Synthesis of Bis(2,4-diarylimidazol-5-yl) Diselenides from *N*-Benzylbenzimidoyl Isoselenocyanates

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The reaction of *N*-benzylbenzamides **6** with $SOCl_2$ under reflux gave the corresponding *N*-benzylbenzimidoyl chlorides **7**. Further treatment with KSeCN in dry acetone yielded imidoyl isoselenocyanates **3** (*Scheme 2*). These compounds, obtained in satisfying yields, proved to be stable enough to be purified and analyzed. Reaction of **3** with morpholine in dry acetone led to the corresponding selenourea derivatives **8**. On treatment with Et_3N, the 4-nitrobenzyl derivatives of type **3** were transformed into bis(2,4-diarylimidazol-5-yl) diselenides **9** (*Scheme 3*). This transformation takes place only when the benzyl residue bears an NO_2 group and the phenyl group is not substituted with a strong electron-donating group. A reaction mechanism for the formation of **9** is proposed in *Scheme 4*. The key structures have been established by X-ray crystallography.

1. Introduction. – In recent years, interest in the chemistry of Se-containing compounds has increased remarkably due to their chemical properties [1–4] and biological activities [5–7]. Although selenium was obtained for the first time by *Berzelius* in 1817 [8] and the preparation of the first organoselenium compound, *i.e.*, ethylselenol, by *Wöhler* and *Siemens* dates from 1847 [9], most progress in the area of the synthetic organic chemistry of Se was accomplished more than 100 years later, in contrast to the chemistry of O- and S-containing organic molecules, which is much better developed. Currently, organic Se compounds are frequently used in organic synthesis in many different ways (*cf.* [10–14] and refs. cited therein).

The properties of Se-containing compounds mostly resemble those of their S analogues, but some remarkable differences are also observed. Organic Se compounds are, in some cases, oxidation- and photo-sensitive, and appear, in general, to be less stable than their S analogues. Furthermore, they are often evil-smelling and very toxic. Therefore, new approaches to organic Se compounds by using more stable and less toxic starting materials are an attractive goal. Such products with the potential for use in the syntheses of Se compounds appear to be aroyl isoselenocyanates **1**, which are easily prepared from aroyl chlorides and KSeCN [15] (*cf.* [16–18]).

Unfortunately, the intermediates of type **1** could not be isolated in a pure state. They were obtained as mixtures of monomers and oligomers in low yield, *e.g.*, as precursors of selenoureas [19][20]. For the preparation of Se heterocycles, *N*-phenylbenzimidoyl isoselenocyanates of type **2** were also used [21][22]. They are relatively stable and, in some reactions, led to products in high yields and of high purity. In the present research project, we have used *N*-benzylbenzimidoyl isoselenocyanates **3**

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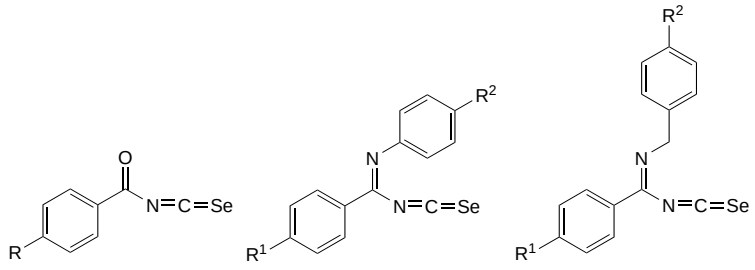
[1]) Part of the planned Ph.D. thesis, Universität Zürich.

[2]) Postdoctoral stay at the University of Zürich (08.98–12.99).

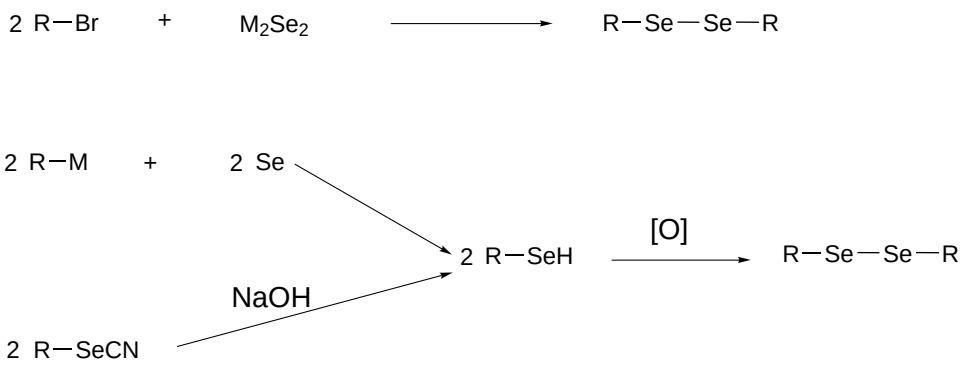


1 **2** **3**

as starting materials. They are conveniently prepared from benzylamines and aroyl chlorides and are stable compounds, too. They proved to be suitable intermediates for the syntheses of organic Se compounds, *e.g.*, bis(imidazol-5-yl) diselenides.

Diselenides belong to the basic reagents in the organic chemistry of Se [2–4]. The most important routes to these compounds are the treatment of organic halides with metal diselenides or reactions that lead to selenols that are further oxidized to give diselenides (*Scheme 1*) [23–28] (*cf.* also [29–35]).

Scheme 1



Diaryl diselenides are of importance in organic as well as in medicinal chemistry. After *in situ* oxidation to electrophilic or reduction to nucleophilic intermediates, they have been extensively used in the synthesis of organic compounds, *e.g.*, as auxiliary agents to introduce new functional groups under mild conditions [36] or to generate new stereogenic centers in substrates by means of chiral diselenides [3a]. On the other hand, bis(imidazol-2-yl) disulfides have been used as an auxiliary in cyclizations to give macrolides [37] and have also been found to be effective against certain cancer cell lines [38]. Recently, the highly cytotoxic imidazol-5-yl disulfide polycarpine was isolated from the Pacific Ocean ascidians *Polycarpa aurata* and *Polycarpa clavata* [39], and the synthesis of the compound was carried out [40]. Furthermore, as mimics of glutathione peroxidase, the antioxidant activity of aryl diselenides with substituents containing N- or O-atoms in the proximity of the Se-atom is of current interest [41].

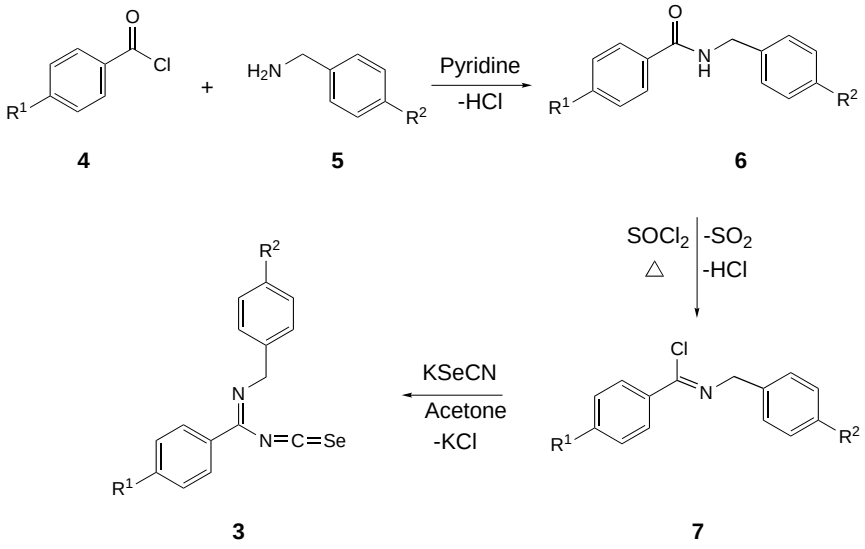
Some diselenides act as immunostimulants by the induction of cytokines [42], and they are promising candidates for a new strategy for the chemotherapy of AIDS [43].

In the present paper, we report a practical and efficient method for the preparation of bis(imidazol-5-yl) diselenides from easily accessible imidoyl isoselenocyanates, which was developed as part of our efforts to create less-toxic and stable isoselenocyanates as starting materials for Se-containing heterocycles (*cf.* [20][22]). A similar method has been used previously for the synthesis of bis[(arylsulfonyl)imidazol-5-yl] disulfides [44].

2. Results and Discussion. – The *N*-benzylbenzamides **6a**–**l**, which are starting materials for the synthesis of *N*-benzylbenzimidoyl chlorides **7**, were conveniently prepared by slow addition of benzoyl chlorides **4** to a cooled solution (*ca.* 0°) of the appropriate benzylamine **5** in pyridine under stirring. Then, the mixture was heated to 90° for 1 h, and the solution was poured into ice-water. The precipitate was washed with cold H_2O and recrystallized from EtOH [45] to give **6** (*Scheme 2* and *Table 1*).

A mixture of **6** and 2–3 equiv. of $SOCl_2$ was then heated to reflux until the evolution of SO_2 ceased (*ca.* 3 h). The excess of $SOCl_2$ was evaporated, and the crude imidoyl chloride **7** was dried (24 h, *in vacuo*)[3]). This material was dissolved in dry acetone, and the solution was added under stirring to a freshly prepared solution of 1.1 equiv. of KSeCN in dry acetone at room temperature. After 30 min, the mixture was poured slowly into ice-water and the precipitate was filtered and air-dried. The crude product was recrystallized from CH_2Cl_2/hexane to give imidoyl isoselenocyanate **3** as yellow crystals[4]) (*Scheme 2* and *Table 1*). The structures of the isoselenocyanates **3**

Scheme 2



[3]) Surprisingly, no imidoyl chloride was formed in the cases of $R^1 = Cl$ or NO_2 and $R^2 = NO_2$.

[4]) During crystallization, the product partially decomposed.

Table 1. *Yields* [%] *of the Prepared Amides* **6**, *Isoselenocyanates* **3**, *Selenoureas* **8**, *and Diselenides* **9**

	R^1	R^2	**6**	**3**	**8**	**9**
a	H	NO_2	65	51.2	99.5	58.3
b	Br	NO_2	72	47.3	48.8	36.9
c	Cl	NO_2	67	37.8	–	35.8
d	F	NO_2	55	73.7	64.5	37.5
e	Me	NO_2	82	43.1	75.0	–
f	MeO	NO_2	78	17.6	75.6	–
g	CN	NO_2	60	58.6	51.4	47.0
h	CO_2Me	NO_2	63	33.8	90.0	–
i	NO_2	H	83	28.2	53.2	–
k	Cl	Cl	85	46.3	55.5	–
l	CN	Cl	80	42.6	81.0	–

have been established on the basis of their spectroscopic and analytical data and, in the case of **3b**, by an X-ray crystal-structure determination (*Fig. 1*).

