EurJOC European Journal of Organic Chemistry

FULL PAPER

DOI: 10.1002/ejoc.201301547

Organocatalytic Synthesis of (Arylselanyl)phenyl-1*H*-1,2,3-triazole-4-carboxamides by Cycloaddition between Azidophenyl Arylselenides and β-Oxo-amides

Natália Seus,[a] Bruna Goldani,[a] Eder J. Lenardão,[a] Lucielli Savegnago,[b] Márcio W. Paixão,[c] and Diego Alves*[a]

Keywords: Organoselenium compounds / Selenium / Organocatalysis / Cycloaddition / 1,2,3-Triazoles / β-Oxoamides

We describe the use of β-oxo-amides in organocatalytic cycloaddition with aryl azidophenyl selenides. The cycloaddition reactions were performed under mild conditions, with β-oxo-amides and aryl azidophenyl selenides in the presence of a catalytic amount of Et_2NH (5 mol-%), and the corresponding products were obtained in good to excellent yields. This organocatalytic methodology tolerated a range of substituents either in the β-oxo-amides or in the aryl azidophenyl selenides and proved to be an efficient methodology for the combinatorial synthesis of new selenium-containing triazole compounds.

Introduction

Heterocycles represent the most general structural units in several natural and synthetic bioactive compounds.[1] In particular, 1,2,3-triazoles[2] are an interesting class of nitrogen-based heterocycles widely used in the discovery and modulation of drug candidates,[3] the development of new materials,[4] supramolecular chemistry,[5] the design of new supported catalysts,[6] and the biotechnology area.[7] Several methodologies for the synthesis of the 1,2,3-triazole scaffold based on 1,3-dipolar cycloaddition between azides and alkynes have therefore already been reported.[8,9] However, the necessity of transition metals has restricted the application of these methodologies in chemical biology,[10] because some transition metals can induce damage in different biological systems such as bacterial or mammalian cells or oligonucleotides.[11]

To overcome this limitation, an organocatalytic approach has been utilized to promote the synthesis of functionalized 1,2,3-triazoles through enamide–azide cycloaddition between a range of carbonyl compounds and organic azides.[12] Ramachary and co-workers, for example, described a practical and environmentally friendly amino-acid-catalyzed cascade process for the synthesis of highly substituted 1,2,3-triazoles through cascade [3+2] cycloaddition/hydrolysis with Hagemann esters and *p*-toluenesulfonyl azide (TsN_3) in the presence of proline as a catalyst.[12a] More recently, our research group described the application of the organocatalytic enamide–azide cycloaddition for the synthesis of 1,2,3-triazoles bearing organoselenium moieties.[13] In this sense, organoselenides are valuable compounds in organic synthesis, because these scaffolds are important units in biological sciences[14] and also serve as versatile building blocks.[15] Among them, those containing nitrogen atoms in their structures are a special class of molecules and have been used for several purposes.[16] In addition, selenium-containing 1,2,3-triazole compounds are an interesting and as yet unexplored class of molecules that might have broader biological applications, because they combine the well-known activity of the 1,2,3-triazole core[1,17] with that of the selenium-containing group.[14–16] The development of new and efficient protocols for the synthesis of highly functionalized nitrogen-containing organoselenium compounds therefore remains an important challenge in synthetic organic chemistry.

In the context of functionalized nitrogen compounds, β-oxo-amides and their derivatives showed attractive structural features as versatile organic intermediates. Several molecules containing these units display biological activities,[18] and they are found in natural products (e.g., pestalamides A, B and C, aspernigrin A and carboranone A, Figure 1).[19] Consequently, several robust approaches using β-oxo-amides have been reported for the production of a plethora of heterocycles such as 2- and 4-pyridones,[20] dihydropyranones,[21] dihydropyrimidones,[22] 3-acyloxindoles,[23] isoxazoles,[24] and nicotinamides,[25] among others.[26] More recently, iron-catalyzed Wolff cycloconden-

[a] Laboratório de Síntese Orgânica Limpa – LASOL – CCQFA – Universidade Federal de Pelotas – UFPel, Pelotas, RS, Brazil
E-mail: diego.alves@ufpel.edu.br
http://wp.ufpel.edu.br/lasol
[b] Grupo de Pesquisa em Neurobiotecnologia – GPN, CDTec, Universidade Federal de Pelotas, UFPel, Pelotas, RS, Brazil
[c] Laboratório de Síntese de Produtos Naturais, Universidade Federal de São Carlos, São Carlos, 13565-905 SP, Brazil

Supporting information for this article is available on the WWW under http://dx.doi.org/10.1002/ejoc.201301547.

sation between α-diazo-β-oxo-amides and aromatic or aliphatic amines, described by Dong and co-workers, has come to represent a powerful approach to the synthesis of a range of 1,2,3-triazole-4-carboxamides.[27] Furthermore, 1,2,3-triazole-4-carboxamide derivatives potently inhibited the replication of various H3N2 and H1N1 influenza A virus strains.[28]

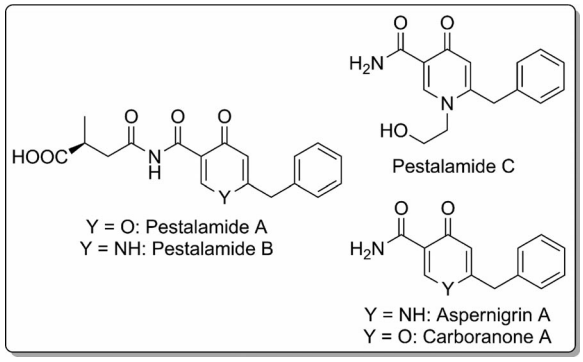
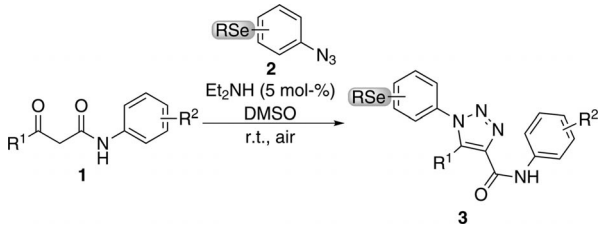


Figure 1. Natural products containing β-oxo-amide units.

To the best of our knowledge, however, the direct use of β-oxo-amides to synthesize highly functionalized 1,2,3-triazoles through organocatalytic enamide–azide cycloaddition with organic azides has not been explored. In this context and in continuation of our interest in the synthesis of 1,2,3-triazoles bearing organoselenium moieties, here we describe the application of β-oxo-amides in organocatalytic enamide–azide cycloaddition for the synthesis of a range of (arylselanyl)phenyl-1*H*-1,2,3-triazole-4-carboxamides (Scheme 1).

