87. Syntheses of Segmental Heteroleptic Ligands for the Self-Assembly of Heteronuclear Helical Supramolecular Complexes

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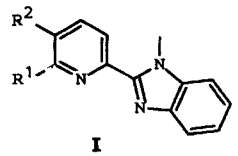
The development of a modified *Phillips* reaction allows the synthesis of complicated heteroleptic ligands based on pyridine and 1*H*-benzimidazole moieties. The key-step formation of aromatic 1*H*-benzimidazole rings from *N*-(2-nitroaryl)arenecarboxamides significantly improves the possibilities of the classical intermolecular *Phillips* reactions and can be applied to the synthesis of large oligo-multidentate units. Segmental heteroleptic ligands containing two different bidentate coordinating units (see **14**) or bidentate and terdentate sites connected by 'diphenylmethane' (= methylenebis(phenylene)) spacers (see **15** and **16**) were obtained in fair to good yield by using multistep syntheses following this strategy. Heterotrileptic ligands (bidentate-terdentate-bidentate, see **19** and **20**; terdentate-terdentate-terdentate, see **23**) requiring the simultaneous formation of four 1*H*-benzimidazole rings in one step were prepared and demonstrate the extended possibilities of this methodology. Data are presented to show that the milder conditions used for this modified *Phillips* reaction together with its flexibility are essential for the development of ligands adapted for the self-assembly of heteronuclear helical complexes.

Introduction. – The spontaneous and selective assembly of polynuclear helical structures from tailored ligands and metal ions is a theme of current interest in supramolecular chemistry [1–4]. Among the various paramaters which control the self-assembly process, the structural informations encoded in the ligands were soon recognized as essential for the formation of the helical complexes [4–6]. In particular, the ligands should possess well-defined binding sites separated by spacers which arrange them in such a way as to favor the formation of the final polynuclear assembled complexes [4] [5]. Many such oligo-multidentate systems based on 2,2′-bipyridine [7] [8], 1,10-phenanthroline [8] [9], 2,2′:6′,2″-terpyridine [10] [11] and analogous bidentate [4] and terdentate units [12] were recently developed. In all cases, only identical coordinating units were introduced in the ligands leading to the formation of homoleptic linear systems designed for the formation of helical *homopolynuclear* complexes. However, the recent development of molecular and supramolecular devices (light conversion [13], energy transfer [14], electron transfer [15], *etc.* ...) implies the use of *heteropolynuclear* architectures based on ligands possessing different binding units [16]. The use of helical complexes for this purpose [12] requires the synthesis of new segmental heteroleptic ligands containing various bidentate and terdentate coordination sites along the strand, and this represents a major goal of research in this domain. Very recently, *Constable* and coworkers [17] used quinquepyridine as a potential bidentate-terdentate unit, but the lack of spacer between the pyridine rings

allows some ambiguity concerning its binding mode as illustrated by the various coordination possibilities of the higher oligopyridines sexipyridine (bis-terdentate or tris-bidentate [18]) and septipyridine [3]. The introduction of suitable spacers [4] [12] [19] between the different units removes this ambiguity, and we describe in this paper a new strategy for the synthesis of segmental heteroleptic ligands containing various bidentate and terdentate coordinating units based on pyridine and 1*H*-benzimidazole moieties.

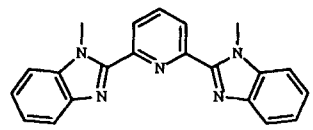
Results and Discussions. – *Target Molecules and Synthetic Strategy.* The substituted bidentate 2-(pyridin-2-yl)-1*H*-benzimidazole units **I** [4] [20] and terdentate 2,2′-(pyridin-2,6-diyl)bis[1*H*-benzoimidazole] unit **II** [12] were previously connected by a methylene group, thus creating a 'diphenylmethane' (= methylenebis(phenylene)) spacer between the coordinating units, to give the homodileptic ligands **III** and **IV** which led to the self-assembly of dinuclear double [4], triple-helical [4] [12] [20], and trinuclear toroidal [21] complexes.

Heteroleptic ligands based on the introduction of both building blocks **I** and **II** separated by methylene groups (→'diphenylmethane' spacers) in the same linear ligand would offer new possibilities for the synthesis of heterodi- and heterotrinuclear

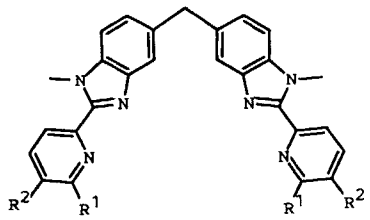


I

$R^1 = Me, R^2 = H$
$R^1 = H, R^2 = Me$



II



III

$R^1 = Me, R^2 = H$
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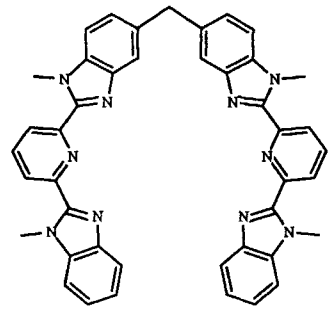
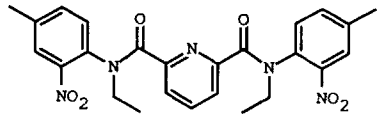
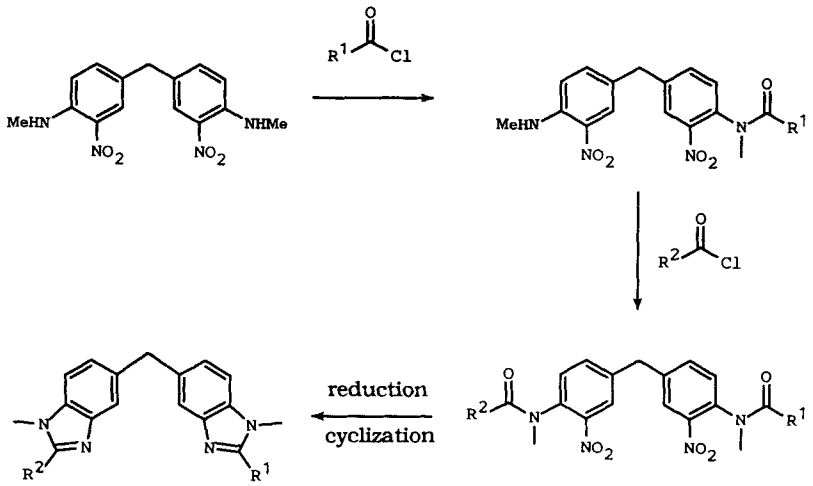


