.17–7.24 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.54–7.64 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.9, 34.8, 38.6, 47.0, 123.7, 131.3, 132.6, 132.9, 170.5.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{11}H_{13}BrN_2O_2S$: 316.9955; found: 316.9486.

1-Ethyl-1-oxo-2-(*p*-tolyl)-1λ^6-thia-2,6-diazacyclohex-6-en-3-one (5c)

From **4c** (713 mg, 2.64 mmol); yield: 400 mg (60%); white solid; mp 88–90 °C.

IR (KBr): 2974, 2873, 1701, 1508, 1300, 1141, 1018, 833, 725, 671, 609, 528 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.32 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.32 (s, 3 H, ArCH_3), 2.62–2.79 (m, 2 H, NCH_2), 2.96–3.18 (m, 2 H, SCH_2), 3.41–3.49 (m, 1 H, $COCH_2$), 3.75–3.82 (ddd, *J* = 4.3, 10.5, 13.1 Hz, 1 H, $COCH_2$), 7.10–7.15 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.18–7.23 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.9, 21.2, 35.0, 38.7, 46.8, 129.4, 130.4, 130.7, 139.7, 170.9.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{16}N_2O_2S$: 253.1005; found: 253.0983.

1-Ethyl-2-(4-methoxyphenyl)-1-oxo-1λ^6-thia-2,6-diazacyclohex-6-en-3-one (5d)

From **4d** (177 mg, 0.62 mmol); yield: 100 mg (60%); white solid; mp 80–82 °C.

IR (KBr): 2951, 2854, 1701, 1512, 1303, 1261, 1018, 822, 732, 667, 574 cm^{-1}.

^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.38 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.70–2.85 (m, 2 H, NCH_2), 3.02–3.24 (m, 2 H, SCH_2), 3.46–3.64 (m, 1 H, $COCH_2$), 3.81 (s, 3 H, OCH_3), 3.73–3.92 (m, 1 H, $COCH_2$), 6.90–7.02 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.14–7.30 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.8, 34.9, 38.5, 46.6, 55.4, 114.9, 125.4, 130.7, 160.1, 170.9.

HRMS (EI): *m/z* [M + H]$^+$ calcd for $C_{12}H_{16}N_2O_3S$: 269.0955; found: 269.0910.

1-Ethyl-2-(*o*-tolyl)-1-oxo-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5e)
From **4e** (600 mg, 2.23 mmol); yield: 310 mg (55%); yellow oil.

IR (film): 2970, 1697, 1489, 1303, 1012, 783, 758 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.42 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.23 (s, 3 H, ArCH_3), 2.70–2.75 (m, 2 H, NCH_2), 3.20–3.24 (m, 2 H, SCH_2), 3.44–3.48 (m, 1 H, $COCH_2$), 3.76–3.79 (m, 1 H, $COCH_2$), 7.02–7.04 (m, 1 H, ArH), 7.18–7.20 (m, 1 H, ArH), 7.26–7.29 (m, 2 H, ArH); rotamers were observed in ^1H NMR spectrum.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 9.1, 11.7, 35.0, 38.5, 47.4, 127.0, 128.8, 129.9, 132.1, 132.8, 138.7, 170.9.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{12}H_{16}N_2O_2S$: 253.1005; found: 253.1005.

2-(2,6-Dimethylphenyl)-1-ethyl-1-oxo-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5f)
From **4f** (1.10 g, 3.84 mmol); yield: 460 mg (45%); yellow oil.

IR (film): 2976, 1696, 1473, 1290, 1136, 999 855, 831, 725, 663 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.39 (t, *J* = 7.2 Hz, 3 H, CH_3), 2.23 (s, 3 H, ArCH_3), 2.13 (s, 3 H, ArCH_3), 2.80–2.85 (m, 2 H, NCH_2), 3.13–3.28 (m, 2 H, SCH_2), 3.53–3.57 (td, *J* = 4.7, 13.1 Hz, 1 H, $COCH_2$), 3.80–3.89 (m, 1 H, $COCH_2$), 7.12–7.19 (m, 2 H, 2 × *m*-$CH_{Ar}N$), 7.19–7.28 (m, 1 H, *p*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.3, 18.5, 19.2, 35.0, 38.8, 48.1, 128.8, 129.4, 129.6, 131.7, 136.9, 139.0, 170.4.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{18}N_2O_2S$: 267.1162; found: 267.1151.

1-Cyclopropyl-1-oxo-2-phenyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5g)
From **4g** (800 mg, 3.00 mmol); yield: 450 mg (60%); white solid; mp 126–128 °C.

IR (KBr): 3523, 2873, 1697, 1300, 1122, 1022, 877, 833, 543 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 0.85–0.95 (m, 2 H, cyclopropyl CH_2), 1.03–1.20 (m, 2 H, cyclopropyl CH_2), 2.40–2.50 (tt, *J* = 4.8, 7.6 Hz, 1 H, SCH), 2.68–2.86 (m, 2 H, NCH_2), 3.50–3.56 (ddd, *J* = 3.1, 5.6, 13.0 Hz, 1 H, $COCH_2$), 3.84–3.90 (ddd, *J* = 4.1, 10.9, 13.0 Hz, 1 H, $COCH_2$), 7.30–7.37 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.41–7.49 (m, 3 H, 2 × *m*-$CH_{Ar}N$, *p*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 6.1, 7.6, 30.6, 34.7, 38.8, 129.4, 130.3, 133.7, 170.5.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{12}H_{14}N_2O_2S$: 251.0850; found: 251.0761.