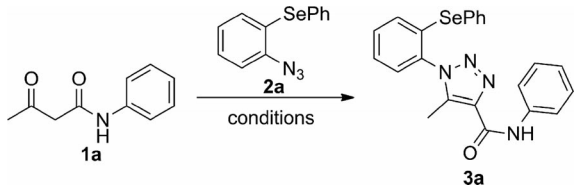


Scheme 1. Synthesis of (arylselanyl)phenyl-1*H*-1,2,3-triazole-4-carboxamides **3**.

Results and Discussion

To identify appropriate reaction conditions for this organocatalytic enamide–azide cycloaddition, a set of experiments was performed with the β-oxo-amide **1a** and aryl azidophenyl selenide **2a** as standard substrates (Table 1). We started the reaction screening with 3-oxo-*N*-phenylbutanamide (**1a**, 0.3 mmol) and 2-azidophenyl phenyl selenide (**2a**, 0.3 mmol) in DMSO (0.6 mL) together with 10 mol-% of pyrrolidine at 70 °C (Table 1, Entry 1). Under these reaction conditions the desired product **3a** was obtained in excellent yield after only 4 h (Table 1, Entry 1, 90%). On changing the organocatalyst to L-proline (10 mol-%) no product **3a** was obtained (Table 1, Entry 2). To our delight, however, a small improvement in the chemical yield of compound **3a** was achieved on replacement of the organocatalyst with Et_2NH (10 mol-%, Table 1, Entry 3).

Table 1. Optimization of organocatalytic cycloaddition of β-oxo-amide **1a** and aryl azidophenyl selenide **2a**.[a]



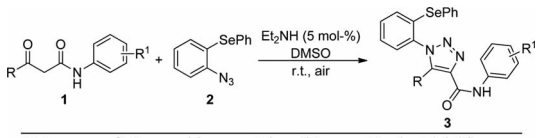
Entry	Organocatalyst ([mol-%])	DMSO [mL]/ temperature [°C]	Time [h]	Yield **3a** [%][b]
1	pyrrolidine (10)	0.6/70	4	90
2	L-proline (10)	0.6/70	48	n.d.
3	Et_2NH (10)	0.6/70	2	93
4	Et_2NH (10)	0.6/room temp.	2	84
5	Et_2NH (10)	0.3/room temp.	2	85
6	pyrrolidine (10)	0.3/room temp.	4	69
7	Et_2NH (10)	0.3/70	2	87
8	Et_2NH (5)	0.3/70	2	78
9	Et_2NH (1)	0.3/70	2	65
10	Et_2NH (5)	0.3/room temp.	2	83[c]
11	Et_2NH (1)	0.3/room temp.	12	72
12	–	0.3/room temp.	48	n.d.
13	–	0.3/70	48	n.d.

[a] Reactions were performed with 3-oxo-*N*-phenylbutanamide (**1a**, 0.3 mmol) and aryl azidophenyl selenide **2a** (0.3 mmol) in DMSO as solvent under air and were monitored by TLC until total disappearance of the starting materials. [b] Yields are given for isolated products. [c] When the reaction was performed under N_2 the same yield was obtained.

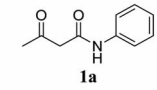
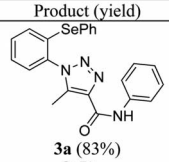
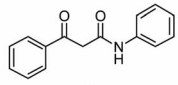
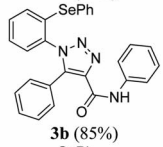
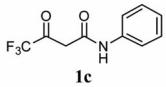
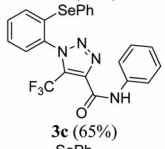
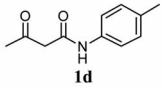
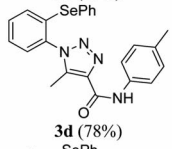
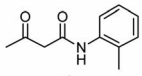
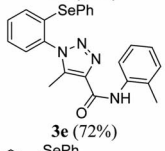
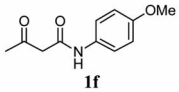
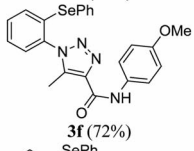
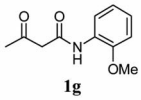
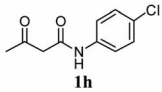
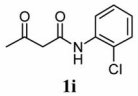
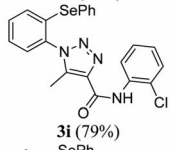
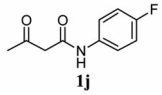
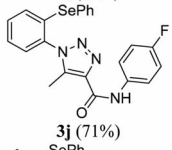
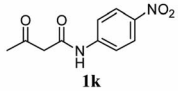
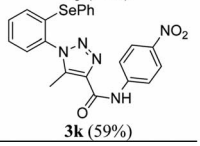
Inspired by this result, we performed additional experiments with Et_2NH as organocatalyst. Reactions performed in the presence of 10 mol-% of catalyst at room temperature gave good yields of the desired product **3a** at both 0.5 and 1.0 M concentrations (Table 1, Entries 4 and 5). When the reaction was performed with Et_2NH (10 mol-%) and 0.3 mL of DMSO at 70 °C a good yield of product **3a** was also obtained (Table 1, Entry 7). On decreasing the organocatalyst loading from 10 to 1 mol-% in reactions in the presence of 0.3 or 0.6 mL of DMSO and at 70 °C or room temperature, slight decreases in the reaction yields were observed (Table 1, Entries 8–11). In the absence of an organocatalyst no reaction had taken place even after 48 h (Table 1, Entries 12 and 13).

Analyzing the results shown in Table 1, we judged that the best reaction conditions to afford selenium-containing triazole-carboxamide **3a** are those in Entry 10, with 3-oxo-*N*-phenylbutanamide (**1a**, 0.3 mmol), aryl azidophenyl sele-

Table 2. Scope and generality of the cycloaddition reaction.