The bond lengths in the N=C=Se group are very short (1.173(3) Å for C=N and 1.720(3) Å for C=Se) and indicate significant π-interactions between these atoms. The cumulated π-system is further supported by the very large bond angle (176.6(2)°) involving the N-atom of this group. The molecule has two planar sections: the nitrophenyl group up to C(5) and the bromophenyl group right through to C(5) and including N(2)[5]). These two planes intersect at an angle of 18.60(8)°. The atom C(1)

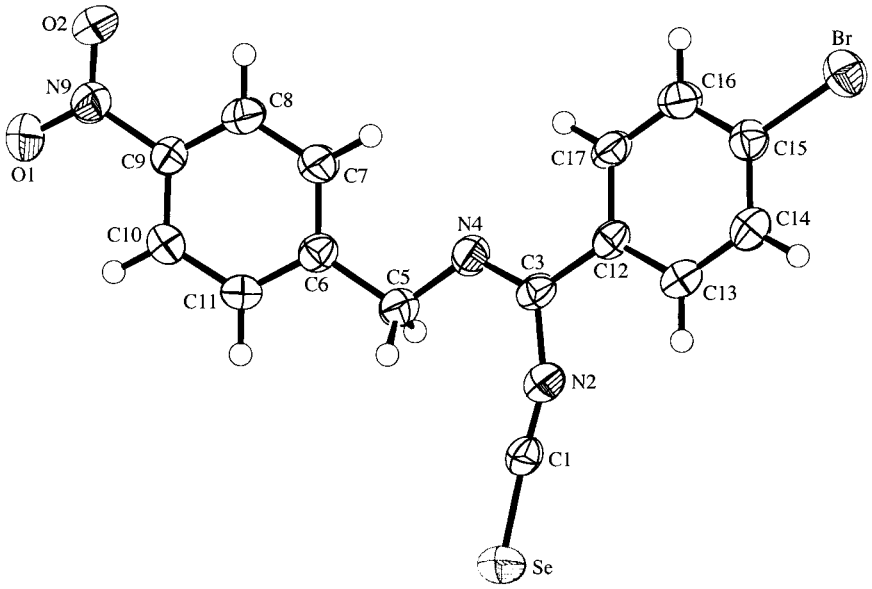


Fig. 1. *ORTEP Plot* [46] *of the molecular structure of* **3b** (arbitrary numbering of the atoms; 50% probability ellipsoids)

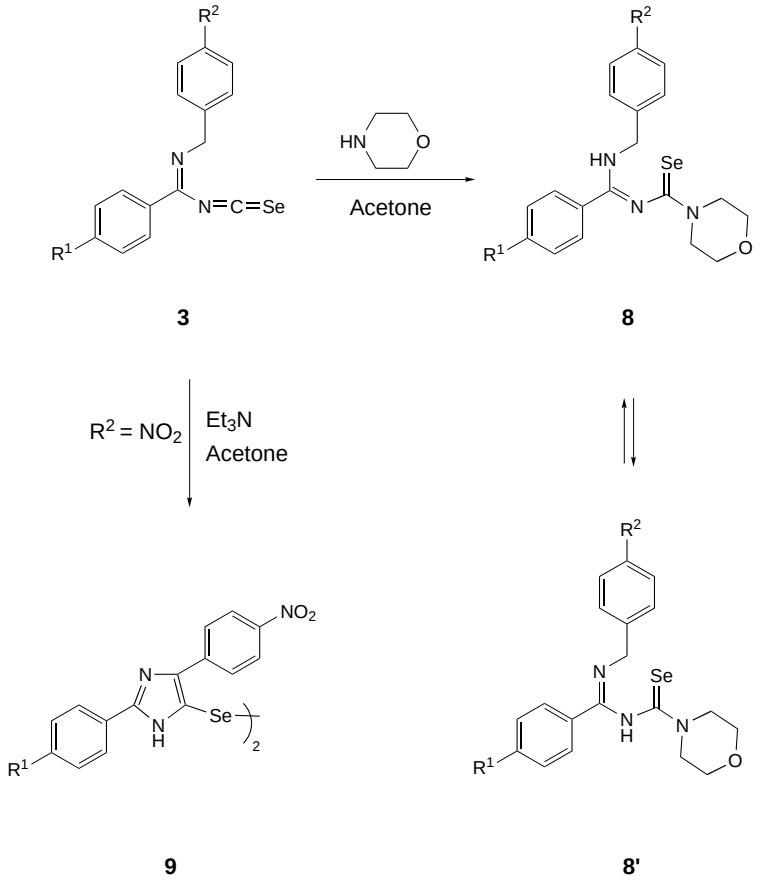
[5]) Arbitrary numbering of the atoms used in *Fig. 1*.

deviates only slightly from the second plane (0.019(3) Å), whereas the deviation of the Se-atom is significant (0.115(1) Å).

When 1.1 equiv. of morpholine were added to a stirred solution of **3** in acetone at room temperature, the yellow color of the solution changed to dark brown. According to TLC, the reaction was complete within 15–30 min. After ice-water was added to the mixture, a yellow precipitate was formed. The crude product was recrystallized from CH_2Cl_2/hexane, and the structures of the selenourea derivatives **8** were determined from their spectroscopic data and elemental analyses (*Scheme 3* and *Table 1*). In the case of **8b**, the structure was established by X-ray crystallography (*Fig. 2*).

The crystal structure of **8b** shows that the NH group is adjacent to the benzylic CH_2 group, and the C=N bond is adjacent to the Se-bearing C-atom. The asymmetric unit also contains one half of a benzene molecule, which sits across a center of inversion. The NH group forms an intermolecular H-bond with the Se-atom of a neighboring molecule, thereby linking the molecules into infinite one-dimensional chains that run parallel to the *b*-axis and have a graph-set motif [47] of C(6).

Scheme 3



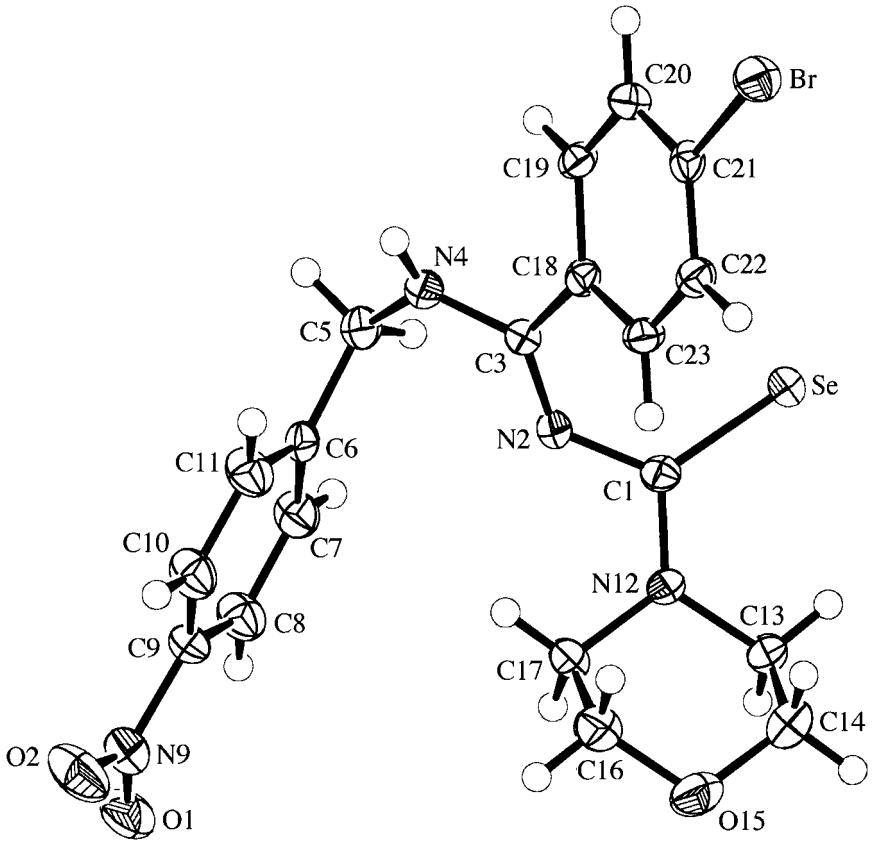


Fig. 2. *ORTEP Plot* [46] *of the molecular structure of* **8b** (arbitrary numbering of the atoms; 50% probability ellipsoids; the solvent molecule has been omitted for clarity)

Compounds of type **8** may exist in two tautomeric forms **8** and **8′** (*Scheme 3*; *cf.* [22]). For **8b**, the X-ray data show the presence of tautomer **8b** in the crystalline state. The existence of the same tautomer in (D_6)DMSO solution was evidenced by ^{1}H-NMR spectroscopy: in the spectrum of **8b** in (D_6)DMSO, NH appears as a *t* at 8.99 ppm and ArCH_2 absorbs at 4.64 as a *d* ($J = 5.6$ Hz). Similar signals are observed for **8f** (*t* at 8.85 and *d* at 4.64 ppm). Given that, in **8b**, R^2 is an electron-withdrawing group, whereas it is an electron-donating substituent in **8f**, and both compounds were detected as tautomer of type **8**, we deduce by analogy that all prepared selenoureas of type **8** exist in the same tautomeric form.

Dropwise addition of 1.1 equiv. of Et_3N to a stirred solution of **8** in dry acetone led to the formation of an orange-red precipitate. After the addition of ice-water to the mixture, an additional amount of the precipitate was formed. Filtration and recrystallization of the solid material from EtOH gave the diselenides **9a**–**d** and **9g** in reasonable yields (*Scheme 3* and *Table 1*). Their structures were deduced from the elemental analyses and the spectroscopic data, and, in the cases of **9a** and **9b**, they were established by X-ray crystallography (*Fig. 3*).