IV



V

Scheme 1. *Strategy for the Synthesis of Segmental Heteroleptic Ligands*

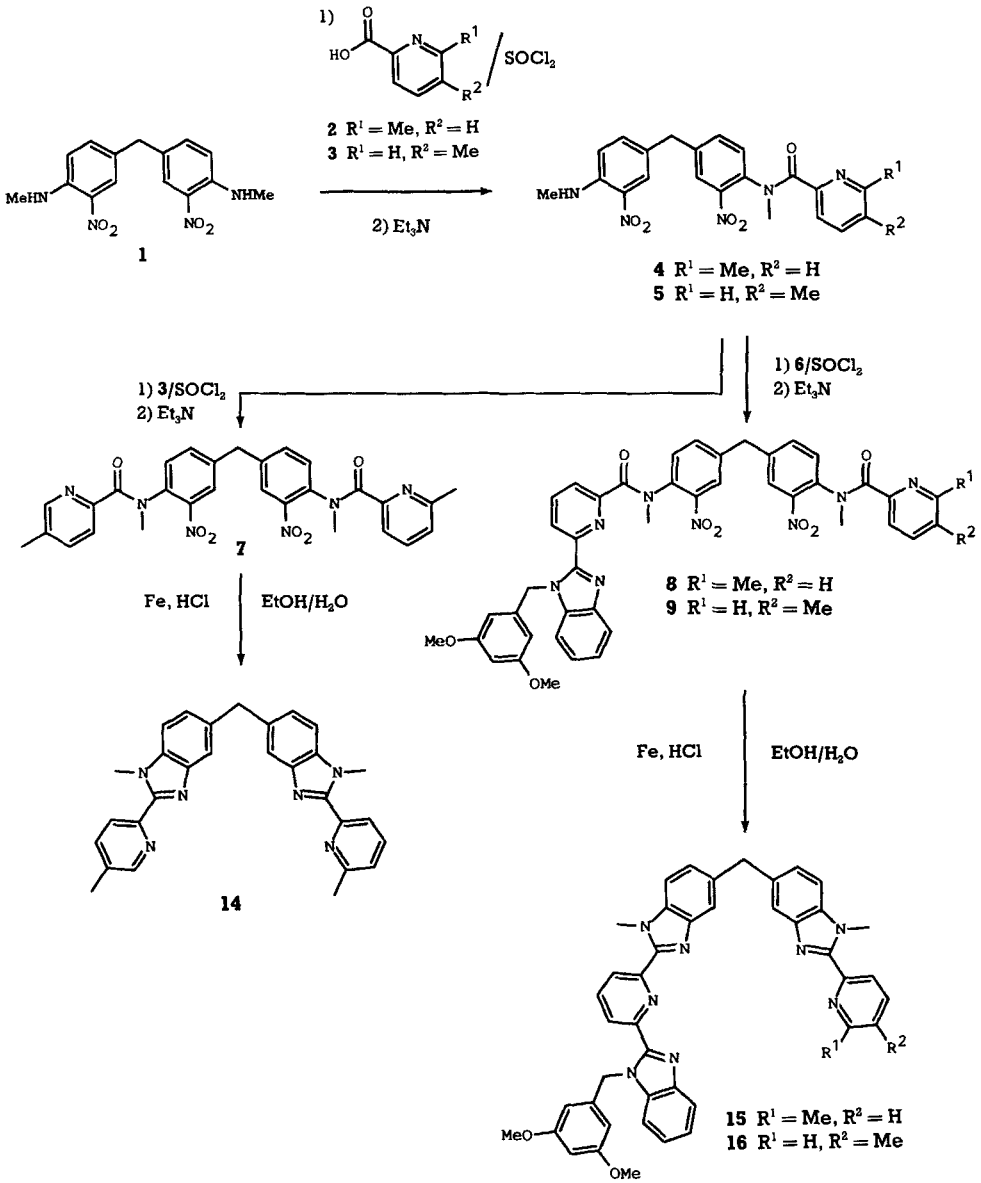


supramolecular complexes and are thus our target molecules. According to *Scheme 1*, our synthetic strategy uses a *Phillips*-type reaction [22] as a key step for the synthesis of aromatic benzimidazole rings from arene-1,2-diamines or their precursors and carboxylic acids. However, the selective introduction of different groups R^1 and R^2 requires their successive binding before the cyclization step which is not compatible with the harsh conditions used for the intermolecular *Phillips* reaction [22]. A modified version was thus developed using *N*-(2-nitroaryl)arenecarboxamides as precursors [23] which can be reduced and cyclized in one step according to the following synthetic strategy: *i*) Connection of the different coordinating units R^1 and R^2 by succesive acylations of the substituted 'diphenylmethane' spacer **1**; *ii*) reduction of the NO_2 groups and formation of the benzimidazole rings during the key step.

Heterodileptic Ligands. The three possible heterodileptic ligands **14**–**16** based on the various combinations of the building blocks **I** and **II** are synthesized using our new strategy (*Scheme 2*). Thus, 4,4′-methylene-2,2′-dinitrobis[benzamine] **1** is converted into the nonsymmetrical *N*-(2-nitroaryl)pyridine-2-carboxamides **4** and **5** by monoacylation using the 6- or 5-methylpyridine-2-carbonyl chloride obtained from the parent carboxylic acids **2** and **3**, respectively, using the method of *Bosshard et al.* [24]. Dropwise addition of the acyl chlorides is crucial for minimizing the formation of the unwanted symmetrical *N*,*N*′-[methylene(2-nitrophen-4,1-ylene)]bis[pyridine-2-carboxamides]. A second successive acylation of **4** or **5** with the acyl chlorides derived from **3** or **6** (see *Scheme 3*) leads to the formation of the nonsymmetrical *N*,*N*′-[methylene(2-nitrophen-4,1-ylene)]bis-[pyridine-2-carboxamides] **7**–**9**.

During the synthesis of **8** and **9**, particular attention should be paid to the conversion of the carboxylic acid **6** into its acyl chloride because 3,5-dimethoxybenzoyl groups (used further as diastereotopic ^{1}H-NMR [25] and fragmentation [21] probes) are very sensitive to traces of sulfuryl chloride [26]. Acid **6** is obtained in four steps from 6-(1*H*-benzimidazol-1-yl)pyridine-6-carboxylic acid [12] (**10**) according to a classical protection-alkyla-

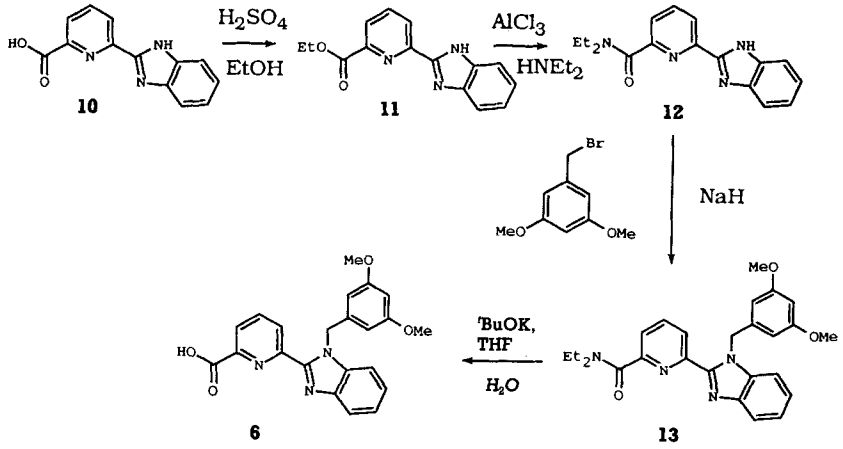
Scheme 2. *Synthesis of Heterodileptic Ligands*



tion-deprotection scheme (*Scheme 3*). Esterification of **10** (→ **11**) and transamidation [27] yield the protected *N,N*-diethylamide **12**. Subsequent *N*-alkylation [25] (→ **13**) followed by selective hydrolysis [28] gives **6** in fair yield (57% from **10**).