1 2 3

Entry	β-Oxo-amide	Time [h]	Product (yield)
1	 **1a**	2	 **3a** (83%)
2	 **1b**	2	 **3b** (85%)
3	 **1c**	5[b]	 **3c** (65%)
4	 **1d**	2	 **3d** (78%)
5	 **1e**	4	 **3e** (72%)
6	 **1f**	2	 **3f** (72%)
7	 **1g**	2	 **3g** (83%)
8	 **1h**	2	 **3h** (87%)
9	 **1i**	2	 **3i** (79%)
10	 **1j**	4	 **3j** (71%)
11	 **1k**	4	 **3k** (59%)

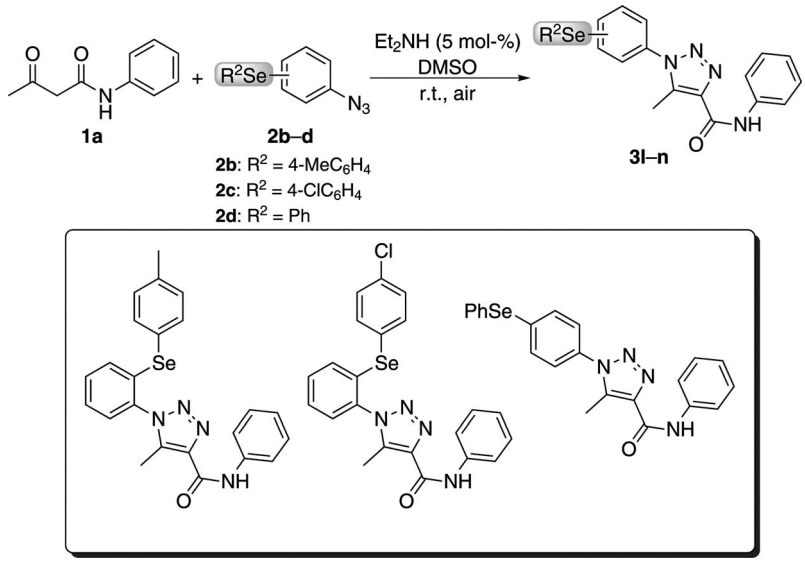
[a] Yields are given for isolated products. [b] Reaction was performed at 70 °C.

nide **2a** (0.3 mmol), Et_2NH (5 mol-%) as organocatalyst, and DMSO (0.3 mL) as solvent at room temperature under air (Table 1, Entry 10). After that, we focused our attention on extending the scope of this methodology by using 2-azidophenyl phenyl selenide (**2a**) as selenium partner with a number of β-oxo-amides under the optimized reaction conditions.

The results shown in Table 2 reveal that our protocol worked well for a range of substituted β-oxo-amides, affording suitable yields of the desired products. In a general way, the reactions are sensitive to the electronic conditions at the oxo group in the β-oxo-amides. β-Oxo-amide **1c**, containing an electron-withdrawing group ($–CF_3$) adjacent to the oxo group, for example, gave a lower yield than β-oxo-amides **2a** and **2b** (Table 2, Entries 1 and 2 vs. 3). Furthermore, β-oxo-amides containing either an electron-donating group (EDG) or an electron-withdrawing group (EWG) on the amide aromatic ring delivered the desired selenium-containing triazole-carboxamides **3d**–**j** in good isolated yields (Table 2, Entries 4–10). However, when the reaction was performed with β-oxo-amide **1k**, containing a strongly electron-withdrawing group (NO_2), the corresponding product **3k** was obtained in only 59% isolated yield (Table 2, Entry 11).

We next evaluated the reactivity of 3-oxo-*N*-phenylbutanamide (**1a**) with the different functionalized aryl azidophenyl selenides **2b**–**d** (Scheme 2) under the same reaction conditions. Substituted aryl 2-azidophenyl selenides **2b** and **2c** efficiently cyclized with 3-oxo-*N*-phenylbutanamide (**1a**), and the reactions are sensitive to electronic effects in the aromatic ring in the arylselanyl moiety. Aryl azidophenyl selenide **2b**, containing an EDG (4-Me) in the aromatic ring, gave a lower yield than the aryl azidophenyl selenide **2c**, containing an EWG (4-Cl). In addition, 4-azidophenyl phenyl selenide (**2d**) was treated with β-oxo-amide **1a** to afford the desired product in 93% yield as a mixture of regioisomers (6:1).

It is possible to propose a possible mechanism for the synthesis of selenium-containing triazole-carboxamides **3** based on recently published reports on organocatalytic enamide–azide cycloadditions[12] involving organic azides (Figure 2). We believe that the enamine intermediate **A** should be formed first, after condensation of Et_2NH with the β-oxo-amide **1**. After that, 1,3-dipolar cycloaddition between enamine **A** and the aryl azidophenyl selenide **2** would give the triazoline intermediate **B**, which after a possible 1,3-hydride shift could afford the triazoline intermediate **C**. Finally, the zwitterionic form of **C**, represented as intermediate **D**, could undergo an elimination reaction to regenerate Et_2NH in the next catalytic cycle and produce the desired product **3** (Figure 2). The excellent reactivity and high regioselectivity observed with the aryl azidophenyl selenide **2** is probably explained on the basis of the major contributing mesomeric structure represented in **2**, according to the electronic effects of the arylselanyl moiety.[12f,29] The reaction between mesomeric structure **2** and enamine intermediate **A** would selectively furnish the adduct **B** through a concerted 1,3-dipolar cycloaddition.



Scheme 2. Cycloaddition reaction of **1a** with different aryl azidophenyl selenides.

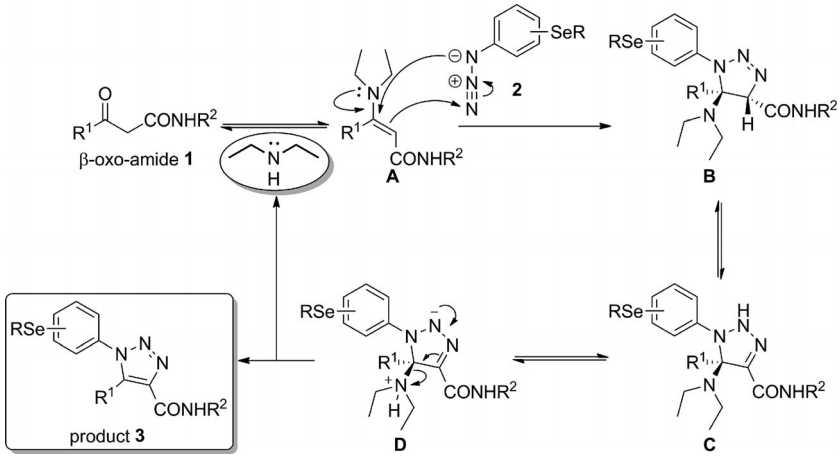


Figure 2. Proposed mechanism.

Conclusions

We describe the use of β-oxo-amides in organocatalytic cycloadditions with aryl azidophenyl selenides. Under optimized mild reaction conditions, a range of (arylselanyl)-phenyl-1*H*-1,2,3-triazole-4-carboxamides were synthesized in high yields with use of catalytic amounts of Et_2NH in DMSO as solvent. This organocatalytic methodology tolerated a range of substituents in the β-oxo-amides or aryl azidophenyl selenides and proved to be an efficient methodology for combinatorial synthesis of new selenium-containing triazole compounds.