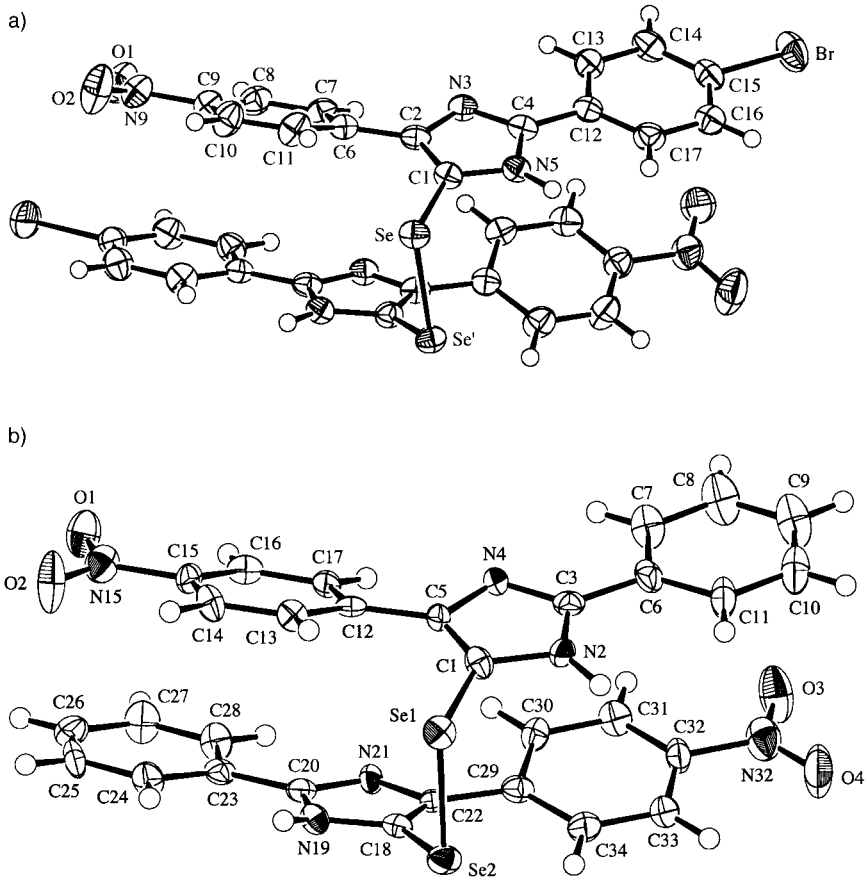


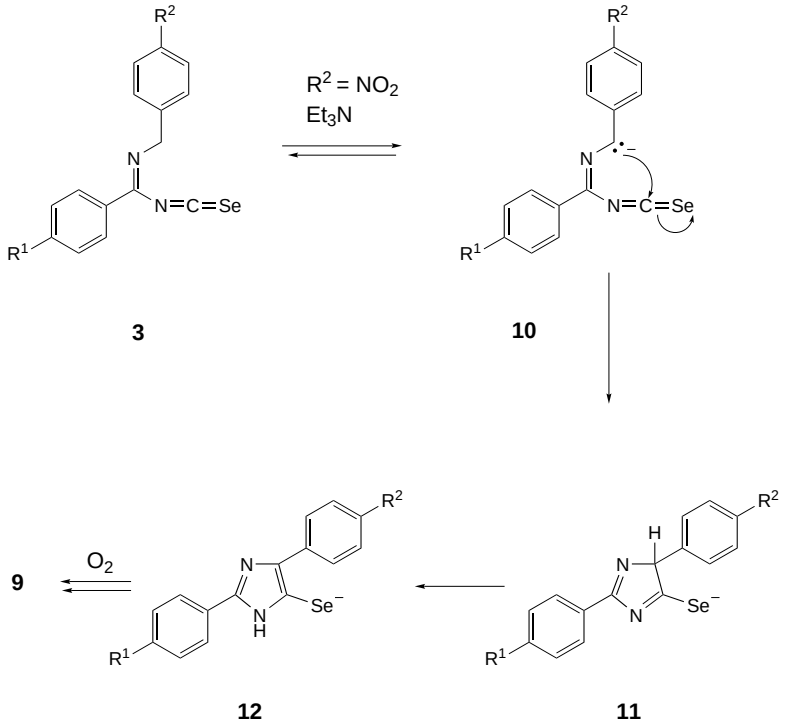
Fig. 3. *ORTEP Plots* [46] *of the molecular structures of* a) **9b** *and* b) **9a** (arbitrary numbering of the atoms; 50% probability ellipsoids; the solvent molecules have been omitted for clarity)

The crystal structure of **9b** shows that the molecule is a dimer of the expected 2,4-diarylimidazole-5-selenol with the coupling occurring *via* an Se–Se bond. The molecule has crystallographic C_2 symmetry, and the asymmetric unit contains one half of this molecule plus one highly disordered DMF molecule. Each half of the molecule has two planar sections: the nitrophenyl group, and the five-membered ring with its bromophenyl substituent. These two planes intersect at an angle of 29.28(9)°. The Se–Se bridge links the two halves of the molecule to form an overall sandwich or U-shaped conformation where the two halves of the molecule lie over and approximately parallel to one another. The nitrophenyl group in one half overlays and is parallel to the five-membered ring plus its bromophenyl substituent of the other half of the molecule and *vice versa*. Each NH group of **9b** forms an intermolecular H-bond with the amide O-atom of a neighboring DMF molecule. The overall crystal packing thus forms a layered structure with DMF molecules interspersed between the layers.

The crystal structure of **9a** is similar to that of **9b** with the two 2,4-diarylimidazole moieties being oriented almost antiparallel to one another. The asymmetric unit contains one molecule of the diselenide plus two molecules of AcOEt. The two NH groups of **9a** form intermolecular H-bonds with the C=O O-atom of each of the two AcOEt molecules. Therefore, these interactions link the three symmetry-independent moieties in the structure into a single trimeric entity.

A reaction mechanism for the formation of the diselenides of type **9** is proposed in *Scheme 4*. Deprotonation of the benzylic CH_2 group, which is acidified by the NO_2 group in the *para* position, leads to the carbanion **10**. Cyclization by nucleophilic attack at the isoselenocyanate C-atom gives the 2,4-diaryl-4*H*-imidazole-5-selenolate **11**, which aromatizes to yield **12**. The latter undergoes oxidative dimerization to give the final product **9**.

Scheme 4



It is worth mentioning that the reaction fails in the absence of the *p*-NO_2 group in the benzyl moiety ($R^2 \neq NO_2$). Obviously, the benzylic CH_2 group is not acidic enough in these cases to be deprotonated by Et_3N. Similarly, the electron-donating substituents $R^1 = Me$ and MeO of the 'benzamidine' ring also prevent deprotonation. On the other hand, halogen substituents, as well as a CN group, in the *p*-position are tolerated.

In conclusion, bis(imidazol-5-yl) diselenides **9** with $R^1 = NO_2$ and R^2 not being an electron-donating group are conveniently accessible *via* the reaction of isoselenocya-

nates of type **3** with Et_3N. The isoselenocyanates **3** are easily obtained from the reaction of benzimidoyl chlorides **7** and KSeCN. As *N*-benzylbenzamides **6** are the starting materials for the preparation of **7**, and KSeCN is smoothly prepared from elemental Se and KCN in EtOH, the described synthesis of diselenides **9** is cheap and safe as no highly toxic Se compounds are used.

We thank the analytical units of our institute for spectra and analyses. Financial support of this work by the *Swiss National Science Foundation*, the *Dr. Helmut Legerlotz-Stiftung*, and *F. Hoffmann-La Roche AG*, Basel, is gratefully acknowledged.

Experimental Part

1. *General*. See [20].

2. *Preparation of* N-*Benzylbenzamides. General Procedure.* To a cooled soln. of the appropriate benzylamine (0.036 mol) in pyridine (50 ml, ice-bath) was slowly added the corresponding benzoyl chloride (0.039 mol) under stirring. After 10 min, the ice-bath was removed, and the mixture was stirred for 3 h at r.t. in the cases of liquid benzoyl chlorides or for 1 h at 90° when the benzoyl chloride was solid. Then, cold H_2O (100 ml) was added, and the mixture was stirred at 0° for 10 min. The residue was filtered and washed several times with cold H_2O. The crude product was recrystallized from EtOH. When recrystallization was not possible, the crude product was simply washed with hot EtOH.

N-*(4-Nitrobenzyl)benzamide* (**6a**). From 6.79 g (36 mmol) of *4-nitrobenzylamine hydrochloride* (**5a**·**HCl**) and 5.60 g (39 mmol) of *benzoyl chloride* (**4a**): 6.0 g (65%). Yellowish crystals. M.p. 155.0–156.0° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.62 (br. *s*, NH); 8.18, 7.63 (*AA′BB′*, *J* = 8.8, 4 arom. H); 7.70–7.40 (*m*, 5 arom. H); 4.73 (*d*, *J* = 6.1, ArC*H*$_2$NH).

4-Bromo-N-*(4-nitrobenzyl)benzamide* (**6b**). From 6.79 g (36 mmol) of **5a**·**HCl** and 8.56 g (39 mmol) of *4-bromobenzoyl chloride* (**4b**): 8.7 g (72%). Yellowish crystals. M.p. 173.0–174.0° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.52 (br. *s*, NH); 8.19 (*AA′*BB′, *J* = 8.8, 2 arom. H); 7.89 (*CC′*DD′, *J* = 8.7, 2 arom. H); 7.80–7.60 (*m*, 4 arom. H); 4.73 (*d*, *J* = 6.0, CH$_2$).

4-Chloro-N-*(4-nitrobenzyl)benzamide* (**6c**). From 6.79 g (36 mmol) of **5a**·**HCl** and 6.82 g (39 mmol) of *4-chlorobenzoyl chloride* (**4c**): 7.0 g (67%). Yellowish crystals. M.p. 168.0–168.2° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.52 (br. *s*, NH); 8.19, 7.65 (*AA′BB′*, *J* = 8.8, 4 arom. H); 7.96, 7.51 (*CC′DD′*, *J* = 8.7, 4 arom. H); 4.74 (*d*, *J* = 6.0, CH$_2$).

4-Fluoro-N-*(4-nitrobenzyl)benzamide* (**6d**). From 6.79 g (36 mmol) of **5a**·**HCl** and 6.18 g (39 mmol) of *4-fluorobenzoyl chloride* (**4d**): 5.4 g (55%). Yellowish crystals. M.p. 171.0–172.0° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.50 (br. *s*, NH); 8.19, 7.64 (*AA′BB′*, *J* = 8.8, 4 arom. H); 8.20–7.90 (*m*, 2 arom. H); 7.30–7.15 (*m*, 2 arom. H); 4.73 (*d*, *J* = 6.0, CH$_2$).