Characterization of the nonsymmetrical bis[pyridinecarboxamides] **7**–**9** is rather difficult since ^{1}H- and ^{13}C-NMR measurements show only very complicated spectra as a result of the hindered rotations around the various OC–N amide bonds [29]. Variable-tempera-

Scheme 3

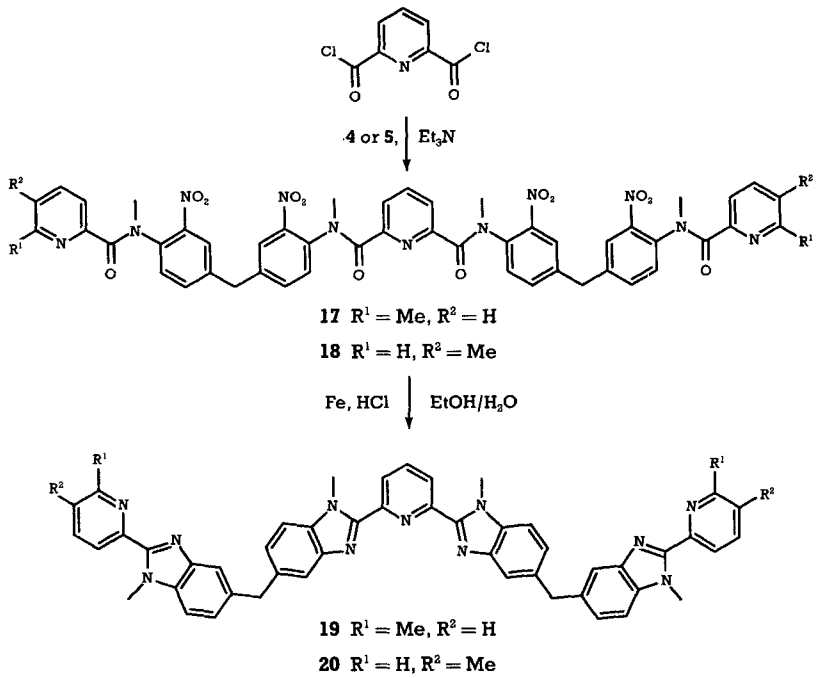


ture ^{1}H-NMR measurements in $CDCl_3$ (−20→60°) do not significantly simplify the spectra, and a detailed analysis of the symmetrical bis[pyridinecarboxamide] **V** shows that a minimum of four chiral blocked conformations are found at room temperature which strongly suggest that hindered rotations are not limited to OC−N amide bonds but also occur for N−C(aryl) bonds [30] due to the presence of *o*-NO_2 substituents. As a result of their low thermal stability (decomposition between 70 and 130°), EI-MS spectra are often difficult to explain in detail, and the molecular peaks, when observed, are always of very low intensity. However, the soft-ionization electrospray (ES) MS technique [21] [31] (from MeCN +0.1% HCOOH solutions) produces very simple and clear spectra dominated by the $[M + H]^+$ and $[M + 2H]^{2+}$ ions and appears to be the method of choice for the characterization of these compounds.

In-situ reduction of the NO_2 groups with metallic Fe under weakly acidic conditions followed by cyclization under mild conditions (0.2M HCl) converts **7**–**9** into the target ligands **14** (95%), **15** (83%), and **16**·H_2O (66%) in fair-to-good yield. As previously reported, the presence of H_2O as a co-solvent is critical [22] [23], but in our case, the concentration of HCl also strongly influences the reaction, and significantly lower yields are obtained with either smaller or larger amounts of HCl. Compared to the classical intermolecular *Phillips* reaction, the intramolecular modification described here shows many advantages: *i*) milder conditions compatible with various substituents bound to the aromatic rings, *ii*) no isolation of the air-sensitive polyamine [4] [12], *iii*) better control of the regio- and stereoselectivity, and *iv*) small-scale synthesis (crucial for multisteps strategy). The major limitation is the rather tedious preparation and characterization of the nonsymmetrical *N*,*N*′-[methylene(2-nitrophen-4,1-ylene)]bis[pyridine-2-carboxamide] intermediates.

Heterotrileptic Ligands. Extension of our synthetic strategy using pyridine-2,6-dicarbonyl dichloride as acylating reagent and **4**, **5**, or **21** allows the preparation, *via* **17**, **18**, and **22**, respectively, of ligands **19**, **20**, and **23**, respectively, containing three different sites separated by two 'diphenylmethane' spacers (*Schemes 4* and *5*), *i.e.* of heterotrileptic

Scheme 4. *Synthesis of Heterotrileptic Ligands* (bidentate-terdentate-bidentate)