Experimental Section

General Remarks: Proton nuclear magnetic resonance (^{1}H NMR) spectra were obtained at 400 MHz with a Bruker ARX 400 NMR spectrometer. Spectra were recorded in $CDCl_3$. Chemical shifts are reported in ppm, referenced to tetramethylsilane (TMS) as the external reference. Data are reported as follows: chemical shift (δ), multiplicity, coupling constant (J) in Hertz, and integrated intensity. Carbon-13 nuclear magnetic resonance (^{13}C NMR) spectra were obtained at 100 MHz with a Bruker ARX 400 NMR spectrometer. Spectra were recorded in $CDCl_3$. Chemical shifts are reported in ppm, referenced to the solvent peak of $CDCl_3$. Mass spectra (MS) were measured with a Shimadzu GC–MS-QP2010 mass spectrometer. High-resolution mass spectra (HRMS) were recorded with a Bruker Micro TOF-QII spectrometer 10416. Column chromatography was performed with Merck silica gel (230–400 mesh). Thin layer chromatography (TLC) was performed with Merck GF_{254} silica gel (0.25 mm thickness). For visualization, TLC plates were either placed under ultraviolet light or stained with iodine vapor or acidic vanillin.

General Procedure for the Synthesis of (Arylselanyl)phenyl-1*H*-1,2,3-triazole-4-carboxamides 3a–n: The appropriate β-oxo-amide (out of **1a**–**k**, 0.3 mmol) was first added to a solution of the appropriate arylselanyl azide (out of **2a**–**d**, 0.3 mmol) in DMSO (0.3 mL), followed by diethylamine (0.015 mmol) as catalyst. The reaction mixture was stirred in an open vial for the time indicated in Table 2 and Scheme 2. After completion of the reaction, the crude product

was purified by column chromatography on silica gel with a mixture of hexane/ethyl acetate (5:1) as eluent to afford the desired product (**3a**–**n**). Spectral data for the products prepared are listed below.

5-Methyl-*N*-phenyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3a): Yield: 0.108 g (83%); orange oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.12 (s, 1 H), 7.72 (d, J = 8.1 Hz, 2 H), 7.47 (d, J = 8.2 Hz, 2 H), 7.41–7.25 (m, 9 H), 7.13 (t, J = 7.4 Hz, 1 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.07, 138.43, 138.01, 137.66, 135.09, 134.92, 133.10, 132.85, 131.20, 129.58, 128.94, 128.72, 127.78, 127.71, 127.69, 124.17, 119.73, 9.26 ppm. MS: *m*/*z* (%) = 435 (12), 434 (47), 431 (23), 328 (14), 314 (37), 312 (20), 249 (100), 234 (26), 232 (28), 207 (37), 206 (33), 157 (25), 152 (50), 129 (19), 77 (64), 51 (20). HRMS: calcd. for $C_{22}H_{19}N_4OSe$ [M + H]$^+$ 435.0724; found 435.0744.

***N*,5-Diphenyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3b):** Yield: 0.127 g (85%); yellow solid; m.p. 133–134 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.26 (s, 1 H), 7.70 (d, J = 8.1 Hz, 2 H), 7.40 (d, J = 8.1 Hz, 2 H), 7.35–7.23 (m, 14 H), 7.10 (t, J = 7.4 Hz, 1 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 158.05, 140.65, 138.16, 137.66, 135.59, 134.76, 133.26, 132.76, 130.84, 130.49, 129.75, 129.53, 128.90, 128.58, 128.50, 128.16, 127.98, 127.46, 125.04, 124.18, 119.84 ppm. MS: *m*/*z* (%) = 498 (8), 496 (37), 391 (27), 376 (39), 374 (20), 348 (54), 311 (100), 267 (48), 219 (18), 190 (27), 165 (44), 152 (39), 77 (40), 51 (13). HRMS: calcd. for $C_{27}H_{21}N_4OSe$ [M + H]$^+$ 497.0881; found 497.0993.

***N*-Phenyl-1-[2-(phenylselanyl)phenyl]-5-(trifluoromethyl)-1*H*-1,2,3-triazole-4-carboxamide (3c):** Yield: 0.095 g (65%); yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.13 (s, 1 H), 7.74 (d, J = 8.3 Hz, 2 H), 7.46–7.26 (m, 11 H), 7.17 (t, J = 7.4 Hz, 1 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 155.44, 141.37, 137.11, 135.95, 134.66, 133.99, 132.26, 131.86, 129.62, 129.06, 128.68, 128.12, 127.94, 127.29, 124.86, 119.94, 118.33 (q, J = 271.4 Hz) ppm. MS: *m*/*z* (%) = 488 (6), 368 (39), 366 (21), 314 (14), 303 (100), 261 (30), 234 (14), 157 (17), 152 (20), 77 (55), 365 (15), 51 (14). HRMS: calcd. for $C_{22}H_{16}F_3N_4OSe$ [M + H]$^+$ 489.0441; found 489.0495.

5-Methyl-1-[2-(phenylselanyl)phenyl]-*N*-*p*-tolyl-1*H*-1,2,3-triazole-4-carboxamide (3d): Yield: 0.105 g (78%); yellow solid; m.p. 48–49 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.05 (s, 1 H), 7.60 (d, J = 8.2 Hz, 2 H), 7.46 (d, J = 7.0 Hz, 2 H), 7.37–7.28 (m, 7 H), 7.17 (d, J = 8.2 Hz, 2 H), 2.51 (s, 3 H), 2.33 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 158.97, 138.31, 138.10, 135.18, 135.12, 135.06, 134.96, 133.77, 133.09, 132.89, 131.19, 129.59, 129.45, 128.73, 127.77, 127.73, 119.76, 20.79, 9.26 ppm. MS: *m*/*z* (%) = 448 (1), 446 (1), 77 (3), 44 (23), 42 (13), 40 (100). HRMS: calcd. for $C_{23}H_{21}N_4OSe$ [M + H]$^+$ 449.0881; found 449.0905.

5-Methyl-1-[2-(phenylselanyl)phenyl]-*N*-*o*-tolyl-1*H*-1,2,3-triazole-4-carboxamide (3e): Yield: 0.097 g (72%); yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.04 (s, 1 H), 8.14 (d, J = 7.9 Hz, 1 H), 7.49–7.47 (m, 2 H), 7.38–7.22 (m, 9 H), 7.09 (d, J = 7.4 Hz, 1 H), 2.52 (s, 3 H), 2.43 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.08, 138.33, 138.23, 135.60, 135.17, 134.97, 133.07, 132.94, 131.20, 130.42, 129.61, 128.76, 128.41, 127.77, 127.74, 126.67, 124.68, 121.96, 53.35, 17.67, 9.27 ppm. MS: *m*/*z* (%) = 450 (9), 448 (39), 446 (22), 420 (92), 418 (52), 314 (38), 274 (21), 271 (26), 263 (100), 248 (50), 235 (19), 232 (45), 207 (59), 198 (44), 196 (24), 169 (38), 157 (48), 152 (79), 129 (35), 91 (57), 77 (85), 51 (25). HRMS: calcd. for $C_{22}H_{19}N_4OSe$ [M + H]$^+$ 449.0881; found 449.0902.