2-(4-Fluorophenyl)-1-oxo-1-*sec*-butyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5h)
From **4h** (675 mg, 2.24 mmol); yield: 350 mg (55%); white solid; mp 167–169 °C.

IR (KBr): 2954, 1709, 1507, 1306, 1220, 1139, 1021, 955, 875, 800, 662, 573 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.06 (d, *J* = 4.3 Hz, 3 H, CH_3), 1.08 (d, *J* = 4.3 Hz, 3 H, CH_3), 2.24–2.34 (m, 1 H, SCH), 2.72–2.85 (m, 2 H, NCH_2), 2.94–3.06 (m, 2 H, CH_2), 3.49–3.55 (m, 1 H, $COCH_2$), 3.81–3.84 (ddd, *J* = 4.8, 9.5, 13.1 Hz, 1 H, $COCH_2$), 7.14–7.17 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.25–7.33 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 22.2, 22.6, 25.2, 34.9, 38.8, 60.0, 116.6, 116.8, 129.3, 131.9, 161.6, 164.1, 170.5.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{17}FN_2O_2S$: 285.1068; found: 285.096.

2-(2-Methoxyphenyl)-1-oxo-1-*sec*-butyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5i)
From **4i** (995 mg, 3.17 mmol); yield: 470 mg (50%); yellow oil.

IR (film): 2979, 1696, 1591, 1498, 1293, 1113, 1019, 875, 763, 676, 568 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 0.99 (d, *J* = 6.8 Hz, 3 H, CH_3), 1.03 (d, *J* = 6.8 Hz, 3 H, CH_3), 2.22–2.28 (m, 1 H, SCH), 2.76–2.79 (m, 2 H, NCH_2), 2.85–2.91 (dd, *J* = 7.2, 14.0 Hz, 1 H, CH_2), 3.10–3.19 (m, 1 H, CH_2), 3.50–3.53 (td, *J* = 5.3, 13.1 Hz, 1 H, $COCH_2$), 3.79–3.84 (m, 1 H, $COCH_2$), 3.85 (s, 3 H, OCH_3), 7.00–7.06 (m, 2 H, ArH), 7.37–7.44 (m, 2 H, ArH); rotamers were observed in ^1H NMR spectrum.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.2, 21.8, 23.6, 33.5, 38.2, 54.7, 58.9, 110.9, 119.7, 120.5, 120.8, 130.1, 131.0, 154.5, 168.2.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{14}H_{20}N_2O_3S$: 297.1267; found: 297.0782.

1-Isopropyl-1-oxo-2-phenyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5j)
From **4j** (450 mg, 1.67 mmol); yield: 300 mg (71%); white solid; mp 144–146 °C.

IR (KBr): 2981, 2854, 1705, 1323, 1300, 1122, 1014, 825, 698, 555 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.37 (t, *J* = 7.2 Hz, 6 H, 2 × CH_3), 2.63–2.76 (m, 2 H, NCH_2), 3.11–3.18 (sept, *J* = 6.8 Hz, 1 H, SCH), 3.44–3.49 (ddd, *J* = 2.6, 5.6, 12.9 Hz, 1 H, $COCH_2$), 3.76–3.84 (m, 1 H, $COCH_2$), 7.24–7.27 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.34–7.45 (m, 3 H, 2 × *m*-$CH_{Ar}N$, *p*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.3, 17.0, 34.0, 37.2, 52.4, 128.3, 128.5, 128.7, 132.6, 170.1.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{12}H_{16}N_2O_2S$: 253.1005; found: 253.0958.

1-Benzyl-1-oxo-2-phenyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5k)
From **4k** (400 mg, 1.28 mmol); yield: 270 mg (70%); white solid; mp 184–186 °C.

IR (KBr): 2868, 1707, 1490, 1305, 1240, 1022, 962, 866, 696, 601, 534 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 2.34–2.38 (ddd, *J* = 5.4, 10.0, 17.0 Hz, 1 H, NCH_2), 2.58–2.64 (m, 1 H, NCH_2), 3.37–3.47 (ddd, *J* = 5.1, 9.7, 13.0 Hz, 1 H, $COCH_2$), 3.70–3.76 (ddd, *J* = 3.8, 9.7, 13.2 Hz, 1 H, $COCH_2$), 4.36 (s, 2 H, SCH_2), 7.36–7.45 (m, 7 H, 2 × *o*-$CH_{Ar}N$, 2 × *o*-$CH_{Ar}CH_2$, 2 × *m*-$CH_{Ar}CH_2$, *p*-$CH_{Ar}CH_2$), 7.45–7.56 (m, 3 H, 2 × *m*-$CH_{Ar}N$, *p*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 34.6, 39.4, 58.8, 127.8, 128.8, 129.3, 129.5, 129.6, 130.2, 131.1, 131.5, 133.3, 170.7.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{16}H_{16}N_2O_2S$: 301.1005; found: 301.0990.