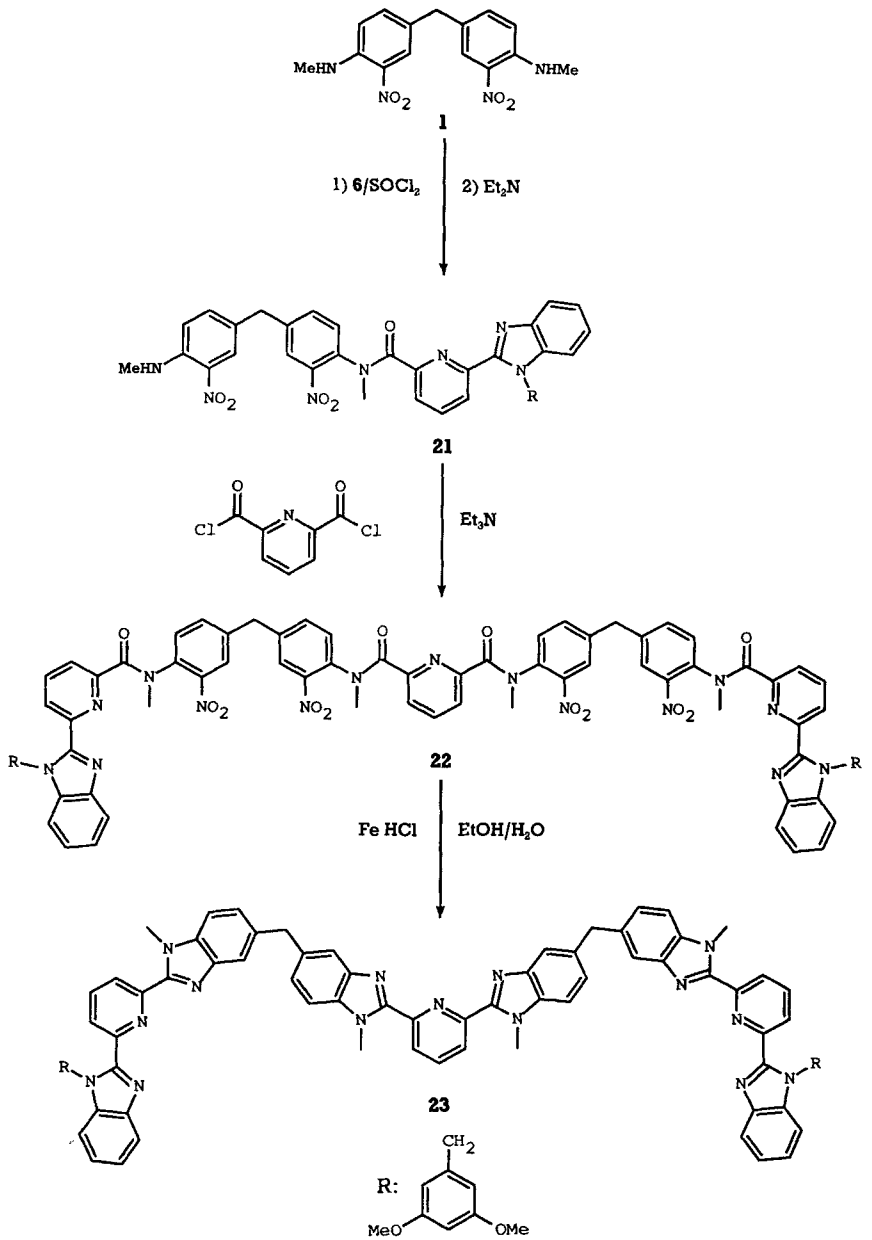


ligands of C_{2v} symmetry containing successively bidentate-terdentate-bidentate (see **19**, and **20**) and terdentate-terdentate-terdentate (see **23**) coordinating units. Four NO_2 groups are reduced and four cyclizations occur during the final key step leading to **19**·0.5 H_2O (63%), **20**·H_2O (62%), and **23**·3 H_2O (68%) in satisfactory yield corresponding to *ca.* 90% yield for the formation of each benzimidazole ring.

As often encountered with similar homoleptic ligands [4] [12] [20], H_2O molecules are incorporated in the final crystals of **16**, **19**, **20**, and **23** as confirmed by ^{1}H-NMR, IR, and elemental analysis.

Conclusions. – The flexibility and the mild conditions required by this new synthetic approach for the development of oligo-multidentate ligands based on pyridine and 1*H*-benzimidazole moieties allow the introduction of different coordinating units and various structural probes [4] [25] [21] along the strand. The easy incorporation of substituted terdentate units at different positions (terminal in **15** and **16** or central in **19** and **20**) is of particular interest if one considers the complicated synthetic pathways required for the introduction of analogous terpyridine units into supramolecular structures [11] [32]. This new generation of segmental heteroleptic ligands **14**–**16**, **19**, **20**, and **23** displays many properties which appear to be essential if these ligands are to give heteronuclear self-assembled helical structures: *i*) they contain various coordinating units with different affinities for the different metal ions [4] [12] [20] and which are held together within the same linear strand; *ii*) each coordinating unit is well-defined and well-separated from its neighbors by spacers which favorize helical structures [4] [12] [20]; *iii*) ^{1}H-NMR

Scheme 5. *Synthesis of Heterotrileptic Ligands* (terdentate-terdentate-terdentate)



diastereotopic probes [25] and fragmentation probes [21] are easily introduced into the ligand backbone which is crucial for the study of the final supramolecular structure.

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Experimental Part

General. Solvents and starting materials were purchased from *Fluka AG* (Buchs, Switzerland) and used without further purification, unless otherwise stated. The 1,2-dichloroethane and DMF were distilled from CaH_2, THF, pyridine, and toluene from Na. CH_2Cl_2 and $CHCl_3$ (anal. grade) were filtered over basic Al_2O_3 (*Merck*, act. I) prior to use. The 6-methylpyridine-2-carboxylic acid [33] (**2**), 5-methylpyridine-2-carboxylic acid [20] (**3**), 3,5-dimethoxybenzyl bromide [25], 6-(1′*H*-benzimidazol-2′-yl)pyridine-2-carboxylic acid [12] (**10**) and *N,N′*-dimethyl-4,4′-methylene-2,2′-dinitrobisbenzenamine [4] (**1**) were prepared, according to literature procedures. All reactions were carried out under N_2 if not stated otherwise. Prep. column chromatography (CC): Al_2O_3 (*Merck*, act. II–III, 0.063–0.200 mm) and silica gel (*Merck 60*, 0.040–0.060 mm). Melting point: uncorrected; *Büchi* apparatus, model Dr. *Tottoli*. IR Spectra: KBr pellets; *Perkin-Elmer-IR-883* spectrophotometer. ^{1}H-NMR, Homonuclear-2D-Cosy, ^{13}C-NMR, and ^{13}C-DEPT-NMR Spectra: *Varian-Gemini-300* spectrometer; chemical shifts δ in ppm rel. to $SiMe_4$, J in Hz. EI-MS (70 eV): *VG-7000E* and *Finnigan-4000* instruments. ES-MS (pneumatically assisted electron-spray-MS): MeCN + 0.1% HCOOH solns.; *API II* tandem mass spectrometer (*PE Sciex*) under low declustering energy conditions. Elemental analyses were performed by Dr. *H. Eder* of the Microchemical Laboratory of the University of Geneva.

*N,6-Dimethyl-*N-{*4′-[4″-(methylamino)-3″-nitrobenzyl]-2′-nitrophenyl*}*pyridine-2-carboxamide* (**4**). Acid **2** (0.55 g, 4.01 mmol) was refluxed in freshly distilled $SOCl_2$ (40 ml) with dry DMF (1 ml) for 90 min. $SOCl_2$ was evaporated and the crude residue dried under vacuum, then dissolved in dry $CHCl_3$ (20 ml) and added dropwise to a stirred soln. of **1** (1.155 g, 3.65 mmol) and Et_3N (3.69 g, 36.5 mmol) in $CHCl_3$ (70 ml). The resulting soln. was stirred for 15 h at r.t. and evaporated. The brown solid was partitioned between CH_2Cl_2 (300 ml) and half-sat. aq. NH_4Cl soln. (200 ml). The aq. phase was extracted with CH_2Cl_2 (2 × 100 ml), the combined org. phase dried (Na_2SO_4) and evaporated, and the residue purified by CC (Al_2O_3, CH_2Cl_2/hexane 85:15→100:0), then crystallized from CH_2Cl_2/hexane: 798 mg (50%) of **4**. Orange needles. TLC (Al_2O_3, CH_2Cl_2): R_f 0.21. M.p. 123° (dec.). IR (KBr): 3400*m* (NH); 3080*w*, 3050*w* (C=CH); 2920*m*, 2850*w* (sat. CH); 1640*vs* (CO); 1595*m*, 1570*s*, 1525*s* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.09 (*s*, 3 H); 3.03 (*d*, ^3J = 5, 3 H); 3.49 (*s*, 3 H); 3.94 (*s*, 2 H); 6.83 (*d*, ^3J = 8, 1 H); 6.97 (*d*, ^3J = 8, 1 H); 7.19 (*d*, ^3J = 8, 1 H); 7.26 (*dd*, ^3J = 8, ^4J = 2, 1 H); 7.30 (*dd*, ^3J = 8, ^4J = 2, 1 H); 7.53 (*t*, ^3J = 8, 1 H); 7.60 (*d*, ^3J = 8, 1 H); 7.74 (*d*, ^4J = 2, 1 H); 7.95 (*d*, ^4J = 2, 1 H); 8.03 (*q*, ^3J = 5, 1 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 23.40, 29.74, 38.54 (prim. C); 39.51 (sec. C); 114.10, 121.26, 124.26, 124.81, 126.30, 130.73, 133.74, 136.71, 136.95 (tert. C); 125.99, 131.59, 137.64, 141.30, 145.28, 146.96, 151.25, 156.42 (quat. C); 167.07 (CO). EI-MS (70 eV): 435 (M^+), 389 ($[M - NO_2]^+$).

