Wusheng Sheng, Shouri Sheng,* Jiangbo Zeng, Zhenzhong Huang, and Mingzhong Cai

Key Laboratory of Functional Small Organic Molecule, Ministry of Education, Jiangxi Normal University, JiangxiNanchang 330022, People's Republic of China
*E-mail: shengsr@jxnu.edu.cn
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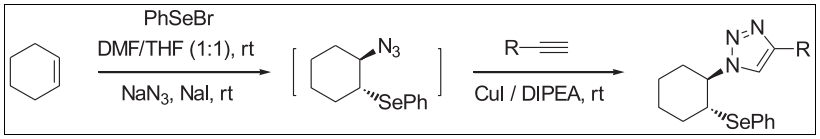

An efficient, one-pot, three-step, regioselective synthesis of 4-substituted 1-(2-phenylselenocyclohexyl)-1,2,3-triazoles, involving *in situ* generation of *l*-azido-2-phenylselenocyclohexane has been developed via four-component reaction of phenylselenenyl bromide, cyclohexene, sodium azide and terminal alkynes catalyzed by copper iodide in a mixture of DMF/THF (1:1) at room temperature under mild conditions with simple workup and good yields.

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INTRODUCTION

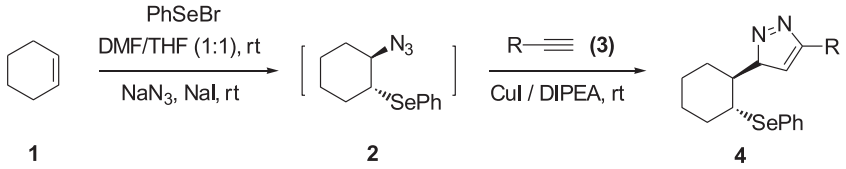
1,2,3-Triazoles are one of the most useful heterocycles [1] and have been widely used in many research fields such as materials, chemical, and biological sciences [2]. Because Meldal and Sharpless developed the copper-catalyzed Huisgen's 1,3-dipolar cycloaddition reaction of azides with alkynes [3], "click chemistry" has received growing interest in the regioselective synthesis of 1,4-disubstituted 1,2,3-triazoles [4]. Multicomponent reactions (MCRs) are one of the most useful synthetic methods because they allow rapid and convergent construction of complex molecules without the isolation of intermediates [5–7]. Moreover, this process is especially useful when the reaction intermediates are unstable and difficult to isolate. Therefore, the development and optimization of new, MCRs to construct efficiently 1,2,3-triazole libraries from readily available, diverse and functional starting materials is of importance in synthesizing new compounds that might deliver future lead compounds for the pharmaceutical community. The organoselenium chemistry has played an important role in organic synthesis [8,9], and the organoselenium reagents have been increasingly used to introduce functional groups into organic substrates under extremely mild conditions. So, the introduction of an organoselenium moiety into the triazole framework will be of interest and might be an effective way for the development of new biological and pharmacological molecules. Although many MCRs have been recent explored for the synthesis of 1,2,3-triazoles [10], to our knowledge, there have been no reports on the synthesis of 1,2,3-triazole molecules containing an organoselenium moiety through MCRs method. We report herein a new and sequential one-pot synthesis of 4-substituted 1-(2-phenylselenocyclohexyl)-1,2,3-triazoles (**4**), which involves *in situ* generation of *l*-azido-2-phenylselenocyclohexane (**2**) via reaction of phenylselenenyl bromide and cyclohexene, subsequent with sodium azide, followed by coupling with a terminal alkyne, as shown in Scheme 1. These 1,4-disubstituted 1,2,3-triazoles are not reported in the literature.

RESULTS AND DISCUSSION

Apparently, the formation of *l*-azido-2-phenylselenocyclohexane (**2**) *in situ* is the key for the success of this protocol. Previously, compound **2** [11] was prepared in 79% yield by stirring a mixture of the cyclohexene with (diacetoxyiodo)benzene, diphenyl diselenide, and sodium azide in methylene chloride at RT. However, apart from the yield of **2** was not high, an excess of (diacetoxyiodo) benzene and diphenyl diselenide was necessary, which is problematic in the latter isolation and purification procedure. Additionally, compound **2** is solvolytically unstable in solvents such as acetic acid and alcohols [12]. Consequently, its *in situ* formation is advantageous to handle it safely and conveniently.