***N*-(4-Methoxyphenyl)-5-methyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3f):** Yield: 0.100 g (72%); yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.03 (s, 1 H), 7.64 (d, J = 8.9 Hz, 2 H), 7.50–7.31 (m, 9 H), 6.93 (d, J = 8.9 Hz, 2 H), 3.82 (s, 3 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 158.93, 156.38, 138.25, 138.11, 135.16, 134.97, 133.08, 132.93, 131.21, 130.82, 129.61, 128.76, 127.77, 127.74, 121.48, 114.19, 55.41, 9.26 ppm. MS: *m*/*z* (%) = 466 (22), 464 (100), 462 (54), 314 (20), 251 (25), 207 (25), 198 (84), 196 (43), 157 (29), 152 (37), 146 (68), 122 (35), 77 (35), 51 (11). HRMS: calcd. for $C_{23}H_{21}N_4O_2Se$ [M + H]$^+$ 465.0830; found 465.0850.

***N*-(2-Methoxyphenyl)-5-methyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3g):** Yield: 0.116 g (83%); white solid; m.p. 111–112 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.71 (s, 1 H), 8.53 (d, J = 7.9 Hz, 1 H), 7.47 (d, J = 8.1 Hz, 2 H), 7.39–7.25 (m, 7 H), 7.08–6.92 (m, 3 H), 3.94 (s, 3 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.03, 148.38, 138.42, 138.22, 135.14, 134.99, 133.04, 132.93, 131.13, 129.58, 128.71, 127.75, 127.74, 127.72, 127.51, 123.74, 120.82, 119.62, 110.05, 55.69, 9.27 ppm. MS: *m*/*z* (%) = 466 (2), 464 (8), 434 (25), 433 (100), 431 (52), 342 (2), 316 (3), 314 (14), 286 (6), 279 (9), 271 (7), 264 (8), 248 (5), 235 (7), 232 (13), 207 (15), 198 (10), 169 (5), 157 (15), 152 (18), 77 (20), 55 (10). HRMS: calcd. for $C_{23}H_{21}N_4O_2Se$ [M + H]$^+$ 465.0830; found 465.0855.

***N*-(4-Chlorophenyl)-5-methyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3h):** Yield: 0.122 g (87%); yellow solid; m.p. 121–122 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.10 (s, 1 H), 7.68 (d, J = 8.8 Hz, 2 H), 7.47 (d, J = 8.2 Hz, 2 H), 7.39–7.29 (m, 9 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.12, 138.66, 137.88, 136.34, 135.19, 134.94, 133.21, 132.97, 131.34, 129.68, 129.22, 129.06, 128.84, 127.87, 127.77, 127.73, 120.98, 9.33 ppm. MS: *m*/*z* (%) = 470 (32), 469 (19), 468 (68), 466 (35), 314 (77), 312 (19), 286 (31), 285 (40), 283 (100), 274 (25), 271 (30), 268 (22), 248 (20), 232 (44), 219 (29), 206 (68), 198 (42), 169 (20), 152 (91), 129 (43), 102 (29), 91 (21), 77 (84), 67 (23), 55 (27), 44 (30). HRMS: calcd. for $C_{22}H_{18}ClN_4OSe$ [M + H]$^+$ 469.0334; found 469.0371.

***N*-(2-Chlorophenyl)-5-methyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3i):** Yield: 0.111 g (79%); yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.69 (s, 1 H), 8.55 (d, J = 9.2 Hz, 1 H), 7.48–7.27 (m, 11 H), 7.07 (t, J = 8.7 Hz, 1 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.09, 138.59, 137.91, 135.07, 134.89, 134.56, 133.11, 132.82, 131.21, 129.57, 129.10, 128.72, 127.79, 127.71, 127.69, 127.47, 124.47, 123.22, 121.21, 9.25 ppm. MS: *m*/*z* (%) = 470 (19), 468 (37), 433 (100), 363 (23), 314 (43), 312 (23), 283 (55), 248 (28), 207 (57), 206 (45), 157 (37), 152 (67), 129 (29), 77 (52), 51 (19). HRMS: calcd. for $C_{22}H_{18}ClN_4OSe$ [M + H]$^+$ 469.0334; found 469.0347.

***N*-(4-Fluorophenyl)-5-methyl-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3j):** Yield: 0.096 g (71%); yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.10 (s, 1 H), 7.68 (dd, J = 9.0, 4.8 Hz, 2 H), 7.49–7.46 (m, 2 H), 7.40–7.28 (m, 7 H), 7.06 (t, J = 8.8 Hz, 2 H), 2.52 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.32 (d, J = 242.0 Hz), 159.07, 138.51, 137.89, 135.15, 134.92, 133.71 (d, J = 2.8 Hz), 133.14, 132.92, 131.27, 129.63, 128.79, 127.77 (d, J = 8.0 Hz), 127.71, 121.56, 121.48, 115.61 (d, J = 22.5 Hz), 9.27 ppm. MS: *m*/*z* (%) = 454 (19), 452 (89), 450 (48), 347 (32), 314 (71), 312 (37), 274 (25), 271 (28), 267 (100), 239 (28), 232 (44), 230 (22), 207 (56), 198 (40), 196 (20), 157 (47), 152 (76), 129 (32), 95 (21), 77 (60), 51 (24). HRMS: calcd. for $C_{22}H_{18}FN_4OSe$ [M + H]$^+$ 453.0630; found 453.0647.

5-Methyl-*N*-(4-nitrophenyl)-1-[2-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3k): Yield: 0.085 g (59%); white solid; m.p. 176–177 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.46 (s, 1 H), 8.25 (d, J = 9.1 Hz, 2 H), 7.91 (d, J = 9.1 Hz, 2 H), 7.48–7.30 (m, 9 H),

2.53 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.29, 143.58, 143.50, 139.27, 137.43, 135.10, 134.74, 133.25, 132.83, 131.46, 129.68, 128.85, 127.93, 127.71, 127.61, 125.08, 119.08, 9.33 ppm. MS: *m/z* (%) = 481 (23), 480 (26), 479 (100), 477 (55), 374 (53), 372 (27), 359 (25), 357 (14), 314 (37), 312 (21), 294 (92), 286 (29), 270 (31), 231 (44), 220 (20), 207 (68), 206 (60), 198 (23), 179 (10), 157 (47), 117 (14), 105 (18), 103 (20), 102 (19), 77 (56), 76 (17), 67 (14), 55 (13). HRMS: calcd. for $C_{22}H_{18}N_5O_3Se$ [M + H]$^+$ 480.0575; found 480.0570.