4-Methyl-N-*(4-nitrobenzyl)benzamide* (**6e**). From 6.79 g (36 mmol) of **5a**·**HCl** and 6.03 g (39 mmol) of *4-methylbenzoyl chloride* (**4e**): 8.0 g (82%). Yellowish crystals. M.p. 172.5–173.6° (EtOH). ^{1}H-NMR (CDCl$_3$): 8.17, 7.49 (*AA′,BB′*, *J* = 8.3, 4 arom. H); 7.71, 7.24 (*CC′DD′*, *J* = 8.1, 4 arom. H); 6.71 (br. *s*, NH); 4.72 (*d*, *J* = 6.1, CH$_2$); 2.40 (*s*, Me).

4-Methoxy-N-*(4-nitrobenzyl)benzamide* (**6f**). From 6.79 g (36 mmol) of **5a**·**HCl** and 6.65 g (39 mmol) of *4-methoxybenzoyl chloride* (**4f**): 8.0 g (78%). Yellowish crystals. M.p. 161.7–162.4° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.30 (br. *s*, NH); 8.18, 7.63 (*AA′BB′*, *J* = 6.8, 4 arom. H); 7.93, 6.99 (*CC′DD′*, *J* = 7.0, 4 arom. H); 4.71 (*d*, *J* = 6.1, CH$_2$); 3.85 (*s*, MeO).

4-Cyano-N-*(4-nitrobenzyl)benzamide* (**6g**). From 5.30 g (28 mmol) of **5a**·**HCl** and 5.0 g (30 mmol) of *4-cyanobenzoyl chloride* (**4g**): 4.73 g (60%). Yellowish crystals. M.p. 197.0–198.0° (EtOH). This product has been used for the following reaction without characterization.

*Methyl 4-[*N-*(4-Nitrobenzyl)carbonylamino]benzoate* (**6h**). From 4.15 g (22 mmol) **5a**·**HCl** and 5.0 g (25 mmol) of *methyl 4-(chlorocarbonyl)benzoate* (**4h**): 4.3 g (63%). Yellowish crystals. M.p. 168.0–168.5° (EtOH). ^{1}H-NMR (CDCl$_3$): 8.17, 7.49 (*AA′BB′*, *J* = 8.7, 4 arom. H); 8.08, 7.86 (*CC′DD′*, *J* = 8.4, 4 arom. H); 6.95 (br. *s*, NH); 4.73 (*d*, *J* = 5.9, CH$_2$); 3.93 (*s*, MeO).

N-*Benzyl-4-nitrobenzamide* (**6i**). From 6.42 g (60 mmol) of *benzylamine* (**5b**) and 11.7 g (63 mmol) of *4-nitrobenzoyl chloride* (**4i**): 12.7 g (83%). Yellowish crystals. M.p. 144.0–145.0° (EtOH). ^{1}H-NMR (CDCl$_3$): 8.22, 7.94 (*AA′BB′*, *J* = 8.9, 4 arom. H); 7.50–7.15 (*m*, 5 arom. H); 6.85 (br. *s*, NH); 4.62 (*d*, *J* = 5.7, CH$_2$).

4-Chloro-N-*(4-chlorobenzyl)benzamide* (**6k**). From 5.0 g (36 mmol) of *4-chlorobenzylamine* (**5c**) and 6.83 g (39 mmol) of *4-chlorobenzoyl chloride* (**4c**): 8.4 g (85%). Yellowish crystals. M.p. 172.0–173° (EtOH). ^{1}H-NMR ((D$_6$)acetone): 8.21 (br. *s*, NH); 7.93, 7.49 (*AA′BB′*, *J* = 8.6, 4 arom. H); 7.40–7.20 (*m*, 4 arom. H); 4.58 (*d*, *J* = 6.0, CH_2).

4-Cyano-N-*(4-chlorobenzyl)benzamide* (**6l**). From 2.56 g (18 mmol) of **5c** and 3.0 g (18 mmol) of **4g**: 3.91 g (80%). This product has been used for the following reaction without characterization.

3. *Preparation of Benzimidoyl Isoselenocyanates. General Procedure.* A mixture of an *N*-benzylbenzamide of type **6** and 2–3 equiv. $SOCl_2$ was heated to reflux until the evolution of SO_2 ceased (2–3 h). Excess $SOCl_2$ was evaporated, and the corresponding *N*-benzylbenzimidoyl chloride was dried *in vacuo* for 24 h. This crude material was dissolved in dry acetone, and the soln. was added slowly to a freshly prepared soln. of 1.1 equiv. of KSeCN in dry acetone under stirring. After stirring the mixture at r.t. for 30 min, it was poured onto ice/H_2O, and the product was filtered by suction and air-dried. The crude product was recrystallized from CH_2Cl_2/hexane[6]).

Similar to *N*-phenylbenzimidoyl isoselenocyanates of type **2** [10], these products are relatively stable in solid state at r.t. but decompose slowly in $CDCl_3$ and other organic solvents.

N-*(4-Nitrobenzyl)benzimidoyl Isoselenocyanate* (**3a**). From 5.38 g (21 mmol) of **6a**: 3.7 g (51.2%). Yellowish crystals. M.p. 87.0–88.0° (CH_2Cl_2/hexane)[7]). IR: 3076*w*, 3027*w*, 2921*w*, 2872*w*, 2057*s*, 2017*s*, 1613*s*, 1603*s*, 1577*m*, 1520*s*, 1490*m*, 1448*m*, 1386*w*, 1339*s*, 1309*m*, 1298*m*, 1267*s*, 1206*m*, 1171*m*, 1157*w*, 1109*m*, 1079*m*, 1027*s*. ^{1}H-NMR ($CDCl_3$): 8.22 (*AA′*BB′, *J* = 8.8, 2 arom. H); 8.15–7.55 (*m*, 7 arom. H); 4.98 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 147.1, 145.8, 141.5 (3*s*, 3 arom. C); 138.6 (*s*, NCSe); 132.4 (*s*, CN_2); 132.1, 128.7, 128.3, 127.6, 123.7 (5*d*, 9 arom. C); 55.5 (*t*, CH_2). CI-MS (NH_3): 348 (16), 347 (14), 346 (100, $[M+1]^+$), 345 (7), 344 (47), 343 (16), 342 (16), 298 (5), 266 (24), 256 (9), 241 (5), 239 (8). Anal. calc. for $C_{15}H_{11}N_3O_2Se$ (344.23): C 52.34, H 3.22, N 12.21; found: C 52.63, H 3.39, N 12.15.

4-Bromo-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3b**). From 8.37 g (25 mmol) of **6b**: 5.0 g (47.3%). Yellowish crystals. M.p. 117.0–117.5° (CH_2Cl_2/hexane). IR: 3082*w*, 2849*w*, 2031*s*, 1623*s*, 1597*s*, 1585*s*, 1567*m*, 1511*s*, 1482*s*, 1397*s*, 1346*s*, 1289*m*, 1259*s*, 1195*m*, 1137*s*, 1110*m*, 1069*s*, 1008*s*. ^{1}H-NMR ($CDCl_3$): 8.23, 7.60 (*AA′BB′*, *J* = 8.7, 4 arom. H); 7.85, 7.60 (*CC′DD′*, *J* = 8.7, 4 arom. H); 4.96 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 147.3, 145.7, 140.9, 131.5, 127.1 (4*s*, 4 arom. C, CN_2); 139.5 (*s*, NCSe); 132.1, 129.1, 128.4, 123.9 (4*d*, 8 arom. C); 55.7 (*t*, CH_2). Anal. calc. for $C_{15}H_{10}BrN_3O_2Se$ (423.12): C 42.58, H 2.38, N 9.93; found: C 42.57, H 2.55, N 9.98.

Crystals suitable for X-ray crystal-structure determination were grown from CH_2Cl_2/hexane.

4-Chloro-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3c**). From 6.7 g (23 mmol) of **6c**: 3.3 g (37.8%). Yellowish crystals. M.p. 106.3–107.6° (CH_2Cl_2/hexane). IR: 3107*w*, 3080*w*, 3059*w*, 2924*w*, 2849*w*, 2076*s*, 2022*s*, 1620*s*, 1599*s*, 1593*s*, 1570*m*, 1510*s*, 1487*s*, 1401*m*, 1353*s*, 1291*m*, 1225*m*, 1196*w*, 1173*m*, 1111*m*, 1089*s*, 1071*s*, 1012*s*, 1001*m*. ^{1}H-NMR ($CDCl_3$): 8.23, 7.60 (*AA′BB′*, *J* = 8.7, 4 arom. H); 7.93, 7.44 (*CC′,DD′*, *J* = 8.6, 4 arom. H); 4.98 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 147.2, 145.6, 138.5, 130.9 (4*s*, 4 arom. C); 140.6, 138.8 (2*s*, NCSe, CN_2); 129.0, 128.9, 128.3, 123.7 (4*d*, 8 arom. C); 55.6 (*t*, CH_2). Anal. calc. for $C_{15}H_{10}ClN_3O_2Se$ (378.67): C 47.58, H 2.66, N 11.10, found: C 47.42, H 2.92, N 11.10.

4-Fluoro-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3d**). From 6.16 g (22.5 mmol) of **6d**: 6.0 g (73.7%). Yellowish crystals. M.p. 98.0–99.0° (CH_2Cl_2/hexane). IR: 3108*w*, 3081*w*, 3046*w*, 2849*w*, 2069*s*, 2012*s*, 1625*s*, 1600*s*, 1505*s*, 1410*m*, 1400*m*, 1347*s*, 1320*m*, 1292*s*, 1265*s*, 1231*s*, 1197*m*, 1154*s*, 1111*m*, 1101*m*, 1068*s*, 1010*m*. ^{1}H-NMR ($CDCl_3$): 8.23, 7.60 (*AA′BB′*, *J* = 8.7, 4 arom. H); 8.10–7.90, 7.30–7.15 (2*m*, 4 arom. H); 4.97 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 165.2 (*d*, ^1J(C,F) = 254, 1 arom. C); 147.3, 145.8, 128.8 (3*s*, 3 arom. C); 140.5, 139.2 (2*s*, NCSe, CN_2); 129.8 (*dd*, ^3J(C,F) = 9, 2 arom. C); 128.3, 123.8 (2*d*, 4 arom. C); 115.9 (*dd*, ^2J(C,F) = 22, 2 arom. C); 55.6 (*t*, CH_2). Anal. calc. for $C_{15}H_{10}FN_3O_2Se$ (362.22): C 49.74, H 2.78, N 11.60; found: C 49.74, H 3.05, N 11.54.