*N,5-Dimethyl-*N-{*4′-[4″-(methylamino)-3″-nitrobenzyl]-2′-nitrophenyl*}*pyridine-2-carboxamide* (**5**). To a suspension of **3** (0.55 g, 4.01 mmol) in dry 1,2-dichloroethane (40 ml), $SOCl_2$ (2.92 ml, 40.1 mmol) and DMF (200 µl) were added. The resulting mixture was refluxed for 90 min. After evaporation, the crude green solid was quickly dissolved in $CHCl_3$ (20 ml) and added dropwise to a stirred soln. of **1** (1.155 g, 3.65 mmol) and Et_3N (3.69 g, 36.5 mmol) in $CHCl_3$ (100 ml). Workup and purification similar to those described for **4** gave 790 mg (50%) of **5**. Orange needles. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.54. M.p. 65° (dec.). IR (KBr): 3400*m* (NH); 3080*w* (C=CH); 2920*m* (sat. CH); 1645*vs* (CO); 1575*m*, 1525*s* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.20–2.40 (*m*, 3 H); 2.90 (*d*, ^3J = 5, 3 H); 3.45 (*m*, 3 H); 3.90 (*m*, 2 H); 6.82 (*d*, ^3J = 8, 1 H); 7.20–7.34 (*m*, 3 H); 7.42 (*d*, ^3J = 8, 1 H); 7.6–7.7 (*m*, 2 H); 7.88 (*s*, 1 H); 7.92 (*s*, 1 H); 8.02 (*q*, ^3J = 5, 1 H). EI-MS (70 eV): 435 (M^+), 389 ($[M - NO_2]^+$).

*N,N′,5,6′-Tetramethyl-*N,N′-*[methylenebis(2-nitrophen-4,1-ylene)]bis[pyridine-2-carboxamide]* (**7**). As described for **4** from **3** and **4**. After standard workup, the crude product was purified by CC (silica gel, CH_2Cl_2/MeOH 99.3:0.7→98:2): 88% of **7**. Pale yellow powder. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.18. M.p. 71° (dec.). IR (KBr): 3060*w* (C=CH); 2940*m* (sat. CH); 1655*vs* (CO); 1590*m*, 1570*m*, 1530*s*, 1500*m* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.2–2.6 (*m*, 6 H); 3.47 (*s*, 6 H); 4.05 (*s*, 2 H); 6.9–8.5 (*m*, 12 H). EI-MS (70 eV): 508 ($[M - NO_2]^+$). ES-MS: 555 ($[M + H]^+$).

*6-[1″″-(3,5-Dimethoxybenzyl)-1″″*H*-benzimidazol-2″″-yl]-*N*-methyl-*N-{*4′-*{*4″-*{*N*-*methyl*-N-*[(6‴-methylpyridin-2‴-yl)carbonyl]amino*}*-3″-nitrobenzyl*}*-2′-nitrophenyl*}*pyridine-2-carboxamide* (**8**). A mixture of **6** (0.5 g, 1.28 mmol), freshly distilled $SOCl_2$ (1.52 g, 12.8 mmol), and DMF (100 µl) was heated at 80° for 2 h in 1,2-dichloroethane (70 ml). The mixture was evaporated and the solid residue suspended in $CHCl_3$ (50 ml) and added dropwise to a stirred soln. of **4** (373 mg, 0.857 mmol) and Et_3N (0.65 g, 6.43 mmol) in $CHCl_3$ (50 ml). The soln. was heated at 70° for 15 h and the crude product isolated according to the standard workup procedure and purified by CC (silica gel, CH_2Cl_2/MeOH 99:1→98:2): 511 mg (74%) of **8**. Pale yellow powder. TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1): R_f 0.25. M.p. 105° (dec.). IR (KBr): 3060*vw* (C=CH); 2960*m*, 2930*m* (sat. CH); 1660*vs* (CO); 1610*s*, 1590*s*, 1570*m*, 1530*vs* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.0–2.6 (*m*, 3 H); 3.1–3.5 (*m*, 6 H); 3.6–3.65 (*m*, 6 H); 3.7–4.1 (*m*, 2 H); 5.0–6.3 (*m*, 5 H); 6.5–8.6 (*m*, 16 H). EI-MS (70 eV): 806 (M^+), 760 ($[M - NO_2]^+$).

6-[1'''-(3,5-Dimethoxybenzyl)-1'''H-benzimidazol-2'''-yl]-N-methyl-N-{4'-{4''-{N-methyl-N-[(5'''-methylpyridin-2'''-yl)carbonyl]amino}-3''-nitrobenzyl}-2'-nitrophenyl}pyridine-2-carboxamide (**9**). As described for **8**, from **5** and **6**: 69% of **9**. Pale yellow powder. TLC (silical gel, CH_2Cl_2/MeOH 95:5): R_f 0.27. M.p. 126° (dec.). IR (KBr): 3060*w*, 3000v*w* (C=CH); 2940*m*, 2840*w* (sat. CH); 1655v*s* (CO); 1610v*s*, 1590v*s*, 1570*s*, 1530v*s*, 1500*m* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.15–2.45 (*m*, 3 H); 3.0–3.5 (*m*, 6 H); 3.55–3.7 (*m*, 6 H); 3.7–4.1 (*m*, 2 H); 5.3–6.5 (*m*, 5 H); 6.6–8.5 (*m*, 16 H). EI-MS (70 eV): 806 (M^+), 760 ([$M - NO_2$]$^+$).

1,1'-Dimethyl-5,5'-methylene-2-(5-methylpyridin-2-yl)-2'-(6-methylpyridin-2-yl)bis[1H-benzimidazole] (**14**). To a soln. of **7** (0.25 g, 0.45 mmol) in EtOH/H_2O (90 ml:22.5 ml), activated Fe powder (755 mg, 13.5 mmol) and conc. HCl soln. (37%; 2.8 ml, 33.8 mmol) were added. The mixture was refluxed for 4 h, then H_2O (30 ml) added to the dark blue soln., excess of Fe filtered off, and EtOH distilled under vacuum. The resulting mixture was poured into CH_2Cl_2 (100 ml), $Na_2H_2EDTA \cdot 2\ H_2O$ (5 g) in H_2O (40 ml) was added, and the resulting stirred mixture neutralized (pH 8.5) with 12% aq. NH_4OH soln. Conc. H_2O_2 soln. (30%; 2 ml) was added under vigorous stirring. After 15 min, the org. layer was separated and the aq. phase extracted with CH_2Cl_2 (2 × 100 ml). The combined org. phase was dried (Na_2SO_4) and evaporated and the crude residue purified by CC (silica gel, CH_2Cl_2/MeOH 98.5:1.5→97:3) then crystallized from hot MeCN: 197 mg (0.429 mmol, 95%) of **14**. White prisms. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.31. M.p. 164–165°. IR (KBr): 3030v*w* (C=CH); 2960*m*, 2920*m* (sat. CH); 1580v*s*, 1485v*s* (C=C, C=N); 1455v*s*, 1420v*s*. ^{1}H-NMR (300 MHz, $CDCl_3$): 2.40 (*s*, 3 H); 2.62 (*s*, 3 H); 4.21 (*s*, 3 H); 4.24 (*s*, 3 H); 4.27 (*s*, 2 H); 7.17 (*d*, ^3J = 8, 1 H); 7.19 (*dd*, ^3J = 8, ^4J = 1.5, 2 H); 7.30 (*d*, ^3J = 8, 2 H); 7.63 (*ddq*, ^3J = 8, ^4J = 2, ^4J = 0.6, 1 H); 7.68 (*m*, 2 H); 7.69 (*t*, ^3J = 8, 1 H); 8.14 (*dd*, ^3J = 8, ^4J = 1.5, 1 H); 8.25 (*dd*, ^3J = 8, ^4J = 1.5, 1 H); 8.50 (*dq*, ^4J = 2, ^4J = 0.6, 1 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 18.39, 24.41, 32.61, 32.70 (prim. C); 42.30 (sec. C); 109.63, 109.65, 119.77, 119.85, 121.60, 122.99, 124.17, 124.52, 124.58, 136.91, 137.25, 148.88 (tert. C); 133.36, 135.83, 135.85, 136.30, 142.83, 142.85, 148.13, 150.06, 150.50, 150.52, 157.31 (quat. C). EI-MS (70 eV): 450 (M^+). Anal. calc. for $C_{29}H_{26}N_6$: C 75.96, H 5.72; N 18.33; found: C 75.76, H 5.82, N 18.25.