On the basis of these results, together with the literature report on the electrophilic addition reaction of phenylselenenyl bromide to cyclohexene [12], as well as varying the reaction conditions, the best result for the *in situ* generation of L-azido-2-phenylselenocyclohexane (**2**) was conveniently achieved in 93% yield by simply adding anhydrous sodium azide and a small amount of sodium iodide to a solution of phenylselenenyl bromide and cyclohexene in DMF at RT. In the experiment, an immediate electrophilic addition of phenylselenenyl bromide to cyclohexene and subsequent substitution reaction occurred, and the mixture turned a pale yellow white. Other solvents such as DMSO, MeCN, and THF, and their combination are also applicable for this conversion. However, a decrease

Scheme 1. One-pot synthesis of 4-substituted 1-(2-phenylselenocyclohexyl)-1,2,3-triazoles.



in the product yield of **2** was tested using CH_2Cl_2 even if the reaction time was prolonged or at refluxing temperature.

Following successful formation of *l*-azido-2-phenylselenocyclohexane (**2**) *in situ*, one-pot four-component reactions of phenylselenenyl bromide, cyclohexene, sodium azide, and terminal alkynes (**3**) were investigated (Scheme 1). To find the most suitable conditions for our purpose, we examined a template reaction involving phenylselenenyl bromide, cyclohexene, sodium azide, and phenylacetylene (**3a**) in various solvents such as DMF, DMSO, THF, MeCN, and their co-solvents in the presence of copper(I)-catalyst and organic bases such as triethylamine (Et_3N) and diisopropylethylamine (DIPEA) at RT, and the results are summarized in Table 1.

As can be seen from Table 1, DMF/THF (1:1) mixed solvent gave best result in the model reaction (Table 1, entry 5). Thus, DMF/THF was chosen as the typical solvent in subsequent experiments. It should be pointed out that organic bases could promote the "click reaction" (Table 1, entries 6 and 7), which is in accordance with the reported results [3b]. Especially, DIPEA was found to be better base to promote the reaction. It was found that 10 mol% of CuI gave best result (Table 1, entry 7). When 15 mol% of CuI was used, the yield of the product **4a** was not improved significantly (Table 1, entry 8). Whereas reducing the amount of the catalyst CuI to 5 mol% led to a drop of product **4a** to 68% (Table 1, entry 9). In addition, other Cu(I) catalysts such as CuBr, CuCl, and $CuSO_4 \cdot 5H_2O$/Na ascorbate were also examined, which showed a significant decrease in the product yield (Table 1, entries 10 and 12).

Table 1

Optimisation of experimental conditions for one-pot process.[a]

Entry	Solvent	Cu(I)	Base	Yield (%) [b]
1	MeCN	CuI	– [c]	70
2	THF	CuI	– [c]	70
3	DMSO	CuI	– [c]	72
4	DMF	CuI	– [c]	75
5	DMF/THF (1:1)	CuI	– [c]	80
6	DMF/THF (1:1)	CuI	Et_3N	85
7	DMF/THF (1:1)	CuI	DIPEA	88
8	DMF/THF (1:1)	CuI	DIPEA	89[d]
9	DMF/THF (1:1)	CuI	DIPEA	68[e]
10	DMF/THF (1:1)	CuBr	DIPEA	78
11	DMF/THF (1:1)	CuCl	DIPEA	76
12	DMF/THF (1:1)	$CuSO_4$/Vc[f]	DIPEA	74

DIPEA, diisopropylethylamine.
[a]Phenylselenenyl bromide (1.0 mmol), cyclohexene (1.2 mmol), sodium azide (1.2 mmol), **3a** (1.2 mmol), base (40 mol%), Cu(I) (10 mol%), solvent (5 mL), RT, 12–15 h.
[b]Isolated yield based on phenylselenenyl bromide.
[c]No base was used.
[d]CuI (15 mol%) was used.
[e]CuI (5 mol%) was used.
[f]Vc = Na ascorbate