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6) To avoid decomposition during recrystallization, the product was dissolved in CH_2Cl_2 at r.t., and then hexane was added. The soln. was concentrated *i.v.* (44°) and then cooled on ice. Within 1 h, yellow crystals were formed. A red oil (decomposed material) remained on the bottom of the flask. In some cases, the red oil was formed on the bottom of the flask as a separate layer before crystallization and was separated from the homogeneous yellow-reddish soln. To avoid decomposition, the temp. during the recrystallization should be kept as low as possible, and the product should be kept in the soln. as shortly as possible.

7) In an analogous experiment, almost pure **3a** was obtained without recrystallization in 99.5% yield (m.p. 85.5–86.5°).

4-Methyl-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3e**). From 7.0 g (26 mmol) of **6e**: 4.0 g (43.1%). Yellowish crystals. M.p. 94.6–95.6° (CH_2Cl_2/hexane). IR: 2928*w*, 2840*w*, 2075*s*, 2036*s*, 1666*w*, 1620*s*, 1600*s*, 1570*m*, 1520*s*, 1510*s*, 1491*m*, 1403*m*, 1394*m*, 1379*w*, 1341*s*, 1290*m*, 1256*m*, 1196*w*, 1184*m*, 1122*w*, 1108*m*, 1066*m*, 1015*w*. ^{1}H-NMR ($CDCl_3$): 8.22, 7.60 (*AA′BB′*, *J* = 8.8, 4 arom. H); 7.87, 7.26 (*CC′DD′*, *J* = 8.3, 4 arom. H); 4.96 (*s*, CH_2); 2.42 (*s*, Me). ^{13}C-NMR ($CDCl_3$): 147.2, 146.1, 142.9, 129.9 (4*s*, 4 arom. C, CN_2); 138.3 (*s*, NCSe); 129.5, 128.4, 127.7, 123.8 (4*d*, 8 arom. C); 55.6 (*t*, CH_2); 21.5 (*q*, Me). Anal. calc. for $C_{16}H_{13}N_3O_2Se$ (358.25): C 53.64, H 3.66, N 11.73; found: C 53.68, H 3.61, N 11.66.

4-Methoxy-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3f**). From 7.4 g (26 mmol) of **6f**: 1.7 g (17.6%). Yellowish crystals. M.p. 93.1–93.3° (CH_2Cl_2/hexane). IR: 3108*w*, 3079*w*, 3002*w*, 2971*w*, 2849*w*, 1999*s*, 1731*w*, 1628*s*, 1606*s*, 1576*s*, 1523*s*, 1509*s*, 1465*m*, 1421*m*, 1342*s*, 1317*m*, 1297*m*, 1253*s*, 1169*s*, 1110*m*, 1057*s*, 1029*s*. ^{1}H-NMR ($CDCl_3$): 8.22, 7.59 (*AA′BB′*, *J* = 8.7, 4 arom. H); 7.93, 6.96 (*CC′DD′*, *J* = 8.9, 4 arom. H); 4.95 (*s*, CH_2); 3.87 (*s*, MeO). ^{13}C-NMR ($CDCl_3$): 162.9, 147.2, 146.3, 141.2 (4*s*, 4 arom. C); 138.5 (*s*, NCSe); 125.1 (*s*, CN_2); 129.5, 128.4, 123.8, 114.2 (4*d*, 8 arom. C); 55.6 (*q*, MeO); 55.5 (*t*, CH_2). Anal. calc. for $C_{16}H_{13}N_3O_3Se$ (374.25): C 51.35, H 3.50, N 11.23; found: C 51.84, H 3.73, N 11.16.

4-Cyano-N-*(4-nitrobenzyl)benzimidoyl Isoselenocyanate* (**3g**). From 4.2 g (15 mmol) of **6g**: 3.23 g (58.6%). Yellowish crystals. M.p. 130.0–131.0° (CH_2Cl_2/hexane). ^{1}H-NMR ($CDCl_3$): 8.24, 7.61 (*AA′BB′*, *J* = 8.8, 4 arom. H); 8.12, 7.77 (*CC′DD′*, *J* = 8.6, 4 arom. H); 5.03 (*s*, CH_2). ^{13}C-NMR: 147.4, 145.3, 140.3, 136.5 (4*s*, 3 arom. C, CN_2); 138.8 (*s*, NCSe); 132.4, 128.3, 128.1, 123.8 (4*d*, 8 arom. C); 117.9 (*s*, CN); 115.6 (*s*, arom. *C*CN); 55.8 (*t*, CH_2).

Methyl 4-{(Isoselenocyanato)[(4-nitrobenzyl)imino]methyl}benzoate (**3h**). From 3.77 g (12 mmol) of **6h**: 1.63 g (33.8%). Yellowish crystals. M.p. 119.0–120.0° (CH_2Cl_2/hexane). ^{1}H-NMR ($CDCl_3$): 8.24, 7.62 (*AA′BB′*, *J* = 8.8, 4 arom. H); 8.13, 8.05 (*CC′DD′*, *J* = 8.7, 4 arom. H); 5.01 (*s*, CH_2); 3.95 (*s*, MeO). ^{13}C-NMR: 166.1 (*s*, *C*OOMe); 147.3, 145.6, 136.3, 133.3 (4*s*, 4 arom. C); 140.9, 138.7 (2*s*, CN_2, NCSe); 129.9, 128.4, 127.7, 123.9 (4*d*, 8 arom. C); 55.9 (*t*, CH_2); 52.5 (*q*, MeO).

N-*Benzyl-4-nitrobenzimidoyl Isoselenocyanate* (**3i**). From 11.52 g (45 mmol) of **6i**: 4.37 g (28.2%). Yellowish crystals. M.p. 74.0–75.0° (CH_2Cl_2/hexane). IR: 3104*w*, 3073*m*, 2894*w*, 2858*w*, 1994*s*, 1522*s*, 1493*m*, 1454*m*, 1408*m*, 1346*s*, 1267*s*, 1105*w*, 1083*m*, 1072*s*, 1028*m*, 1011*m*. ^{1}H-NMR ($CDCl_3$): 8.29, 8.15 (*AA′BB′*, *J* = 8.1, 4 arom. H); 7.51–7.28 (*m*, 5 arom. H); 4.95 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 149.7, 138.4, 137.6 (3*s*, 3 arom. C); 140.8, 138.7 (2*s*, NCSe, CN_2); 128.8, 128.7, 127.9, 127.5, 123.8 (5*d*, 9 arom. C); 57.2 (*t*, CH_2). Anal. calc. for $C_{15}H_{11}N_3O_2Se$ (344.23): C 52.34, H 3.22, N 12.21; found: C 52.30, H 3.48, N 12.10.

4-Chloro-N-*(4-chlorobenzyl)benzimidoyl Isoselenocyanate* (**3k**). From 7.56 g (27 mmol) of **6k**: 4.6 g (46.3%). Yellowish crystals. M.p. 74.0–75.0° (CH_2Cl_2/hexane). IR: 3037*w*, 2926*w*, 2854*w*, 2074*s*, 2038*s*, 1617*s*, 1590*s*, 1568*s*, 1489*s*, 1399*s*, 1346*m*, 1294*m*, 1277*m*, 1252*s*, 1223*m*, 1196*m*, 1176*m*, 1109*w*, 1089*s*, 1071*s*, 1013*s*. ^{1}H-NMR ($CDCl_3$): 7.89, 7.41 (*AA′BB′*, *J* = 8.6, 4 arom. H); 7.40–7.20 (*m*, 4 arom. H); 4.84 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 138.9 (*s*, NCSe); 139.8, 138.3, 136.6, 133.1, 131.2 (5*s*, 4 arom. C, CN_2); 129.0, 128.9, 128.8, 128.7 (4*d*, 8 arom. C); 55.9 (*t*, CH_2). Anal. calc. for $C_{15}H_{10}Cl_2N_2Se$ (368.12): C 48.94, H 2.74, N 7.61; found: C 48.66, H 2.99, N 7.40.

N-*(4-Chlorobenzyl)-4-cyanobenzimidoyl Isoselenocyanate* (**3l**). From 1.95 g (7.2 mmol) of **6l**: 1.1 g (42.6%). Yellow-brownish crystals. M.p. 111.0–112.0°. IR: 3093*w*, 3076*w*, 2924*w*, 2888*w*, 2852*w*, 2023*s*, 1615*s*, 1574*m*, 1563*m*, 1490*s*, 1402*s*, 1342*m*, 1317*m*, 1304*m*, 1294*s*, 1277*m*, 1254*s*, 1194*m*, 1173*s*, 1113*w*, 1077*s*, 1014*s*. ^{1}H-NMR ($CDCl_3$): 8.08, 7.74 (*AA′BB′*, *J* = 8.6, 4 arom. H); 7.42–7.25 (*m*, 4 arom. H); 4.88 (*s*, CH_2). ^{13}C-NMR ($CDCl_3$): 139.7 (*s*, NCSe); 136.6, 136.2, 133.3, 129.4 (4*s*, 3 arom. C, CN_2); 132.5, 129.2, 128.9, 128.2 (4*d*, 8 arom. C); 117.9 (*s*, CN); 115.4 (*s*, arom. *C*CN); 56.2 (*t*, CH_2). Anal. calc. for $C_{16}H_{10}ClN_3Se$ (358.68): C 53.58, H 2.81, N 11.72; found: C 53.79, H 3.01, N 11.42.

4. *Preparation of Selenourea Derivatives.* 4.1. *General Procedure.* To a stirred soln. of isoselenocyanates **3** in acetone, 1.1 equiv. of morpholine was added at r.t. The color of the mixture changed immediately to dark yellow. After 15–30 min, **3** was completely consumed according to TLC, and to the mixture was added slowly cold H_2O until a yellow precipitate was formed. The solid was filtered by suction, air-dried, and the crude product was recrystallized from CH_2Cl_2/hexane.