5-Methyl-*N*-phenyl-1-[2-(*p*-tolylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3l): Yield: 0.090 g (67%); white solid; m.p. 113–114 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.12 (s, 1 H), 7.72 (d, *J* = 7.7 Hz, 2 H), 7.39–7.25 (m, 8 H), 7.13 (t, *J* = 9.5 Hz, 3 H), 2.53 (s, 3 H), 2.33 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.06, 139.13, 138.40, 138.01, 137.66, 135.60, 134.47, 133.55, 132.36, 131.10, 130.44, 128.92, 127.60, 127.36, 124.13, 123.60, 119.70, 21.10, 9.26 ppm. MS: *m/z* (%) = 450 (12), 448 (54), 328 (37), 285 (20), 249 (100), 234 (22), 221 (48), 204 (16), 152 (27), 129 (16), 91 (35), 77 (37), 65 (22). HRMS: calcd. for $C_{23}H_{21}N_4OSe$ [M + H]$^+$ 449.0881; found 449.0897.

1-[2-(4-Chlorophenylselanyl)phenyl]-5-methyl-*N*-phenyl-1*H*-1,2,3-triazole-4-carboxamide (3m): Yield: 0.114 g (81%); white solid; m.p. 72–73 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.11 (s, 1 H), 7.72 (d, *J* = 8.1 Hz, 2 H), 7.43–7.31 (m, 8 H), 7.25 (d, *J* = 8.4 Hz, 2 H), 7.14 (t, *J* = 7.4 Hz, 1 H), 2.53 (s, 3 H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 158.98, 138.36, 138.07, 137.60, 136.22, 135.15, 135.06, 133.22, 132.22, 131.33, 129.78, 128.93, 128.12, 127.78, 126.02, 124.19, 119.72, 9.29 ppm. MS: *m/z* (%) = 470 (21), 468 (44), 348 (18), 249 (75), 241 (23), 232 (18), 157 (19), 152 (32), 97 (35), 85 (50), 77 (34), 71 (67), 57 (100), 43 (60). HRMS: calcd. for $C_{22}H_{18}ClN_4OSe$ [M + H]$^+$ 469.0334; found 469.0338.

5-Methyl-*N*-phenyl-1-[4-(phenylselanyl)phenyl]-1*H*-1,2,3-triazole-4-carboxamide (3n): The mixture of regioisomers was obtained in a 6:1 ratio, as determined by ^{1}H NMR analysis. Yield: 0.121 g (93%); pale yellow solid; m.p. 147–148 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 9.06 (s, 1, H), 7.70 (d, *J* = 7.6 Hz, 2, H), 7.62–7.59 (m, 2, H), 7.53 (d, *J* = 8.5 Hz, 2, H), 7.39–7.31 (m, 7, H), 7.14 (t, *J* = 7.4 Hz, 1, H), 2.66 (s, 3, H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 159.04, 138.86, 137.55, 135.56, 134.69, 133.79, 132.05, 129.72, 129.02, 128.77, 128.52, 126.69, 125.70, 124.28, 119.72, 9.80 ppm. MS: *m/z* (%) = 434 (37), 432 (19), 314 (35), 287 (14), 286 (26), 284 (17), 249 (20), 234 (18), 133 (27), 232 (41), 220 (20), 221 (15), 207 (100), 206 (31), 169 (25), 157 (29), 153 (18), 152 (41), 130 (19), 77 (52), 65 (11), 51 (19), 44 (34), 40 (24). HRMS: calcd. for $C_{22}H_{19}N_4OSe$ [M + H]$^+$ 435.0724; found 435.0728.

Supporting Information (see footnote on the first page of this article): Experimental details, product characterization, and copies of ^{1}H and ^{13}C NMR spectra of all synthesized compounds.

Acknowledgments

We are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (Grant 473165/2012-0), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (09/07281-0), and Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS) for financial support. Prof. Sidnei Moura e Silva of the Biotechnology Laboratory of Natural and Synthetic Products, Biotechnology Institute – UCS – Caxias do Sul – RS, is acknowledged for the HRMS analysis.

[1] a) J. A. Joule, K. Mills, *Heterocyclic Chemistry*, 4th ed., Blackwell, Oxford, **2000**; b) T. Eicher, S. Hauptmann, *The Chemistry of Heterocycles*, Wiley-VCH, Weinheim, **2003**; c) A. R. Katrizky, A. F. Pozharskii, *Handbook of Heterocyclic Chemistry*, 2nd ed., Pergamon, Amsterdam, **2000**.

[2] For a recent set of reviews in this area, see the themed issues: a) *Chem. Soc. Rev.* **2010**, *39*, 1221–1407; b) *Acc. Chem. Res.* **2011**, *44*, 651–840.

[3] a) G. C. Tron, T. Pirali, R. A. Billington, P. L. Canonico, G. Sorba, A. A. Genazzani, *Med. Res. Rev.* **2008**, *28*, 278–308; b) C. D. Hein, X.-M. Liu, D. Wang, *Pharm. Res.* **2008**, *25*, 2216–2230; c) J. Xie, C. T. Seto, *Bioorg. Med. Chem.* **2007**, *15*, 458–473; d) T. Lee, M. Cho, S. Y. Ko, H. J. Youn, D. J. Baek, W. J. Cho, C. Y. Kang, S. Kirn, *J. Med. Chem.* **2007**, *50*, 585–589; e) B. Parrish, T. Emrick, *Bioconjugate Chem.* **2007**, *18*, 263–267.

[4] a) H. Nandivada, X. Jiang, J. Lahann, *Adv. Mater.* **2007**, *19*, 2197–2208; b) B. S. Lee, J. K. Lee, W. J. Kim, Y. H. Jung, S. J. Sim, J. Lee, I. S. Choi, *Biomacromolecules* **2007**, *8*, 744–749.

[5] a) A. M. Deobald, L. R. S. Camargo, D. Alves, J. Zukerman-Schpector, A. G. Corrêa, M. W. Paixão, *Synthesis* **2011**, 4003–4010; b) K. Pérez-Labrada, I. Brovard, C. Morera, I. Estevez, J. Bermejo, D. G. Rivera, *Tetrahedron* **2011**, *67*, 7713–7730; c) D. D. Días, K. Rajagopal, E. Strable, J. Schneider, M. G. Finn, *J. Am. Chem. Soc.* **2006**, *128*, 6056–6057; d) D. Astruc, L. Liang, A. Rapakousiou, J. Ruiz, *Acc. Chem. Res.* **2012**, *45*, 630–640; e) M. A. Tasdelen, G. Yilmaz, B. Iskin, Y. Yagci, *Macromolecules* **2012**, *45*, 56–61.