Under these optimized conditions, reaction of phenylselenenyl bromide (1.0 equiv) and cyclohexene (1.2 equiv) in DMF/THF, and subsequently treated with anhydrous sodium azide (1.2 equiv) and NaI (0.2 equiv) at RT for 1 h, followed by the addition of **3a** (1.2 equiv), CuI (10 mol%), and DIPEA (40 mol%), after stirring at RT for 12 h, 1-(2-phenylselenocyclohexyl)-4-phenyl-1,2,3-triazole (**4a**) was isolated in 88% yield as an exclusive product in one-pot, three-step (Table 1, entry 7). The structure of **4a** was confirmed unambiguously by NMR spectroscopy and from elemental analysis data. The trans stereochemistry in **4a** was indicated by two similar doublets of doublets of doublets with coupling constants of 12.0, 11.2, and 4 Hz, and 11.2, 11.2, and 4 Hz indicative of equatorial substituents at CH—Se and CH-triazolyl, respectively. The correlated ^{13}C spectrum indicates the CH—Se absorption at 47.36 ppm with the corresponding H absorbing at 3.56 ppm, whereas the CH-triazolyl absorbed at 65.14 ppm and the H at 4.45 ppm. Besides, the ^1H-NMR spectrum of **4a** exhibited a characteristic singlet at $\delta = 7.67$ ppm because of the triazolyl C_5—H proton.

Finally, the scope of this one-pot method was further examined using various terminal alkynes. A variety of terminal alkynes including aryl-, aryloxymethyl-, and *n*-butylacetylenes were then subjected to the reaction system under the aforementioned optimized reaction conditions, to afford the corresponding 1,4-disubstituted 1,2,3-triazoles (**4a–4k**) in good yields (Table 2). As seen from Table 2, both aromatic and aliphatic acetylenes underwent the reaction smoothly to give satisfactory results. Moreover, the transrelationship of the two substituents at CH—Se and CH-triazolyl was established on the basis of the coupling constant measured for the anomeric proton.

CONCLUSIONS

In summary, a convenient, one-pot, three-step protocol has been developed for the preparation of 1,4-disubstituted-1,2,3-triazoles bearing functional phenylseleno group involving

Table 2

Yields of 4-substituted 1-(2-phenylselenocyclohexyl)-1,2,3-triazoles (**4a–4k**).

Entry	R	Product	Yield (%)[a]
1	C_6H_5	**4a**	88
2	4-EtC_6H_4	**4b**	90
3	3-FC_6H_4	**4c**	85
4	$C_6H_5OCH_2$	**4d**	86
5	2-Me$C_6H_4OCH_2$	**4e**	85
6	3-Me$C_6H_4OCH_2$	**4f**	87
7	4-Me$C_6H_4OCH_2$	**4g**	88
8	4-$NO_2C_6H_4OCH_2$	**4h**	85
9	2-Naphthoxymethyl	**4i**	83
10	2-Cinnamoylphenoxymethyl	**4j**	84
11	*n*-C_4H_9	**4k**	86

[a]Isolated yield based on phenylselenenyl bromide.

four-component reaction of phenylselenenyl bromide with cyclohexene, followed by sodium azide to generate *in situ* L-azido-2-phenylselenocyclohexane, which immediately reacted with terminal alkynes regioselectively in DMF/THF in the presence of a mixture of DIPEA/CuI. This new one-pot, three-step process will make it possible to rapidly prepare compound libraries for drug discovery programs, as it avoids time-consuming and costly purification protocols of synthetic intermediates. Further investigations based on these new functional 1,4-disubstituted-1,2,3-triazoles with phenylseleno group are now in progress.

EXPERIMENTAL

^{1}H-NMR (400 MHz) and ^{13}C-NMR (100 MHz) spectra were recorded on a Bruker Avance (400 MHz) spectrometer (Bruker Corp., Billerica, MA), using $CDCl_3$ as the solvent and TMS as an internal standard. FTIR spectra were taken on a Perkin-Elmer SP One FTIR spectrophotometer (PerkinElmer, Inc., Waltham, MA). Microanalyses were performed with a Carlo Erba 1106 Elemental Analyzer (Milan, Italy). Phenylselenenyl bromide [13] was prepared according to procedures in literature. Terminal alkynes (**3e–3m**) were prepared by alkylation of the corresponding phenols with propargyl bromide in the presence of K_2CO_3 in acetone under refluxing conditions using similar method described in the literature [14]. The other terminal alkynes were obtained from commercial suppliers (Aldrich, USA and Shanghai Chemical Company, China) and used without purification prior to use. All organic solvents were dried by standard methods.