N′-*[(Morpholin-4-yl)(selenocarbonyl)]*-N-*(4-nitrobenzyl)benzimidamide* (**8a**). From 0.41 g (1.19 mmol) of **3a**: 0.51 mg (99.5%). Yellowish crystals. M.p. 169.0–169.5° (EtOH): ^{1}H-NMR ($CDCl_3$): 8.20 (*AA′*BB′, *J* = 8.7, 2 arom. H); 7.55–7.39 (*m*, 7 arom. H); 4.70 (*d*, *J* = 5.9, ArC*H*$_2$N); 4.28 (*t*-like, *J* ≈ 4.4, CH_2O); 3.80–3.72 (*m*, CH_2O, CH_2N); 3.59–3.57 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[8][9]): 147.3, 145.0, 133.5 (3*s*, 3 arom. C); 131.1,

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[8]) The signal for CSe could not be localized.

[9]) The signal for CN_2 could not be localized.

128.7, 128.0, 127.7, 123.9 (5*d*, 9 arom. C); 66.6, 66.0 (2*t*, 2 CH_2O); 52.5–51.5, 47.5–46.5 (2 br. *t*, 2 CH_2N); 48.0 (*t*, Ar*C*H_2N). CI-MS (NH_3): 433 (6, $[M+1]^+$), 431 (5), 368 (21), 365 (10), 353 (15), 327 (19), 326 (100), 306 (12), 296 (8), 256 (18). Anal. calc. for $C_{19}H_{20}N_4O_3Se$ (431.34): C 52.90, H 4.64, N 12.99; found: C 52.75, H 4.85, N 12.96.

*4-Bromo-*N′*-[(morpholin-4-yl)(selenocarbonyl)]-*N*-(4-nitrobenzyl)benzimidamide* (**8b**). From 0.34 g (0.8 mmol) of **3b**: 0.20 g (48.8%). Yellowish crystals. M.p. 158.0–159.0° (CH_2Cl_2/hexane). IR: 3299*w*, 3077*w*, 2916*w*, 2851*w*, 1605*s*, 1587*s*, 1563*m*, 1478*s*, 1425*m*, 1393*m*, 1347*s*, 1322*m*, 1310*m*, 1285*s*, 1240*m*, 1225*m*, 1198*m*, 1178*m*, 1124*m*, 1109*s*, 1072*m*, 1027*m*, 1007*m*. ^{1}H-NMR ($CDCl_3$): 8.21 (*AA*′BB′, *J* = 8.6, 2 arom. H); 7.60–7.50 (*m*, 4 arom. H); 7.31 (CC′*DD*′, *J* = 8.4, 2 arom. H); 4.68 (*d*, *J* = 6.0, ArCH_2N); 4.28 (*t*-like, *J* ≈ 4.7, CH_2O); 3.90–3.70 (*m*, CH_2O, CH_2N); 3.60–3.58 (*m*, CH_2N). ^{1}H-NMR (600 MHz, (D_6)DMSO)): 8.99 (*t*, *J* = 5.6, NH); 8.21, 7.65 (*AA*′*BB*′, *J* = 8.5, 4 arom. H); 7.67, 7.35 (*CC*′*DD*′, *J* = 8.5, 4 arom. H); 4.64 (*d*, *J* = 5.7, ArCH_2N); 4.05 (*t*-like, *J* ≈ 4.4, CH_2O); 3.59 (*t*-like, *J* ≈ 4.6, CH_2O); 3.52–3.49, 3.49–3.45 (2*m*, 2 CH_2N). ^{13}C-NMR ($CDCl_3$)[9]): 184.6 (*s*, CSe); 147.6, 144.7, 142.3, 133.0 (4*s*, 4 arom. C); 132.2, 129.4, 128.1, 124.1 (4*d*, 8 arom. C); 66.7, 66.2 (2*t*, 2 CH_2O); 53.0–52.0, 48.0–47.0 (2 br. *t*, 2 CH_2N); 48.3 (*t*, Ar*C*H_2N). Anal. calc. for $C_{19}H_{19}BrN_4O_3Se$ (510.24): C 44.72, H 3.75, N 10.98; found: C 44.42, H 4.05, N 10.89.

Crystals suitable for X-ray crystal-structure determination were grown from benzene.

*4-Fluoro-*N′*-[(morpholin-4-yl)(selenocarbonyl)]-*N*-(4-nitrobenzyl)benzimidamide* (**8d**). From 0.25 g (0.69 mmol) of **3d**: 0.20 g (64.5%). Yellowish crystals. M.p. 171.0–172.0° (CH_2Cl_2/hexane). IR: 3408*w*, 3190*s*, 3063*m*, 2903*m*, 2850*m*, 1602*s*, 1585*s*, 1556*s*, 1518*s*, 1504*s*, 1484*s*, 1435*s*, 1346*s*, 1274*s*, 1255*s*, 1224*s*, 1203*s*, 1184*m*, 1154*m*, 1131*m*, 1114*s*, 1064*m*, 1038*m*, 1023*s*. ^{1}H-NMR ($CDCl_3$): 8.20, 7.54 (*AA*′*BB*′, *J* = 8.7, 4 arom. H); 7.50–7.35, 7.30–7.03 (2*m*, 4 arom. H); 4.70 (*d*, *J* = 6.0, ArCH_2NH); 4.28 (*t*-like, *J* ≈ 4.5, CH_2O); 4.10–3.70 (*m*, CH_2O, CH_2N); 3.70–3.50 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[9]): 184.3 (*s*, CSe); 164.1 (*d*, ^1J(C,F) = 253, 1 arom. C); 147.4, 144.8 (2*s*, 3 arom. C); 129.9 (*dd*, ^3J(C,F) = 8.8, 2 arom. C); 128.0, 123.9 (2*d*, 4 arom. C); 115.9 (*dd*, ^2J(C,F) = 22, 2 arom. C); 66.5, 66.0 (2*t*, 2 CH_2O); 51.8, 48.1, 47.4 (3*t*, 2 CH_2N, ArCH_2NH). Anal. calc. for $C_{19}H_{19}FN_4O_3Se$ (449.34): C 50.79, H 4.26, N 12.47; found: C 50.52, H 4.42, N 12.40.

*4-Methyl-*N′*-[(morpholin-4-yl)(selenocarbonyl)]-*N*-(4-nitrobenzyl)benzimidamide* (**8e**). From 0.29 g (0.8 mmol) of **3e**: 0.27 g (75.0%). Yellowish crystals. M.p. 135.0–136.0° (CH_2Cl_2/hexane). IR: 3242*m*, 3074*w*, 2959*m*, 2916*m*, 2850*m*, 1608*s*, 1582*s*, 1549*s*, 1519*s*, 1473*s*, 1430*s*, 1383*m*, 1346*s*, 1321*m*, 1281*s*, 1219*s*, 1203*s*, 1181*m*, 1111*s*, 1063*m*, 1022*s*. ^{1}H-NMR ($CDCl_3$): 8.21, 7.54 (*AA*′*BB*′, *J* = 8.7, 4 arom. H); 7.34, 7.22 (*CC*′*DD*′, *J* = 8.1, 4 arom. H); 4.71 (*d*, *J* = 5.9, ArCH_2NH); 4.40–4.25 (*m*, CH_2O); 4.00–3.69 (*m*, CH_2O, CH_2N); 3.69–3.51 (*m*, CH_2N); 2.38 (*s*, Me). ^{13}C-NMR ($CDCl_3$)[9]): 184.3 (*s*, CSe); 147.5, 145.2, 142.0 (3*s*, 4 arom. C); 129.6, 128.1, 127.8, 124.0 (4*d*, 8 arom. C); 66.7, 66.1 (2*t*, 2 CH_2O); 52.0, 48.1, 47.5 (3*t*, 2 CH_2N, ArCH_2NH); 21.5 (*q*, Me). Anal. calc. for $C_{20}H_{22}N_4O_3Se$ (445.37): C 53.94, H 4.98, N 12.58; found: C 53.84, H 4.94, N 12.34.

*4-Methoxy-*N′*-[(morpholin-4-yl)(selenocarbonyl)]-*N*-(4-nitrobenzyl)benzimidamide* (**8f**). From 0.3 g (0.8 mmol) of **3f**: 0.28 g (75.6%). Yellow-gray crystals. M.p. 164.0–164.5° (CH_2Cl_2/hexane). IR: 3238*m*, 3107*w*, 3073*w*, 2949*m*, 2917*m*, 2850*m*, 2559*w*, 2452*w*, 1604*s*, 1574*s*, 1517*s*, 1472*s*, 1431*s*, 1389*m*, 1347*s*, 1305*s*, 1287*s*, 1255*s*, 1221*s*, 1206*s*, 1178*s*, 1128*s*, 1111*s*, 1065*m*, 1025*s*. ^{1}H-NMR ($CDCl_3$): 8.19, 7.54 (*AA*′*BB*′, *J* = 8.7, 4 arom. H); 7.41, 6.91 (*CC*′*DD*′, *J* = 8.8, 4 arom. H); 4.72 (*d*, *J* = 6.0, ArCH_2NH); 4.29 (*t*-like, *J* ≈ 4.2, CH_2O); 3.83 (*s*, MeO); 3.85–3.65 (*m*, CH_2O, CH_2N); 3.55–3.50 (*m*, CH_2N). ^{1}H-NMR (600 MHz, (D_6)DMSO)): 8.85 (*t*, *J* = 5.4, NH); 8.21, 7.65 (*AA*′*BB*′, *J* = 8.8, 4 arom. H); 7.40, 7.00 (*CC*′*DD*′, *J* = 8.8, 4 arom. H); 4.64 (*d*, *J* = 5.9, ArCH_2N); 4.13–4.02 (*m*, CH_2O); 3.81 (*s*, MeO); 3.62–3.55 (*m*, CH_2O); 3.50–3.45, 3.45–3.40 (2*m*, 2 CH_2N). ^{13}C-NMR ($CDCl_3$)[9]): 184.3 (*s*, CSe); 162.1, 147.1, 145.3 (3*s*, 4 arom. C); 129.7, 128.2, 124.0, 114.3 (4*d*, 8 arom. C); 66.7, 66.2 (2*t*, 2 CH_2O); 55.4 (*q*, MeO); 51.8, 48.1, 47.5 (3*t*, 2 CH_2N, ArCH_2NH). Anal. calc. for $C_{20}H_{22}N_4O_4Se$ (461.37): C 52.07, H 4.81, N 12.14; found: C 52.24, H 5.07, N 11.86.