5-{2'-{6''-[1'''-(3,5-Dimethoxybenzyl)-1'''H-benzimidazol-2'''-yl]pyridin-2''-yl}-1'-methyl-1'H-benzimidazol-5'-ylmethyl}-1-methyl-2-(6''''-methylpyridin-2'''yl)-1H-benzimidazole (= *2-{6-[1-(3,5-Dimethoxybenzyl)-1H-benzimidazol-2-yl]pyridin-2-yl}-1,1'-dimethyl-5,5'-methylene-2'-(6-methylpyridin-2-yl)bis[1H-benzimidazole]*; **15**). As described for **14**; from **8**: 83% of **15**. White microcrystals from CH_2Cl_2/hexane. TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1): R_f 0.18. M.p. 218–220°. IR (KBr): 3060*w* (C=CH); 2960*m*, 2940*m* (sat. CH); 1605v*s*, 1590v*s*, 1570v*s* (C=C, C=N); 1455v*s*, 1420v*s*, 1400*s*. ^{1}H-NMR (300 MHz, $CDCl_3$): 2.63 (*s*, 3 H); 3.52 (*s*, 6 H); 3.67 (*s*, 3 H); 4.24 (*s*, 3 H); 4.27 (*s*, 2 H); 5.92 (*s*, 2 H); 6.15 (*d*, ^4J = 2, 2 H); 6.29 (*t*, ^4J = 2, 1 H); 7.18 (*d*, ^3J = 8, 1 H); 7.20–7.38 (*m*, 7 H); 7.64 (*d*, ^4J = 1, 1 H); 7.65 (*d*, ^4J = 1, 1 H); 7.84–7.90 (*m*, 1 H); 8.02 (*t*, ^3J = 8, 1 H); 8.14 (*d*, ^3J = 8, 1 H); 8.30 (*dd*, ^3J = 8, ^4J = 0.5, 1 H); 8.44 (*dd*, ^3J = 8, ^4J = 0.5, 1 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 24.39, 31.60, 32.72, 55.12 (prim. C); 42.24, 48.79 (sec. C); 99.26, 104.34, 109.70, 109.81, 110.80, 119.74, 119.92, 120.29, 121.68, 123.02, 123.10, 123.87, 124.62, 125.01, 125.36, 125.53, 137.00, 137.97 (tert. C); 135.57, 135.80, 136.33, 136.68, 136.77, 139.53, 142.57, 142.77, 142.84, 149.57, 149.75, 149.84, 150.08, 150.24, 150.45, 157.38, 161.17 (quat. C). EI-MS (70 eV): 710 (M^+). ES-MS: 711.2 ([M + H]$^+$), 356.2 ([M + 2H]$^{2+}$). Anal. calc. for $C_{44}H_{38}N_8O_2$: C 74.35, H 5.39, N 15.76; found: C 74.10, H 5.48, N 15.78.

5-{2'{6''-[1'''-(3,5-Dimethoxybenzyl)-1'''H-benzimidazol-2'''-yl]pyridin-2''-yl}-1'-methyl-1'H-benzimidazol-5'-ylmethyl-}-1-methyl-2-(5''''-methylpyridin-2''''-yl)-1H-benzimidazole (= *2-{6-[1-(3,5-Dimethoxybenzyl)-1H-benzimidazol-2-yl]pyridin-2-yl}-1,1'-dimethyl-5,5'-methylene-2'-(5-methylpyridin-2-yl)bis[1H-benzimidazole]*; **16**). As described for **14**, from **9**: 66% of **16**·H_2O. White microcrystals from CH_2Cl_2/hexane. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.17. M.p. 152–153°. IR (KBr): 3050*w*, 3005*w* (C=CH); 2940*m*, 2840*w* (sat. CH); 1605*s*, 1595v*s*, 1570*s* (C=C, C=N); 1450v*s*, 1425v*s*, 1400*s*. ^{1}H-NMR (300 MHz, $CDCl_3$): 2.39 (*s*, 3 H); 3.51 (*s*, 6 H); 3.66 (*s*, 3 H); 4.21 (*s*, 3 H); 4.26 (*s*, 2 H); 5.90 (*s*, 2 H); 6.14 (*d*, ^4J = 2, 2 H); 6.28 (*t*, ^4J = 2, 1 H); 7.15–7.40 (*m*, 7 H); 7.61 (*dd*, ^3J = 8, ^4J = 0.7, 1 H); 7.66 (*s*, 1 H); 7.69 (*s*, 1 H); 7.82–7.90 (*m*, 1 H); 8.00 (*t*, ^3J = 8, 1 H); 8.22 (*d*, ^3J = 8, 1 H); 8.29 (*d*, ^3J = 8, 1 H); 8.42 (*d*, ^3J = 8, 1 H); 8.49 (br. *s*, 1 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 18.43, 31.59, 32.65, 55.13 (prim. C); 42.24, 48.78 (sec. C); 99.16, 104,24, 109.69, 109.83, 110.88, 119.70, 119.90, 120.26, 123.03, 123.88, 124.20, 124.47, 124.98, 125.35, 125.53, 137.33, 138.03, 148.93 (tert. C); 133.48, 135,53, 135.80, 136.25, 136.69, 139.52, 142.71, 142.81, 147.98, 149.51, 149.73, 150.07, 150.24, 150.56, 161.10 (quat. C). EI-MS (70 eV): 710 (M^+). Anal. calc. for $C_{44}H_{38}N_8O_2 \cdot H_2O$: C 72.51, H 5.53, N 15.37; found: C 72.82, H 5.63, N 15.30.