General procedure for the one-pot preparation of 4-substituted 1-(2-phenylselenocyclohexyl)-1,2,3-triazoles (4a–4k). To a stirred solution of phenylselenenyl bromide (1.0 mmol) in DMF/THF (5 mL, 1:1, v/v) was added cyclohexene (1.2 mmol), followed by the addition of anhydrous sodium azide (1.2 mmol) and NaI (0.2 mmol). An immediate exothermic reaction occurred, and the mixture turned a pale yellow white. After stirring for 1 h, terminal alkyne (1.2 mmol), CuI (10 mol%), and DIPEA (0.052 mL, 0.4 mmol) were added, and the reaction mixture was stirred at RT for 12 h. After completion of the reaction (as monitored by TLC), the reaction mixture was filtered through a short pad of Celite 545, and the solvent was removed under reduced pressure. The crude product was purified by column chromatography on silica gel using (hexane–ethyl acetate) to afford pure product **4a–4k**.

1-(2-Phenylselenocyclohexyl)-4-phenyl-1,2,3-triazole (4a). Pale yellow solid, mp 128–129°C; ^{1}H-NMR: δ = 7.79 (d, *J* = 7.2 Hz, 2 H), 7.67 (s, 1H), 7.42–7.38 (m, 4H), 7.32–7.28 (m, 1H), 7.20–7.12 (m, 3H), 4.45 (ddd, *J* = 11.2, 11.2, 4.0 Hz, 1H), 3.56 (ddd, *J* = 12.0, 11.2, 4.0 Hz, 1H), 2.39 (d, *J* = 13.6 Hz, 1H), 2.22 (d, *J* = 13.6 Hz, 1H), 1.99–1.92 (m, 1H), 1.93–1.87 (m, 1H), 1.79–1.77 (m, 1H), 1.64–1.58 (m, 1H), 1.42–1.32 (m, 2H); ^{13}C-NMR: δ = 147.16, 135.90, 130.86, 128.88, 128.72, 128.13, 127.94, 126.87, 125.75, 118.80, 65.14, 47.36, 34.93, 34.34, 26.53, 25.02; IR (KBr): ν = 3131, 3057, 2936, 2858, 1610, 1578, 1477, 1436, 1371, 1228, 1183, 1075, 1045, 1022, 985, 910, 814, 764, 741, 694 cm^{-1}; *Anal*. Calcd for $C_{20}H_{21}N_3Se$: C, 62.82; H, 5.54; N, 10.99. Found: C, 62.90; H, 5.60; N, 10.95.

1-(2-Phenylselenocyclohexyl)-4-(4-ethylphenyl)-1,2,3-triazole (4b). Pale yellow solid, mp 104–105°C; ^{1}H-NMR: δ = 7.72 (d, *J* = 7.6 Hz, 2H), 7.70 (s, 1H), 7.39–7.38 (m, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.17–7.11 (m, 3H), 4.45 (ddd, *J* = 11.2, 11.2, 4.0 Hz, 1H), 3.55 (ddd, *J* = 12.0, 11.6, 4.0 Hz, 1H), 2.68 (q, *J* = 7.6 Hz, 2H), 2.35 (d, *J* = 13.6 Hz, 1H), 2.16 (d, *J* = 10.8 Hz, 1H), 1.98–1.92 (m, 1H), 1.84–1.81 (m, 1H), 1.74–1.68 (m, 1H), 1.57–1.51 (m, 1H), 1.43–1.32 (m, 2H), 1.23 (t, *J* = 7.6 Hz, 3H); ^{13}C-NMR: δ = 147.24, 144.08, 135.99, 128.87, 128.30, 128.21, 128.13, 126.85, 125.77, 118.59, 64.97, 47.32, 34.90, 34.38, 28.69, 26.51, 25.00, 15.57; IR (KBr): ν = 3134, 3055, 2934, 2858, 1578, 1498, 1476, 1447, 1416, 1371, 1264, 1225, 1184, 1117, 1075, 1045, 1022, 986, 840, 741, 694 cm^{-1}; *Anal*. Calcd for $C_{22}H_{25}N_3Se$: C, 64.38; H, 6.14; N, 10.24. Found: C, 64.45; H, 6.22; N, 10.30.