*4-Cyano-*N′*-[(morpholin-4-yl)(selenocarbonyl)]-*N*-(4-nitrobenzyl)benzimidamide* (**8g**). From 0.30 g (0.8 mmol) of **3g**: 0.19 g (51.4%). Yellowish crystals. M.p. 127.0–127.3° (CH_2Cl_2/hexane). ^{1}H-NMR ($CDCl_3$): 8.21, 7.52 (*AA*′*BB*′, *J* = 8.7, 4 arom. H); 7.70, 7.52 (*CC*′*DD*′, *J* = 8.4, 4 arom. H); 4.65–4.45 (*m*, ArCH_2NH); 4.40–4.25 (*m*, CH_2O); 4.00–3.69 (*m*, CH_2O, CH_2N); 3.71–3.53 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[9]): 184.3 (*s*, CSe); 147.6, 144.2, 114.6 (3*s*, 3 arom. C); 132.6, 128.6, 128.1, 124.2 (4*d*, 8 arom. C); 117.9 (*s*, CN); 114.6 (*s*, arom. *C*CN); 66.5, 66.0 (2*t*, 2 CH_2O); 53.2, 48.3, 47.1 (3*t*, 2 CH_2N, ArCH_2NH).

Methyl 4-[[(Morpholin-4-yl)(selenocarbonyl)amino][(4-nitrobenzyl)amino]methyl]benzoate (**8h**). From 0.25 g (0.62 mmol) of **3h**: 0.27 g (90.0%). Yellowish crystals. M.p. 180.0–181.0° (CH_2Cl_2/hexane). ^{1}H-NMR ($CDCl_3$): 8.20, 7.54 (*AA*′*BB*′, *J* = 8.8, 4 arom. H); 8.06, 7.50 (*CC*′*DD*′, *J* = 8.5, 4 arom. H); 5.30 (*s*, ArCH_2N); 4.70–4.60 (*m*, CH_2O); 3.91 (*s*, MeO); 3.90–3.75 (*m*, CH_2O, CH_2N); 3.60–3.50 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[8])[9]): 166.1 (*s*, *C*OOMe); 147.5, 144.8, 139.0, 132.3 (4*d*, 4 arom. C); 129.9, 128.1, 127.9, 124.1 (4*d*, 4 arom. C); 66.5, 66.0 (2*t*, 2 CH_2O); 52.3 (*q*, MeO); 51.8, 48.1, 47.5 (3*t*, 2 CH_2N, ArCH_2NH).

N-*Benzyl*-N′-*[(morpholin-4-yl)(selenocarbonyl)]-4-nitrobenzimidamide* (**8i**). From 0.30 g (0.87 mmol) of **3i**: 0.20 g (53.2%). Orange-reddish crystals. M.p. 165.0–166.0° (CH_2Cl_2/hexane): IR: 3445*s*, 3053*w*, 2963*m*, 2925*m*, 2896*m*, 2850*m*, 1625*s*, 1591*s*, 1543*s*, 1514*s*, 1495*m*, 1459*s*, 1424*s*, 1384*m*, 1366*m*, 1341*s*, 1310*s*, 1297*s*, 1279*s*, 1238*m*, 1219*s*, 1209*s*, 1111*s*, 1077*m*, 1063*m*, 1017*s*. ^{1}H-NMR ($CDCl_3$): 8.25, 7.60 (*AA′BB′*, *J* = 8.8, 4 arom. H); 7.45–7.20 (*m*, 5 arom. H); 4.70–4.50 (*m*, ArC*H*$_2$NH); 4.38–4.25 (*m*, CH_2O); 4.00–3.75 (*m*, CH_2O, CH_2N); 3.73–3.59 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[8][9]): 148.9, 136.8 (2*s*, 3 arom. C); 129.0, 128.9, 128.0, 127.4, 123.9 (5*d*, 9 arom. C); 66.7, 66.2 (2*t*, 2 CH_2O); 51.8, 48.3, 47.6 (3*t*, 2 CH_2N, Ar*C*H$_2$N). Anal. calc. for $C_{19}H_{20}N_4O_3Se$ (431.35): C 52.90, H 4.67, N 12.99; found: C 52.74, H 4.89, N 12.92.

4-Chloro-N-*(4-chlorobenzyl)*-N′-*[(morpholin-4-yl)(selenocarbonyl)]benzimidamide* (**8k**). From 0.22 g (0.59 mmol) of **3k**: 0.15 g (55.5%). Yellowish crystals. M.p. 173.0–173.5° (CH_2Cl_2/hexane). IR: 3383*w*, 3238*m*, 3051*w*, 2990*w*, 2958*m*, 2915*w*, 2852*m*, 1593*s*, 1567*m*, 1529*s*, 1488*s*, 1472*s*, 1426*s*, 1362*m*, 1335*m*, 1309*m*, 1291*s*, 1279*s*, 1237*m*, 1223*s*, 1207*s*, 1178*m*, 1123*m*, 1112*s*, 1093*s*, 1066*m*, 1024*s*, 1011*s*. ^{1}H-NMR ($CDCl_3$): 7.50–7.15 (*m*, 8 arom. H); 4.65–4.45 (*m*, ArC*H*$_2$NH); 4.35–4.15 (*m*, CH_2O); 3.90–3.65 (*m*, CH_2O, CH_2N); 3.65–3.50 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[8][9]): 137.2, 135.8, 133.6, 132.5 (4*s*, 4 arom. C); 129.3, 129.0, 128.8 (3*d*, 8 arom. C); 66.7, 66.1 (2*t*, 2 CH_2O); 51.8, 48.1, 46.9 (3*t*, 2 CH_2N, Ar*C*H$_2$NH). Anal. calc. for $C_{19}H_{19}Cl_2N_3OSe$ (455.24): C 50.13, H 4.21, N 9.23; found: C 49.96, H 4.50, N 9.13.

N-*(4-Chlorobenzyl)-4-cyano*-N′-*[(morpholin-4-yl)(selenocarbonyl)]benzimidamide* (**8l**). From 0.30 g (0.83 mmol) of **3l**: 0.30 g (81.0%). Yellowish crystals. M.p. 161.0–162.0°. IR: 3384*s*, 3044*w*, 2964*w*, 2926*w*, 2899*m*, 2857*m*, 2237*s*, 1632*m*, 1605*s*, 1522*s*, 1491*s*, 1464*s*, 1426*s*, 1357*m*, 1302*s*, 1290*s*, 1275*s*, 1222*s*, 1206*m*, 1112*s*, 1064*m*, 1019*s*. ^{1}H-NMR ($CDCl_3$): 7.69, 7.53 (*AA′BB′*, *J* = 8.4, 4 arom. H); 7.45–7.18 (*m*, 4 arom. H); 4.65–4.45 (*m*, ArC*H*$_2$NH); 4.38–4.22 (*m*, CH_2O); 3.92–3.69 (*m*, CH_2O, CH_2N); 3.71–3.53 (*m*, CH_2N). ^{13}C-NMR ($CDCl_3$)[9]): 184.3 (*s*, CSe); 135.4, 133.9 (2*s*, 3 arom. C); 132.5, 129.2, 128.8, 128.6 (4*d*, 8 arom. C); 117.9 (*s*, CN); 114.5 (*s*, arom. *C*CN); 66.7, 66.2 (2*t*, 2 CH_2O); 53.2, 48.3, 47.1 (3*t*, 2 CH_2N, Ar*C*H$_2$NH). Anal. calc. for $C_{20}H_{19}ClN_4OSe$ (445.80): C 53.88, H 4.30, N 12.57; found: C 53.64, H 4.26, N 12.31.

5. *Preparation of Bis(imidazol-5-yl) Diselenides.* 5.1. *General Procedure.* Into a soln. of benzimidoyl isoselenocyanates **3** in dry acetone, 1.1 equiv. Et_3N diluted in acetone was dropped under stirring at r.t. A transient violet color was observed during the addition of Et_3N, and, after 20 min, a precipitate was formed. The mixture was further stirred for 2 h, then ice/H_2O was added slowly until a yellow precipitate was formed[10]), which was filtered by suction and recrystallized from EtOH.

Bis[4-(4-nitrophenyl)-2-phenylimidazol-5-yl] Diselenide (**9a**). From 3.44 g (10 mmol) of **3a**: 2.0 g (58.3%). Orange crystals. M.p. 175.0–178.0° (EtOH)[11]). IR: 3301*m*, 3065*w*, 1597*s*, 1540*w*, 1509*s*, 1483*s*, 1457*m*, 1413*w*, 1368*w*, 1335*s*, 1209*w*, 1180*w*, 1134*w*, 1158*w*, 1109*s*, 1028*w*. ^{1}H-NMR ((D_7)DMF): 13.25 (*s*, 2 NH); 8.17 (*AA′BB′*, *J* = 7.7, 4 arom. H); 8.25–7.40 (*m*, 14 arom. H). ^{13}C-NMR ((D_7)DMF): 150.7, 146.8, 145.7 (3*s*, 6 arom. C); 140.1, 130.1, 112.4 (3*s*, 6 C of 2 imidazoles); 129.9, 129.3, 127.9, 126.2, 123.7 (5*d*, 18 arom. C). Anal. calc. for $C_{30}H_{20}N_6O_4Se_2$ (686.44): C 52.49, H 2.94, N 12.24; found: C 52.55, H 2.94, N 12.07.

Bis[2-(4-bromophenyl)-4-(4-nitrophenyl)imidazol-5-yl] Diselenide (**9b**). From 3.67 g (8.67 mmol) of **3b**: 1.35 g (36.9%). Orange crystals. M.p. 253.0–254.0° (EtOH). IR: 3313*m*, 1596*s*, 1506*s*, 1479*s*, 1433*m*, 1379*w*, 1335*s*, 1208*m*, 1182*w*, 1139*w*, 1108*m*, 1069*m*, 1046*w*, 1008*m*. ^{1}H-NMR ((D_7)DMF): 13.28 (*s*, 2 NH); 8.14, 8.00 (*AA′BB′*, *J* = 8.9, 8 arom. H); 7.92, 7.65 (*CC′DD′*, *J* = 8.6, 8 arom. H). ^{13}C-NMR ((D_7)DMF): 149.0, 146.2, 145.4, 122.9 (4*s*, 8 arom. C); 140.1, 128.7, 112.4 (3*s*, 6 C of 2 imidazoles); 131.9, 127.5, 127.3, 123.2 (4*d*, 16 arom. C). Anal. calc. for $C_{30}H_{18}Br_2N_6O_4Se_2$ (844.23): C 42.68, H 2.15, N 9.95; found: C 42.55, H 2.31, N 9.97.