N,N'-Dimethyl-N,N'-bis{4'-{4''-{N-methyl-N-[(6'''-methylpyridin-2'''-yl)carbonyl]amino}-3''-nitrobenzyl}-2'-nitrophenyl}pyridine-2,6-dicarboxamide (= *N,N'-6,6'-Tetramethyl-N,N'-{pyridine-2,6-diylbis{[carbonyl(methyl)nitrilo](3-nitrophen-4,1-ylene)methylene(2-nitrophen-4,1-ylene)}}bis[pyridine-2-carboxamide]*; **17**). To a soln. of **4** (0.5 g, 1.15 mmol) in CH_2Cl_2 (100 ml), solid pyridine-2,6-dicarbonyl dichloride (117 mg,0.57 mmol) was added. The mixture was refluxed for 6 h, a 2nd portion of pyridine-2,6-dicarbonyl dichloride (60 mg, 0.29 mmol) added, and the reflux maintained for 15 h. After cooling, Et_3N (173 mg, 3.45 mmol) was slowly added, and the

standard workup procedure described for **4** gave a crude product which was purified by CC (silica gel; CH_2Cl_2/MeOH 99:1→98:2): 421 mg (73%) of **17**. Pale yellow powder. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.24. M.p. 182° (dec.). IR (KBr): 3080*w* (C=CH); 2960*w*, 2900*w*, 2860*w* (sat. CH); 1655*vs* (CO); 1610*m*, 1585*m*, 1530*vs*, 1500*m* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.0–2.6 (*m*, 6 H); 3.1–3.5 (*m*, 12 H); 3.9–4.1 (*m*, 4 H); 6.9–8.0 (*m*, 21 H). EI-MS (70 eV): 1001 (M^+). ES-MS: 1002 ($[M + H]^+$), 501.5 ($[M + 2H]^{2+}$).

N,N′-*Dimethyl*-N,N′-*bis*{4′-{4″-N-{*methyl*-N-{5‴-*methylpyridin*-2‴-*yl*}*carbonyl*}*amino*}-3″-*nitrobenzyl*}-2′-*nitrophenyl*}*pyridine*-2,6-*dicarboxamide* (= N,N′,5,5′-*Tetramethyl*-N,N′-{*pyridin*-2,6-*diylbis*{[*carbonyl*-(*methyl*)*nitrilo*](3-*nitrophen*-4,1-*ylene*)*methylene*(2-*nitrophen*-4,1-*ylene*)}}*bis*[*pyridine*-2-*carboxamide*]; **18**). As described for **17** from **5** and pyridine-2,6-dicarbonyl dichloride: 61% of **18**. Pale yellow powder. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.23. M.p. 168° (dec.). IR (KBr): 3060*vw* (C=CH); 2915*m*, 2860*w* (sat. CH); 1650*vs* (CO); 1610*s*, 1565*w*, 1530*vs*, 1500*w* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.2–2.4 (*m*, 6 H); 3.1–3.6 (*m*, 12 H); 3.9–4.1 (*m*, 4 H); 7.0–8.5 (*m*, 21 H). ES-MS: 1002 ($[M + H]^+$), 501.5 ($[M + 2H]^{2+}$).

1,1′-Dimethyl-2,2′-*bis*(6-*methylpyridin*-2-*yl*)-5,5′-{*pyridine*-2,6-*diylbis*[(1-*methyl*-1H-*benzimidazole*-2,5-*diyl*)*methylene*]}*bis*[1H-*benzimidazole*] (**19**). Compound **17** (316 mg, 0.315 mmol) was dissolved in hot EtOH/H_2O 8:2 (100 ml). After cooling, activated Fe powder (1.06 g, 18.9 mmol) and conc. HCl soln. (37%; 1.97 ml, 23.6 mmol) were added and the resulting mixture refluxed for 6 h. After workup similar to that described for **14**, the crude residue was purified by CC (silica gel, CH_2Cl_2/MeOH 97:3→95:5), then crystallized from CH_2Cl_2/MeCN: 162 mg (63%) of **19**·0.5 H_2O. White microcrystals. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.13. M.p. > 220°. IR (KBr): 3420*m* (OH); 3080*vw* (C=CH); 2920*m*, 2850*w* (sat. CH); 1580*s* (C=C, C=N); 1450*vs*, 1420*s*, 1390*s*. ^{1}H-NMR (300 MHz, $CDCl_3$): 2.63 (*s*, 6 H); 4.20 (*s*, 6 H); 4.26 (*s*, 6 H); 4.30 (*s*, 4 H); 7.18 (*d*, ^3J = 8, 2 H); 7.25 (*d*, ^3J = 7.5, 2 H); 7.26 (*d*, ^3J = 7.5, 2 H); 7.32 (*d*, ^3J = 7.5, 2 H); 7.35 (*d*, ^3J = 7.5, 2 H); 7.71 (*s*, 2 H); 7.72 (*t*, ^3J = 8, 2 H); 7.74 (*s*, 2 H); 8.02 (*t*, ^3J = 8, 1 H); 8.16 (*d*, ^3J = 8, 2 H); 8.37 (*d*, ^3J = 8, 2 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 24.47, 32.54, 32.79 (prim. C); 42.24 (sec. C); 109.81, 119.73, 120.03, 121.76, 123.19, 124.67, 125.10, 137.04, 137.99 (tert. C); 135.73, 136.37, 136.74, 142.48, 142.82, 149.56, 149.71, 150.22, 150.44, 157.43 (quat. C). EI-MS (70 eV): 809 (M^+), 794 ($[M - Me]^+$). ES-MS: 810 ($[M + H]^+$), 405.5 ($[M + 2H]^{2+}$). Anal. calc. for $C_{51}H_{43}N_{11}$·0.5 H_2O: C 74.79, H 5.42, N 18.81; found: C 75.10, H 5.55, N 18.67.

1,1′-Dimethyl-2,2′-*bis*(5-*methylpyridin*-2-*yl*)-5,5′-{*pyridine*-2,6-*diylbis*[(1-*methyl*-1H-*benzimidazole*-2,5-*diyl*)*methylene*]}*bis*[1H-*benzimidazole*] (**20**). As described for **19**, from **18**: 62% of **20**·H_2O. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.14. M.p. > 220°. IR (KBr): 3420*m* (OH); 3030*vw* (C=CH); 2960*m*, 2920*w* (sat. CH); 1585*m*, 1570*m* (C=C, C=N); 1485*s*, 1450*s*, 1420*vs*. ^{1}H-NMR (300 MHz, $CDCl_3$): 2.42 (*s*, 6 H); 4.21 (*s*, 6 H); 4.24 (*s*, 6 H); 4.30 (*s*, 4 H); 7.21 (*d*, ^3J = 8, 2 H); 7.25 (*d*, ^3J = 8, 2 H); 7.35 (*m*, 4 H); 7.65 (*d*, ^3J = 8, 2 H); 7.70 (*s*, 2 H); 7.75 (*s*, 2 H); 8.02 (*t*, ^3J = 8, 1 H); 8.26 (*d*, ^3J = 8, 2 H); 8.37 (*d*, ^3J = 8, 2 H); 8.50 (*s*, 2 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 18.49, 32.54, 32.70 (prim. C); 43.31 (sec. C); 109.81, 119.74, 120.04, 124.23, 124.54, 125.09, 137.33, 137.97, 148.91 (tert. C); 135.53, 135.73, 136.26, 136.74, 142.70, 142.86, 147.92, 149.57, 150.23, 150.55 (quat. C). EI-MS (70 eV): 809 (M^+), 794 ($[M - Me]^+$). Anal. calc. for $C_{51}H_{43}N_{11}$·H_2O: C 73.98, H 5.48, N 18.61; found: C 74.20, H 5.52, N 18.66.