1-(2-Phenylselenocyclohexyl)-4-(3-fluorophenyl)-1,2,3-triazole (4c). Pale yellow solid, mp 103–104°C; ^{1}H-NMR: δ = 7.64 (s, 1H), 7.54 (d, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 9.6 Hz, 1H), 7.38–7.34 (m, 3H), 7.21–7.10 (m, 3H), 7.03 (t, *J* = 7.6 Hz, 1H), 4.47 (ddd, *J* = 10.8, 11.2, 4.0 Hz, 1H), 3.57 (ddd, *J* = 11.6, 11.6, 4.0 Hz, 1H), 2.43 (d, *J* = 13.6 Hz, 1H), 2.25 (d, *J* = 13.2 Hz, 1H), 2.02–1.91 (m, 2H), 1.84–1.81 (m, 1H), 1.67–1.58 (m, 1H), 1.51–1.37 (m, 2H); ^{13}C-NMR: δ = 164.37, 146.09, 135.74, 133.05, 130.31, 128.89, 128.13, 126.89, 121.35, 119.14, 114.82, 112.76, 65.44, 47.37, 34.93, 34.29, 26.55, 25.03; IR (KBr): ν = 3133, 3071, 2936, 2858, 1619, 1589, 1477, 1438, 1371, 1229, 1199, 1154, 1081, 1044, 1022, 979, 963, 785, 741, 689 cm^{-1}; *Anal*. Calcd for $C_{20}H_{20}FN_3Se$: C, 60.00; H, 5.04; N, 10.50. Found: C, 60.07; H, 5.10; N, 10.56.

1-(2-Phenylselenocyclohexyl)-4-phenoxymethyl-1,2,3-triazole (4d). Yellow oil; ^{1}H-NMR: δ = 7.53 (s, 1H), 7.40–7.37 (m, 2H), 7.32–7.23 (m, 3H), 7.20–7.18 (m, 2H), 7.00–6.95 (m, 3H), 5.13 (s, 2H), 4.40 (ddd, *J* = 11.6, 11.6, 4.0 Hz, 1H), 3.53 (ddd, *J* = 12.0, 11.6, 4.0 Hz, 1H), 2.39–2.37 (m, 1H), 2.20–2.17 (m, 1H), 1.98–1.88 (m, 2H), 1.80–1.78 (m, 1H), 1.67–1.54 (m, 1H), 1.43–1.32 (m, 2H); ^{13}C-NMR: δ = 158.31, 143.62, 135.82, 129.55, 128.88, 128.10, 126.85, 121.79, 121.22, 114.81, 65.21, 62.17, 47.36, 34.82, 34.29, 26.51, 24.99; IR (film): ν = 3057, 2935, 2858, 1599, 1495, 1241, 1174, 1079, 1034, 855, 753, 692 cm^{-1}; *Anal*. Calcd for $C_{21}H_{23}N_3OSe$: C, 61.16; H, 5.62; N, 10.19. Found: C, 61.23; H, 5.67; N, 10.23.

1-(2-Phenylselenocyclohexyl)-4-(2-methylphenoxymethyl)-1,2,3-triazole (4e). Yellow oil; ^{1}H-NMR: δ = 7.71 (s, 1H), 7.56–7.50 (m, 2H), 7.41–7.37 (m, 2H), 7.20–7.14 (m, 3H), 6.95–6.87 (m, 2H), 5.15 (s, 2H), 4.37 (ddd, *J* = 11.6, 11.6,

4.0 Hz, 1H), 3.54 (ddd, J = 12.0, 11.6, 4.0 Hz, 1H), 2.40 (d, J = 13.4 Hz, 1H), 2.24 (s, 3H), 2.20 (d, J = 13.4 Hz, 1H), 2.00–1.88 (m, 3H), 1.81–1.78 (m, 1H), 1.69–1.58 (m, 1H), 1.46–1.37 (m, 2H); ^{13}C-NMR: δ = 167.72, 156.24, 143.34, 135.65, 132.41, 130.95, 128.82, 128.18, 126.87, 122.48, 121.13, 111.62, 65.55, 61.90, 47.15, 34.67, 34.16, 26.40, 24.91, 19.26; IR (film): ν = 3058, 2957, 2862, 1600, 1494, 1462, 1383, 1287, 1244, 1122, 1073, 744, 694 cm^{-1}; *Anal*. Calcd for $C_{22}H_{25}N_3OSe$: C, 61.97; H, 5.91; N, 9.85. Found: C, 61.94; H, 5.85; N, 9.90.