Crystals suitable for X-ray crystal-structure determination were grown from DMF.

Bis[2-(4-chlorophenyl)-4-(nitrophenyl)imidazol-5-yl] Diselenide (**9c**). From 2.80 g (7.39 mmol) of (**3c**): 1.00 g (35.8%). Orange crystals. M.p. 278.3–279.0° (EtOH). IR: 3372*s*, 3318*m*, 3068*w*, 2924*w*, 2437*w*, 1690*w*, 1596*s*, 1508*s*, 1481*s*, 1431*s*, 1380*s*, 1331*s*, 1271*m*, 1199*m*, 1133*m*, 1109*m*, 1087*m*, 1014*m*. ^{1}H-NMR ((D_7)DMF): 13.29 (*s*, 2 NH); 8.14 (*AA′*BB′, *J* = 8.9, 4 arom. H); 8.03–7.91 (*m*, 8 arom. H); 7.51 (*CC′DD′*, *J* = 8.6, 4 arom. H). ^{13}C-NMR ((D_7)DMF): 149.6, 146.8, 145.8, 135.1 (4*s*, 8 arom. C); 140.7, 128.9, 112.7 (3*s*, 6 C of 2 imidazoles); 129.5, 127.9, 127.8, 123.7 (4*d*, 16 arom. C). Anal. calc. for $C_{30}H_{18}Cl_2N_6O_4Se_2$ (755.33): C 47.70, H 2.40, N 11.13, found: C 47.47, H 2.67, N 11.08.

Bis[2-(4-fluorophenyl)-4-(4-nitrophenyl)imidazol-5-yl] Diselenide (**9d**). From 2.54 g (7.0 mmol) of **3d**: 0.95 g (37.5%). Orange crystals. M.p. 321.0–322.0° (EtOH). IR: 3369*m*, 3090*w*, 2921*w*, 1595*s*, 1508*s*, 1493*s*,

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[10]) If too much H_2O was added, the formation of an emulsion was observed.

[11]) In an analogous experiment, almost pure **9a** was obtained without recrystallization in 94.0% yield (m.p. 176–177°).

1440*w*, 1333*s*, 1270*w*, 1228*m*, 1159*m*, 1132*w*, 1108*m*, 1014*w*. ^{1}H-NMR ((D$_7$)DMF): 13.19 (*s*, 2 NH); 8.50–8.27 (*m*, 4 arom. H); 8.27–7.98 (*m*, 8 arom. H); 7.55–7.30 (*m*, 4 arom. H). ^{13}C-NMR ((D$_7$)DMF): 164.9 (*s*, 2 arom. CF)[12]); 149.0, 146.1, 145.8 (3*s*, 6 arom. C); 140.0, 126.1, 113.0 (3*s*, 6 C of 2 imidazoles); 127.9 (*dd*, ^3J(C,F) = 8.5, 4 arom. C); 127.3, 123.1 (2*d*, 8 arom. C); 115.7 (*dd*, ^2J(C,F) = 22, 4 arom. C). Anal. calc. for $C_{30}H_{18}F_2N_6O_4Se_2$ (722.42): C 49.88, H 2.51, N 11.63; found: C 49.58, H 2.85, N 11.56.

Bis[2-(4-cyanophenyl)-4-(4-nitrophenyl)imidazol-5-yl] Diselenide (**9g**). From 0.68 g (1.84 mmol) of **3g**: 0.32 g (47.0%). Yellowish crystals. M.p. 331.0–332.0° (EtOH). ^{1}H-NMR ((D$_7$)DMF): 13.50 (*s*, 2 NH); 8.13 (*AA′*BB′, *J* = 8.4, 4 arom. H); 8.00–7.80 (*m*, 12 arom. H). ^{13}C-NMR ((D$_7$)DMF): 149.6, 146.1, 145.8, 133.0 (4*s*, 8 arom. C); 140.7, 126.0, 111.7 (3*s*, 6 C of 2 imidazoles); 132.7, 127.2, 125.9, 123.0 (4*d*, 16 arom. C); 118.7 (*s*, CN).

6. *X-Ray Crystal-Structure Determination of* **3b**, **8b**, **9b**, *and* **9a** (see *Table 2* and *Figs. 1–3*)[13]). All measurements were performed at low temp. with graphite-monochromated MoK_α radiation (λ 0.71073 Å)

Table 2. *Crystallographic Data for Compounds* **3b**, **8b**, **9b**, *and* **9a**

	3b	**8b**	**9b**	**9a**
Crystallized from	CH_2Cl_2/hexane	benzene	DMF	AcOEt
Empirical formula	$C_{15}H_{10}BrN_3O_2Se$	$C_{19}H_{19}BrN_4O_3Se \cdot 0.5(C_6H_6)$	$C_{30}H_{18}Br_2N_6O_4Se_2 \cdot 2(C_3H_7NO)$	$C_{30}H_{20}N_6O_4Se_2 \cdot 2(C_4H_8O_2)$
Formula weight [g mol^{-1}]	423.07	549.24	990.30	862.53
Crystal color, habit	yellow, prism	pale-brown, prism	orange, plate	red-orange, prism
Crystal dimensions [mm]	0.15 × 0.20 × 0.25	0.10 × 0.12 × 0.30	0.10 × 0.25 × 0.35	0.30 × 0.32 × 0.42
Temp. [K]	160(1)	160(1)	160(1)	173(1)
Crystal system	triclinic	monoclinic	monoclinic	monoclinic
Space group	$P\bar{1}$	$P2_1/c$	$C2/c$	$P2_1/c$
Z	2	4	4	4
Reflections for cell determination	30577	83610	53372	25
2θ Range for cell determination [°]	2–55	4–60	4–60	37–40
Unit-cell parameters a [Å]	5.0146(1)	5.5560(1)	12.2454(2)	14.701(3)
b [Å]	8.6157(2)	13.9170(2)	18.3502(3)	19.378(4)
c [Å]	18.4948(5)	28.6773(3)	17.6110(3)	15.012(4)
α [°]	79.676(1)	90	90	90
β [°]	87.109(1)	90.7483(5)	101.8708(6)	117.54(1)
γ [°]	78.978(1)	90	90	90
V [Å^3]	771.51(3)	2217.22(6)	3872.7(1)	3792(1)
D_x [g cm^{-3}]	1.821	1.645	1.698	1.511
μ(MoK_α) [mm^{-1}]	5.039	3.532	4.034	2.009
Scan type	ϕ and ω	ω	ϕ and ω	$\omega/2\theta$
$2\theta_{(max)}$ [°]	55	60	60	50
Total reflections measured	15804	51430	46292	7187
Symmetry-independent reflections	3516	6339	5637	6879
Reflections used [$I > 2\sigma(I)$]	2823	4553	4422	3352
Parameters refined	200	284	199	495
Final R	0.0373	0.0524	0.0460	0.0501
wR	0.0366	0.0522	0.0466	0.0367
Weights: p in $w = [\sigma^2(F_o) + (pF_o)^2]^{-1}$	0.008	0.01	0.01	0.005
Goodness-of-fit	1.942	2.232	2.280	1.494
Secondary extinction coefficient	$7(2) \times 10^{-7}$	–	–	–
Final Δ_{max}/σ	0.0008	0.001	0.0006	0.002
$\Delta\rho$ (max; min) [e Å^{-3}]	0.43; −0.45	1.87; −1.10	1.30; −1.22	0.54; −0.59

[12]) This is the left part of the *d*, the right part overlaps with *t* of (D$_7$)DMF.

[13]) Crystallographic data (excluding structure factors) for the structures of **3b**, **8b**, **9b**, and **9a** have been deposited with the *Cambridge Crystallographic Data Centre* as supplementary publications No. CCDC-173505–173508. Copies of the data can be obtained, free of charge, on application to the CCDC, 12 Union Road, Cambridge CB2 1EZ, UK (fax: +44-(0)1223-336033; e-mail: deposit@ccdc.cam.ac.uk).

either on a *Nonius KappaCCD* diffractometer fitted with an *Oxford Cryosystems Cryostream 700* cooler (**3b**, **8b**, and **9b**) or on a *Rigaku AFC5R* diffractometer mounted on a 12-KW rotating-anode generator (**9a**). The data collection and refinement parameters are given in *Table 2*, and views of the molecules are shown in *Figs. 1–3*. In the cases of **3b**, **8b**, and **9b**, data reduction was performed with *HKL Denzo* and *Scalepack* [48]. The intensities were corrected for *Lorentz* and polarization effects, and a numerical absorption correction [49] was applied in the cases of **3b**, **8b**, and **9b**, whereas in the case of **9a**, an empirical absorption correction based on Ψ scans was applied [50]. The structures were solved by direct methods with SIR92 [51], which revealed the positions of all non-H-atoms. The non-H-atoms were refined anisotropically. The amine H-atoms of **8b** and **9a** were placed in the positions indicated by a difference-electron-density map and their positions were allowed to refine together with isotropic displacement parameters. All other H-atoms in each structure were fixed in geometrically calculated positions ($d(C-H) = 0.95$ Å) and each was assigned a fixed isotropic displacement parameter with a value equal to 1.2 U_{eq} of its parent atom. In the case of **8b**, the asymmetric unit also contains one half of a benzene molecule, which sits across a center of inversion. The asymmetric unit of **9b** contains one half of the organoselenium molecule plus one highly disordered DMF molecule. As it was difficult to model the disordered DMF molecule adequately, the SQUEEZE [52] function of the program PLATON [53] was used to remove the contribution of the solvent from the reflection intensity data, and the subsequent solvent free model could be refined successfully. The asymmetric unit of **9a** contains one diselenide molecule and two molecules of AcOEt. Refinement of each structure was carried out on F using full-matrix least-squares procedures, which minimised the function $\Sigma w(|F_o| - |F_c|)^2$. A correction for secondary extinction was applied in the case of **3b**. Neutral-atom-scattering factors for non-H-atoms were taken from [54a] and the scattering factors for H-atoms from [55]. Anomalous dispersion effects were included in F_c [56]; the values for f' and f'' were those of [54b], and the values of the mass attenuation coefficients are those of [54c]. All calculations were performed using the teXsan [57] crystallographic software package.

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