[6] a) D. Font, C. Jimeno, M. A. Pericàs, *Org. Lett.* **2006**, *8*, 4653–4655; b) D. Font, A. Bastero, S. Sayalero, C. Jimeno, M. A. Pericàs, *Org. Lett.* **2007**, *9*, 1943–1946; c) D. Font, S. Sayalero, A. Bastero, C. Jimeno, M. A. Pericàs, *Org. Lett.* **2008**, *10*, 337–340.

[7] a) E. Lallana, R. Riguera, E. Fernandez-Megia, *Angew. Chem.* **2011**, *123*, 8956; *Angew. Chem. Int. Ed.* **2011**, *50*, 8794–8804; b) V. Hong, S. I. Presolski, C. Ma, M. G. Finn, *Angew. Chem.* **2009**, *121*, 10063; *Angew. Chem. Int. Ed.* **2009**, *48*, 9879–9883; c) M. F. Debets, S. S. van Berkel, J. Dommerholt, T. Dirks, F. P. J. T. Rutjes, F. L. van Delft, *Acc. Chem. Res.* **2011**, *44*, 805–815.

[8] For thermal conditions see: a) R. Huisgen, *Angew. Chem.* **1963**, *75*, 604–637.

[9] For representative examples of copper or ruthenium catalysis see: a) V. V. Rostovtsev, L. G. Green, V. V. Fokin, K. B. Sharpless, *Angew. Chem.* **2002**, *114*, 2708; *Angew. Chem. Int. Ed.* **2002**, *41*, 2596–2599; b) C. W. Tornøe, C. Christensen, M. Meldal, *J. Org. Chem.* **2002**, *67*, 3057–3064; c) A. Krasinski, Z. Radic, R. Manetsch, J. Raushel, P. Taylor, K. B. Sharpless, H. C. Kolb, *J. Am. Chem. Soc.* **2005**, *127*, 6686–6692; d) L. V. Lee, M. L. Mitchell, S. Huang, V. V. Fokin, K. B. Sharpless, C. Wong, *J. Am. Chem. Soc.* **2003**, *125*, 9588–9589; e) J. E. Hein, J. P. Tripp, L. B. Krasnova, K. B. Sharpless, V. V. Fokin, *Angew. Chem.* **2009**, *121*, 8162; *Angew. Chem. Int. Ed.* **2009**, *48*, 8018–8021; f) L. Zhang, X. Chen, P. Xue, H. H. Y. Sun, I. D. Williams, K. B. Sharpless, V. V. Fokin, G. Jia, *J. Am. Chem. Soc.* **2005**, *127*, 15998–15999; g) B. C. Boren, S. Narayan, L. K. Rasmussen, L. Zhang, H. Zhao, Z. Lin, G. Jia, V. V. Fokin, *J. Am. Chem. Soc.* **2008**, *130*, 8923–8930.

[10] a) J. A. Johnson, J. M. Baskin, C. R. Bertozzi, J. T. Koberstein, N. J. Turro, *Chem. Commun.* **2008**, 3064–3066; b) J. M. Baskin, C. R. Bertozzi, *QSAR Comb. Sci.* **2007**, *26*, 1211–1219.

[11] J. Gierlich, G. A. Burley, P. M. E. Gramlich, D. M. Hammond, T. Carell, *Org. Lett.* **2006**, *8*, 3639–3642.

[12] a) D. B. Ramachary, K. Ramakumar, V. V. Narayana, *Chem. Eur. J.* **2008**, *14*, 9143–9147; b) L. J. T. Danence, Y. Gao, M. Li, Y. Huang, J. Wang, *Chem. Eur. J.* **2011**, *17*, 3584–3587; c) M. Belkheira, D. E. Abed, J.-M. Pons, C. Bressy, *Chem. Eur. J.* **2011**, *17*, 12917–12921; d) L. Wang, S. Peng, L. J. T. Danence, Y. Gao, J. Wang, *Chem. Eur. J.* **2012**, *18*, 6088–6093; e) D. K. J. Yeung, T. Gao, J. Huang, S. Sun, H. Guo, J. Wang, *Green*

Chem. **2013**, *15*, 2384–2388; f) D. B. Ramachary, A. B. Shashank, *Chem. Eur. J.* **2013**, *19*, 13175–13181; g) W. Li, Q. Jia, Z. Du, J. Wang, *Chem. Commun.* **2013**, *49*, 10187–10189.

[13] N. Seus, L. C. Gonçalves, A. M. Deobald, L. Savegnago, D. Alves, M. W. Paixão, *Tetrahedron* **2012**, *68*, 10456–10463.

[14] a) M. J. Parnham, E. Graf, *Prog. Drug Res.* **1991**, *36*, 9–47; b) G. Mugesh, W. W. du Mont, H. Sies, *Chem. Rev.* **2001**, *101*, 2125–2179; c) C. W. Nogueira, G. Zeni, J. B. T. Rocha, *Chem. Rev.* **2004**, *104*, 6255–6285; d) E. E. Alberto, V. Nascimento, A. L. Braga, *J. Braz. Chem. Soc.* **2010**, *21*, 2032–2041; e) C. W. Nogueira, J. B. T. Rocha, *J. Braz. Chem. Soc.* **2010**, *21*, 2055–2071; f) C. W. Nogueira, J. B. T. Rocha, *Arch. Toxicol.* **2011**, *85*, 1313–1359.

[15] a) G. Perin, E. J. Lenardão, R. G. Jacob, R. B. Panatieri, *Chem. Rev.* **2009**, *109*, 1277–1301; b) D. M. Freudendahl, S. A. Shahzad, T. Wirth, *Eur. J. Org. Chem.* **2009**, 1649–1664; c) D. M. Freudendahl, S. Santoro, S. A. Shahzad, C. Santi, T. Wirth, *Angew. Chem.* **2009**, *121*, 8559; *Angew. Chem. Int. Ed.* **2009**, *48*, 8409–8411; d) A. L. Braga, D. S. Lüdtke, F. Vargas, *Curr. Org. Chem.* **2006**, *10*, 1921–1938; e) M. Godoi, M. W. Paixão, A. L. Braga, *Dalton Trans.* **2011**, *40*, 11347–11355.

[16] Recent books: a) F. A. Devillanova, in *Handbook of Chalcogen Chemistry: New Perspectives in S, Se and Te*, Royal Society of Chemistry, Cambridge, UK, **2006**; b) E. E. Alberto, A. L. Braga, *Selenium and Tellurium Chemistry – From Small Molecules to Biomolecules and Materials* (Eds.: W. J. Derek, L. Risto), Springer Verlag, Berlin, Heidelberg, **2011**; c) T. Wirth, *Organoselenium Chemistry: Synthesis and Reactions*, Wiley-VCH, Weinheim, **2011**; d) P. H. Menezes, G. Zeni, "Vinyl Selenides", in *Patai's Chemistry of Functional Groups*, John Wiley & Sons, **2011**; e) *The chemistry of organic selenium and tellurium compounds* (Ed.: Z. Rappoport), Wiley, Chichester, **2012**, vol. 3, parts 1 and 2.