1-(2-Phenylselenocyclohexyl)-4-(3-methylphenoxymethyl)-1,2,3-triazole (4f). Yellow oil; ^{1}H-NMR: δ = 7.52 (s, 1H), 7.37 (d, J = 7.2 Hz, 2H), 7.26–7.15 (m, 4H), 6.80–6.77 (m, 3H), 5.11 (s, 2H), 4.39 (ddd, J = 11.6, 11.2, 4.0 Hz, 1H), 3.52 (ddd, J = 12.0, 11.6, 4.0 Hz, 1H), 2.38–3.27 (m, 4H), 2.18–2.15 (m, 1H), 1.99–1.86 (m, 2H), 1.79–1.73 (m, 1H), 1.62–1.52 (m, 1H), 1.43–1.34 (m, 2H); ^{13}C-NMR: δ = 158.33, 143.70, 139.60, 135.86, 129.30, 128.90, 128.12, 126.81, 122.09, 121.88, 115.68, 111.68, 65.22, 62.10, 47.34, 34.81, 34.28, 26.50, 24.98, 21.59; IR (film): ν = 3054, 2936, 2858, 1599, 1586, 1489, 1447, 1289, 1259, 1156, 1043, 1022, 778, 742, 691 cm^{-1}; *Anal*. Calcd for $C_{22}H_{25}N_3OSe$: C, 61.97; H, 5.91; N, 9.85. Found: C, 61.92; H, 5.96; N, 9.91.

1-(2-Phenylselenocyclohexyl)-4-(4-methylphenoxymethyl)-1,2,3-triazole (4g). Yellow oil; ^{1}H-NMR: δ = 7.51 (s, 1H), 7.37 (d, J = 8.0 Hz, 2H), 7.27–7.17 (m, 3H), 7.09 (d, J = 8.0 Hz, 2H), 6.89 (d, J = 8.4 Hz, 2H), 5.10 (s, 2H), 4.38 (ddd, J = 11.6, 11.6, 4.0 Hz, 1H), 3.50 (ddd, J = 12.0, 11.6, 4.0 Hz, 1H), 2.40–3.37 (m, 1H), 2.27 (s, 3H), 2.18–2.15 (m, 1H), 1.90–1.84 (m, 2H), 1.75–1.68 (m, 1H), 1.60–1.56 (m, 1H), 1.45–1.30 (m, 2H); ^{13}C-NMR: δ = 167.70, 156.17, 143.53, 135.77, 130.98, 128.83, 128.10, 126.85, 122.11, 114.75, 65.45, 62.16, 47.24, 34.76, 34.24, 26.45, 24.94, 20.48; IR (film): ν = 3056, 2934, 2859, 1585, 1510, 1448, 1289, 1241, 1177, 1121, 1073, 1047, 1022, 817, 742, 693 cm^{-1}; *Anal*. Calcd for $C_{22}H_{25}N_3OSe$: C, 61.97; H, 5.91; N, 9.85. Found: C, 61.93; H, 5.95; N, 9.89.

1-(2-Phenylselenocyclohexyl)-4-(4-nitrophenoxymethyl)-1,2,3-triazole (4h). Yellow oil; ^{1}H-NMR: δ = 8.18 (d, J = 9.2 Hz, 2H), 7.75–6.70 (m, 1H), 7.52 (s, 1H), 7.36 (d, J = 6.4 Hz, 2H), 7.21–7.17 (m, 2H), 7.08 (d, J = 9.2 Hz, 2H), 5.25–5.18 (m, 2H), 4.42 (ddd, J = 11.0, 11.2, 4.0 Hz, 1H), 3.53 (ddd, J = 11.6, 11.2, 4.0 Hz, 1H), 2.39–2.36 (m, 1H), 2.21–2.18 (m, 1H), 2.00–1.81 (m, 2H), 1.79–1.74 (m, 1H), 1.72–1.66 (m, 2H), 1.60–1.50 (m, 1H); ^{13}C-NMR: δ = 167.73, 163.25, 141.73, 135.62, 130.92, 128.80, 128.05, 125.87, 122.36, 114.88, 65.52, 62.54, 47.31, 34.76, 34.25, 26.45, 24.93; IR (film): ν = 3074, 2958, 2935, 2861, 1593, 1515, 1496, 1342, 1258, 1175, 1113, 1074, 999, 846, 743, 692 cm^{-1}; *Anal*. Calcd for $C_{21}H_{22}N_4O_3Se$: C, 55.15; H, 4.85; N, 12.25. Found: C, 55.19; H, 4.89; N, 12.31.