2-Isopropyl-1-oxo-1-phenyl-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5m)
From **4m** (820 mg, 3.03 mmol); yield: 420 mg (55%); white solid; mp 81–83 °C.

IR (KBr): 2992, 1681, 1472, 1295, 1218, 1136, 1021, 990, 825, 754, 670, 582 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 0.98 (d, *J* = 6.8 Hz, 3 H, CH_3), 1.42 (d, *J* = 6.8 Hz, 3 H, CH_3), 2.62–2.67 (m, 1 H, NCH_2), 2.78–2.87 (m, 1 H, NCH_2), 3.50–3.56 (ddd, *J* = 2.3, 6.1, 12.9 Hz, 1 H, $COCH_2$), 3.78–3.85 (dt, *J* = 3.1, 12.6 Hz, 1 H, $COCH_2$), 3.93–3.96 [sept, *J* = 6.9 Hz, 1 H, $NCH(CH_3)_2$], 7.54–7.58 (m, 2 H, 2 × *m*-$CH_{Ar}S$), 7.64–7.70 (m, 1 H, *p*-$CH_{Ar}S$), 8.00–8.04 (m, 2 H, 2 × *o*-$CH_{Ar}S$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 19.3, 20.1, 36.2, 38.9, 50.9, 129.2, 129.3, 133.9, 137.7, 170.3.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{12}H_{16}N_2O_2S$: 253.1005; found: 253.1008.

1-Ethyl-5-methyl-1-oxo-2-(*p*-tolyl)-1λ⁶-thia-2,6-diazacyclohex-6-en-3-one (5n + 5o)
From **4n** (850 mg, 3.00 mmol).

Column fraction 1: Yield: 240 mg (30%); white solid; mp 82–84 °C.

IR (KBr): 2970, 2927, 1697, 1508, 1307, 1114, 1018, 825, 744, 532 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.30 (d, *J* = 6.4 Hz, 3 H, CH_3), 1.33 (t, *J* = 7.6 Hz, 3 H, CH_3), 2.30 (s, 3 H, ArCH_3), 2.33–2.40 (dd, 1 H, *J* = 12.0, 16.8 Hz, $COCH_2$), 2.63–2.68 (dd, *J* = 2.6, 16.9 Hz, 1 H, $COCH_2$), 2.93–3.18 (m, 2 H, SCH_2), 3.97–4.08 (m, 1 H, NCH), 7.08–7.14 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.17–7.23 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 9.3, 21.2, 23.6, 42.7, 45.1, 46.9, 129.4, 130.3, 130.9, 139.6, 170.7.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{18}N_2O_2S$: 267.1162; found: 267.0915.

Column fraction 2: Yield: 240 mg (30%); white solid; mp 114–116 °C.

IR (KBr): 2954, 2905, 1701, 1512, 1307, 1269, 1118, 1010, 837, 694, 570, 543 cm^{-1}.

^1H NMR (400 MHz, $CDCl_3$): δ = 1.29 (t, *J* = 7.3 Hz, 3 H, CH_3), 1.39 (d, *J* = 6.5 Hz, 3 H, CH_3), 2.3 (s, 3 H, ArCH_3), 2.51–2.57 (dd, *J* = 7.2, 16.8 Hz, 1 H, $COCH_2$), 2.74–2.80 (dd, *J* = 4.3, 16.8 Hz, 1 H, $COCH_2$), 3.02–3.08 (dq, *J* = 2.3, 7.3 Hz, 2 H, SCH_2), 3.75–3.79 (m, 1 H, NCH), 7.11–7.13 (m, 2 H, 2 × *o*-$CH_{Ar}N$), 7.19–7.21 (m, 2 H, 2 × *m*-$CH_{Ar}N$).

^{13}C NMR (100 MHz, $CDCl_3$): δ = 8.1, 21.2, 23.7, 41.4, 46.5, 48.3, 129.6, 130.4, 139.8, 170.1.

HRMS (EI): *m*/*z* $[M + H]^+$ calcd for $C_{13}H_{18}N_2O_2S$: 267.1162; found: 267.0834.

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(15) Other chlorinating agents like *N*-chlorobenzotriazole also gave similar results, but the separation of product **3** from benzotriazole was tedious.
(16) (a) Treatment of sulfonimidamide **3h** or **3m** with NaOEt in EtOH under reflux conditions led only to hydrolysis of ester functionality to give **4h** or **4m** (see ref. 11). (b) Using *t*-BuOK in refluxing toluene resulted in only **3** being recovered. (c) Under acidic conditions using PTSA in refluxing toluene, **3** was again recovered, with minor cleavage of the R^1NH-moiety being also observed.
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(18) The assignments of the aromatic H's in substituents R^1 for compounds **5** has been made in analogy to the HMBC experiment of **5j** (see Supporting Information).