[17] a) M. J. Fray, D. J. Bull, C. L. Carr, E. C. L. Gautier, C. E. Mowbray, A. Stobie, *J. Med. Chem.* **2001**, *44*, 1951–1962; b) D. K. Mohapatra, P. K. Maity, M. Shabab, M. I. Khan, *Bioorg. Med. Chem. Lett.* **2009**, *19*, 5241–5245; c) C. Gill, G. Jadhav, M. Shaikh, R. Kale, A. Ghawalkar, D. Nagargoje, M. Shiradkar, *Bioorg. Med. Chem. Lett.* **2008**, *18*, 6244–6247.

[18] a) Y.-H. Chen, Y.-H. Zhang, H.-J. Zhang, D.-Z. Liu, M. Gu, J.-Y. Li, F. Wu, X.-Z. Zhu, J. Li, F.-J. Nan, *J. Med. Chem.* **2006**, *49*, 1613–1623; b) S. Chatterjee, D. Dunn, M. Tao, G. Wells, Z.-Q. Gu, R. Bihovsky, M. A. Ator, R. Siman, J. P. Mallamo, *Bioorg. Med. Chem. Lett.* **1999**, *9*, 2371–2374; c) C. E. Augelli-Szafran, C. J. Blankley, B. D. Roth, B. K. Trivedi, R. F. Bousley, A. D. Essenburg, K. L. Hamelehle, B. R. Krause, R. L. Stanfield, *J. Med. Chem.* **1993**, *36*, 2943–2949.

[19] a) G. Ding, L. Jiang, L. Guo, X. Chen, H. Zhang, Y. Che, *J. Nat. Prod.* **2008**, *71*, 1861–1865; b) Y. Ye, H. Zhu, Y. Song, J. Liu, R. Tan, *J. Nat. Prod.* **2005**, *68*, 1106–1108; c) Y. Zhang, T. Zhu, Y. Fang, H. Liu, Q. Gu, W. Zhu, *J. Antibiot.* **2007**, *60*, 153–157.

[20] a) T. Sengupta, K. S. Gayen, P. Pandit, D. K. Maiti, *Chem. Eur. J.* **2012**, *18*, 1905–1909; b) Z. Zhang, S. Fang, Q. Liu, G. Zhang, *J. Org. Chem.* **2012**, *77*, 7665–7670; c) J. B. Pierce, Z. S. Ariyan, G. S. Ovenden, *J. Med. Chem.* **1982**, *25*, 131–136.

[21] Y. Ouyag, J. Huang, W. Pan, Y. Liang, Y. Yang, D. Dong, *Eur. J. Org. Chem.* **2009**, 2003–2009.

[22] a) M. N. S. Saudi, M. M. A. El-Semary, R. Y. Elbayaa, M. I. Jaeda, M. M. Eissa, E. I. Amer, N. M. Baddour, *Med. Chem. Res.* **2012**, *21*, 257–267; b) A. D. Baldev, K. B. Vyas, K. B. Patel, K. S. Nimavat, *J. Chem. Pharm. Res.* **2012**, *4*, 2972–2978; c) P. Salehi, M. Dabiri, M. Koohshari, S. K. Movahed, M. Bararjanian, *Mol. Diversity* **2011**, *15*, 833–837; d) N. C. Desai, M. T. Chhabaria, A. Dodiya, A. M. Bhavsar, B. B. Baldaniya, *Med. Chem. Res.* **2011**, *20*, 1331–1339.

[23] a) W.-W. Chan, T.-L. Kwong, W.-Y. Yu, *Org. Biomol. Chem.* **2012**, *10*, 3749–3755; b) H.-L. Wang, Z. Li, G.-W. Wang, S.-D. Yang, *Chem. Commun.* **2011**, *47*, 11336–11338; c) Z. Yu, L. Ma, W. Yu, *Synlett* **2010**, 2607–2610; d) B. Lu, D. Ma, *Org. Lett.* **2006**, *8*, 6115–6118.

[24] D. Xiang, X. Xin, X. Liu, R. Zhang, J. Yang, D. Dong, *Org. Lett.* **2012**, *14*, 644–647.

[25] G. Tenti, M. T. Ramos, J. C. Menendez, *ACS Comb. Sci.* **2012**, *14*, 551–557.

[26] a) Y. Wang, X. Xin, Y. Liang, Y. Lin, H. Duan, D. Dong, *Adv. Synth. Catal.* **2009**, *351*, 2217–2223; b) D. Dong, X. Bi, Q. Liu, F. Cong, *Chem. Commun.* **2005**, 3580–3582; c) E. Sotoca, C. Allais, T. Constantieux, J. Rodriguez, *Org. Biomol. Chem.* **2009**, *7*, 1911–1920; d) N. Nguyen, G. Ma, D. Romo, *Chem. Commun.* **2010**, *46*, 4803–4805; e) Y. Wang, X. Bi, D. Li, P. Liao, Y. Wang, J. Yang, Q. Zhang, Q. Liu, *Chem. Commun.* **2011**, *47*, 809–811; f) P. Huang, R. Zhang, Y. Liang, D. Dong, *Org. Biomol. Chem.* **2012**, *10*, 1639–1644; g) X. Liu, X. Xin, D. Xiang, R. Zhang, S. Kumar, F. Zhou, D. Dong, *Org. Biomol. Chem.* **2012**, *10*, 5643–5646; h) L. Xia, Y. R. Lee, *Org. Biomol. Chem.* **2013**, *11*, 5254–5263; i) F. Liéby-Muller, T. Constantieux, J. Rodriguez, *J. Am. Chem. Soc.* **2005**, *127*, 17176–17177.

[27] Z. Wang, X. Bi, P. Liao, R. Zhang, Y. Liang, D. Dong, *Chem. Commun.* **2012**, *48*, 7076–7078.

[28] H. Cheng, J. Wan, M.-I. Lin, Y. Liu, X. Lu, J. Liu, Y. Xu, J. Chen, Z. Tu, Y.-S. E. Cheng, K. Ding, *J. Med. Chem.* **2012**, *55*, 2144–2153.

[29] For more information on the reactivity of aryl azides in organic Synthesis see: S. Bräse, C. Gil, K. Knepper, V. Zimmermann, *Angew. Chem. Int. Ed.* **2005**, *117*, 5320–5374.

Received: October 11, 2013
Published Online: December 6, 2013