1-(2-Phenylselenocyclohexyl)-4-(2-naphthoxymethyl)-1,2,3-triazole (4i). Yellow oil; ^{1}H-NMR: δ = 7.76–7.72 (m, 2H), 7.60–7.58 (m, 2H), 7.52 (s, 1H), 7.44–7.40 (m, 1H), 7.36–7.29 (m, 2H), 7.25–7.14 (m, 5H), 5.23 (s, 2H), 4.37 (ddd, J = 11.6, 11.6, 4.0 Hz, 1H), 3.50 (ddd, J = 11.6, 11.2, 4.0 Hz, 1H), 2.35–2.32 (m, 1H), 2.16–2.12 (m, 1H), 1.98–1.73 (m, 3H), 1.60–1.50 (m, 1H), 1.43–1.31 (m, 2H); ^{13}C-NMR: δ = 156.31, 143.41, 135.85, 134.50, 129.58, 129.35, 129.18, 128.92, 128.12, 127.69, 126.99, 126.52, 123.92, 121.99, 118.90, 107.31, 65.16, 62.24, 47.39, 34.81, 34.30, 26.49, 24.97; IR (film): ν = 3056, 2936, 2858, 1628, 1600, 1510, 1470, 1389, 1358, 1257, 1215, 1179, 914, 839, 812, 743, 693 cm^{-1}; *Anal*. Calcd for $C_{25}H_{25}N_3OSe$: C, 64.93; H, 5.45; N, 9.09. Found: C, 64.88; H, 5.52; N, 9.14.

1-(2-Phenylselenocyclohexyl)-4-(2-cinnamoylphenoxymethyl)-1,2,3-triazole (4j). Yellow oil; ^{1}H-NMR: δ = 7.68–7.66 (m, 2H), 7.63 (s, 1H), 7.56–7.48 (m, 5H), 7.44 (s, 1H), 7.40–7.37 (m, 5H), 7.31–7.29 (m, 3H), 5.22 (s, 2H), 4.10 (ddd, J = 11.6, 11.6, 4.0 Hz, 1H), 3.19 (ddd, J = 12.0, 11.2, 4.0 Hz, 1H), 2.27–1.84 (m, 3H), 174–1.70 (m, 1H), 1.57–1.38 (m, 3H); ^{13}C-NMR: δ = 192.62, 156.85, 143.29, 142.36, 135.83, 135.00, 133.23, 130.60, 130.30, 129.75, 129.06, 128.81, 128.44, 128.03, 127.37, 126.75, 121.54, 121.38, 112.97, 64.94, 63.36, 47.04, 34.52, 34.14, 26.31, 24.86; IR (film): ν = 3058, 2936, 2859, 1723, 1658, 1602, 1482, 1450, 1333, 1290, 1240, 1205, 1115, 756, 696 cm^{-1}; *Anal*. Calcd for $C_{30}H_{29}N_3O_2Se$: C, 66.42; H, 5.39; N, 7.75. Found: C, 66.47; H, 5.46; N, 7.80.

***1-(2-Phenylselenocyclohexyl)-4-(n*-butyl)-1,2,3-triazole (4k)**. Yellow oil; ^{1}H-NMR: δ = 7.75 (s, 1H), 7.63–7.58 (m, 2H), 7.35–7.26 (m, 3H), 4.38–4.21 (m, 1H), 3.36 (ddd, J = 9.6, 9.6, 4.0 Hz, 1H), 2.99–2.87 (m, 2H), 2.66–2.63 (m, 1H), 2.42–2.41 (m, 1H), 2.20–2.08 (m, 2H), 176–1.61 (m, 3H), 1.50–1.28 (m, 5H), 0.96 (t, J = 7.6 Hz, 3H); ^{13}C-NMR: δ = 147.93, 135.28, 128.88, 127.92, 127.23, 118.86, 65.09, 47.43, 34.88, 34.33, 31.90, 26.54, 25.67, 25.01, 22.58, 14.01; IR (film): ν = 3070, 2933, 2858, 1580, 1476, 1438, 1381, 1255, 1188, 1115, 1068, 1035, 961, 865, 742, 695 cm^{-1}; *Anal*. Calcd for $C_{18}H_{25}N_3Se$: C, 59.66; H, 6.95; N, 11.60. Found: C, 59.72; H, 6.98; N, 11.64.

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REFERENCES AND NOTES

[1] Fan, W. Q.; Katritzky, A. R. In Comprehensive Heterocyclic Chemistry II; Katritzky, A. R., Rees, C. W., Scriven, C. W. V., Eds.; Elsevier: Oxford, 1996.

[2] (a) Krasiski, A.; Radi, Z.; Manetsch, R.; Raushel, J.; Taylor, P.; Sharpless, K. B.; Kolb, H. C. J Am Chem Soc 2005, 127, 6686; (b) Binder, W. H.; Kluger, C. Curr Org Chem 2006, 10, 1791; (c) Suijkerbuijk, B. M. J. M.; Aerts, B. N. H.; Dijkstra, H. P.; Lutz, M.; Spek, A. L.; Koten, G. V.; Gebbink, R. J. M. K. Dalton Trans 2007, 1273.

[3] (a) Tornøe, C.; Christensen, M. Meldal, J Org Chem 2002, 67, 3057; (b) Rostovtsev, V. V.; Green, L. G.; Fokin, V. V.; Sharpless, K. B. Angew Chem Int Ed 2002, 41, 2596.

[4] For recent reviews, see: (a) Bock, V. D.; Hiemstra, H.; van Maarseveen, J. H. Eur J Org Chem 2006, 51; (b) Gil, M. V.; Arevalo, M. G.; Lopez, O. Synthesis 2007, 1589; (c) Moses, J. E.; Moorhouse, A. D. Chem Soc Rev 2007, 36, 1249; (d) Meldal, M.; Tornøe, C. W. Chem Rev 2008, 108, 2952; (e) Amblard, F.; Cho, J. H.; Schinazi, R. F. Chem Rev 2009, 109, 4207; (f) Kappe, C. O.; Van der Eycken, E. Chem Soc Rev 2010, 39, 1280; (g) Hein, J. E.; Fokin, V. V. Chem Soc Rev 2010, 39, 1302.

[5] For reviews on MCR, see: (a) Armstrong, R. W.; Combs, A. P.; Tempest, P. A.; Brown, S. D.; Keating, T. A. Acc Chem Res 1996, 29, 123; (b) Ramon, D. J.; Miguel, Y. Angew Chem Int Ed 2005, 44, 1602; (c) Döling, A. Chem Rev 2006, 106, 17; (d) Ganem, B. Acc Chem Res 2009, 42, 463; (e) Wessjohann, L. A.; Rivera, D. G.; Vercillo, O. E. Chem Rev 2009, 109, 796; (f) Dotz, K. H.; Stendel, J., Jr. Chem Rev 2009, 109, 3227; (g) Toure, B. B.; Hall, D. G. Chem Rev 2009, 109,

4439; (h) Bonne, D.; Coquerel, Y.; Constantieux, T.; Rodriguez, J. Tetrahedron Asymmetry 2010, 21, 1085; (i) Eelco, R.; Rachel, S.; Romano, V. A. O. Angew Chem Int Ed 2011, 50, 6234.

[6] Zhu, J., Bienaymé, H., Eds. Multicomponent Reactions; Wiley: Weinheim, 2005.

[7] (a) Burke, M. D.; Schreiber, S. L. Angew Chem Int Ed 2004, 43, 46; (b) Spandl, R. J.; Spring, D. R. Org Biomol Chem 2008, 6, 1149.

[8] Paulmier, C., Ed. Selenium Reagents and Intermediates in Organic Synthesis; Pergamon Press: Oxford, 1986.

[9] Reich, H. J. Acc Chem Res 1979, 12, 22.

[10] For recent selective one-pot, multi-component processes for 1,4-disubstituted 1,2,3-triazoles, see: (a) Smith, N. M.; Greaves, M. J.; Jewell, R.; Perry, M. W. D.; Stocks, M. J.; Stonehouse, J. P. Synlett 2009, 1391; (b) Kumar, D.; Reddy, V. B. Synthesis 2010, 1687; (c) Doak, B. C.; Scanlon, M. J.; Simpson, J. S. Org Lett 2011, 13, 537; (d) Bahulayan, D.; Arun, S. Tetrahedron Lett 2012, 53, 2850; (e) Hwang, S.; Bae, H.; Kim, S.; Kim, S. Tetrahedron 2012, 68, 1460.

[11] Tingoli, M.; Tiecco, M.; Chianelli, D.; Balducci, R.; Temperini, A. J Org Chem 1991, 56, 6809.

[12] Sharpless, K. B.; Lauer, R. F. J Org Chem 1974, 39, 429.

[13] Reich, H. J.; Renga, J. M.; Reich, I. L. J Am Chem Soc 1975, 97, 5434.

[14] Pérez-Serrano, L.; Blanco-Urgoiti, J.; Casarrubios, L.; Domínguez, G.; Pérez-Castells, J. J Org Chem 2000, 65, 3513.