6-[1‴-(3,5-*Dimethoxybenzyl*)-1‴H-*benzimidazol*-2‴-*yl*]-N-*methyl*-N-{4′-[4″-(*methylamino*)-3″-*nitrobenzyl*]-2′-*nitrophenyl*}*pyridine*-2-*carboxamide* (**21**). To a suspension of **6** (925 mg, 2.37 mmol) in 1,2-dichloroethane (80 ml), freshly distilled $SOCl_2$ (2.82 g, 23.7 mmol) and DMF (200 µl) were added. The resulting mixture was refluxed for 3 h. After evaporation, the solid residue was dissolved in $CHCl_3$ (50 ml) and added dropwise to a stirred soln. of **1** (0.5 g, 1.58 mmol) in $CHCl_3$ (150 ml) and Et_3N (1.2 g, 11.86 mmol). The mixture was maintained at r.t. for 3 h, then heated at 60° for 15 h. After standard workup as described for **4**, the crude product was purified by CC (Al_2O_3, CH_2Cl_2/hexane 85:15 to separate excess of **1**; then silica gel, CH_2Cl_2/MeOH 99.2:0.8): 555 mg (51%) of **21**. Orange powder. TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1): R_f 0.59. M.p. 86° (dec.). IR (KBr): 3300*m* (NH); 3060*w* (C=CH); 2940*m*, 2840*m* (sat. CH); 1660*vs* (CO); 1610*s*, 1590*vs*, 1570*vs*, 1525*vs* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 2.5–4.0 (*m*, 14 H); 5.4–6.6 (*m*, 5 H); 6.7–8.5 (*m*, 14 H). EI-MS: 687 ($[M]^+$).

N,N′-*Bis*{4′-{4″-{N-{{6‴-[1‴″-(3,5-*dimethoxybenzyl*)-1‴″H-*benzimidazol*-2‴″-*yl*]*pyridin*-2‴-*yl*}*carbonyl*}-N-*methylamino*}-3″-*nitrobenzyl*}-2′-*nitrophenyl*}-N,N′-*dimethylpyridine*-2,6-*dicarboxamide* (= 6,6′-*Bis*[1-(3,5-*dimethoxybenzyl*)-1H-*benzimidazol*-2-*yl*]-N,N′-*dimethyl*-N,N′-{*pyridine*-2,6-*diylbis*{[*carbonyl*(*methyl*)*nitrilo*]-(3-*nitrophen*-4,1-*ylene*)*methylene*}(2-*nitrophen*-4,1-*ylene*)}*bis*[*pyridine*-2-*carboxamide*]; **22**). As described for **17**, from **21** and pyridine-2,6-dicarbonyl dichloride. The crude product was purified by CC (silica gel, CH_2Cl_2/MeOH 99:1→97.5:2.5): 63% of **22**. Pale yellow powder. TLC (silica gel, CH_2Cl_2/MeOH 95:5): R_f 0.20. M.p. 182° (dec.). IR (KBr): 3070*w* (C=CH); 2960*m*, 2940*m*, 2840*w* (sat. CH); 1660*vs* (CO); 1610*s*, 1590*s*, 1570*s*, 1530*vs*, 1500*s* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 3.0–4.1 (*m*, 28 H); 5.4–6.5 (*m*, 10 H); 6.5–8.5 (*m*, 29 H). ES-MS: 1507 ($[M + H]^+$), 754.5 ($[M + 2H]^{2+}$).

2,2'-Bis{6-[1-(3,5-dimethoxybenzyl)-1H-benzimidazol-2-yl]pyridin-2-yl}-1,1'-dimethyl-5,5'-{pyridine-2,6-diylbis[(1-methyl-1H-benzimidazole-2,5-diyl)methylene]}bis[1H-benzimidazole] (**23**). As described for **19**, from **22**: 68% of **23**·3 H_2O. White powder (CC (silica gel, CH_2Cl_2/MeOH 98:2→96.5:3.5)). TLC (silica gel, CH_2Cl_2/MeOH 92:8): R_f 0.10. M.p. > 220°. IR (KBr): 3400*m* (OH); 3060*vw* (C=CH); 2960*m*, 2930*m*, 2840*m* (sat. CH); 1605*vs*, 1590*vs*, 1570*vs* (C=C, C=N); 1450*vs*, 1420*s*, 1400*s*. ^{1}H-NMR (300 MHz, $CDCl_3$): 3.54 (*s*, 12 H); 3.69 (*s*, 6 H); 4.21 (*s*, 6 H); 4.31 (*s*, 4 H); 5.94 (*s*, 4 H); 6.17 (*d*, ^4J = 2, 4 H); 6.31 (*t*, ^4J = 2, 2 H); 7.2–7.4 (*m*, 14 H); 7.71 (*s*, 2 H); 7.74 (*s*, 2 H); 7.85–7.92 (*m*, 2 H); 8.02 (*t*, ^3J = 8, 1 H); 8.03 (*t*, ^3J = 8, 2 H); 8.32 (*dd*, ^3J = 8, ^4J = 1, 2 H); 8.37 (*d*, ^3J = 8, 2 H); 8.45 (*dd*, ^3J = 8, ^4J = 1, 2 H). ^{13}C-NMR (75 MHz, $CDCl_3$): 31.70, 32.60, 55.11 (prim. C); 42.29, 48.86 (sec. C); 99.21, 104.32, 109.89, 109.96, 110.95, 119.96, 120.07, 120.34, 123.14, 123.99, 125.03, 125.12, 125.16, 125.47, 125.60, 138.06, 138.13 (tert. C); 135.61, 135.79, 136.67, 136.74, 136.79, 139.60, 142.77, 142.85, 142.90, 149.60, 149.73, 150.11, 150.31, 150.35, 161.18 (quat. C). ES-MS: 658 ($[M + 2H]^{2+}$), 439 ($[M + 3H]^{3+}$), 329.5 ($[M + 4H]^{4+}$). Anal. calc. for $C_{81}H_{67}N_{15}O_4 \cdot 3H_2O$: C 71.09, H 5.38, N 15.35; found: C 71.40, H 5.41, N 15.28.

Ethyl 6-(1H-Benzimidazol-2-yl)pyridine-2-carboxylate (**11**). A suspension of **10** (6 g, 23.3 mmol) and conc. H_2SO_4 soln. (98%; 6 ml) in EtOH (300 ml) was refluxed until it became clear (2 h). After cooling, the clear soln. was filtered, diluted with H_2O (300 ml), and neutralized (pH 7) with sat. aq. $NaHCO_3$ soln. EtOH was distilled off and the aq. phase extracted with CH_2Cl_2 (3 × 200 ml). The combined org. layer was dried (Na_2SO_4) and evaporated and the crude product crystallized from CH_2Cl_2/hexane: 5.25 g (84%) of **11**. Pale yellow prisms. TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1): R_f 0.62. M.p. 134–136°. IR (KBr): 3200–3100*s* (NH); 1715*vs* (CO); 1590*vs*, 1460*vs* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 1.44 (*t*, ^3J = 7, 3 H); 2.70 (*s*, 1 H); 4.48 (*q*, ^3J = 7, 2 H); 7.24–7.34 (*m*, 2 H); 7.5–7.8 (*m*, 2 H); 7.97 (*t*, ^3J = 8, 1 H); 8.12 (*dd*, ^3J = 8, ^4J = 1, 1 H); 8.60 (*dd*, ^3J = 8, ^4J = 1, 1 H). EI-MS (70 eV): 267 (M^+), 239 ($[M - CO]^+$), 194 ($[M - CO_2Et]^+$).

*6-(1H-Benzimidazol-2-yl)-*N,N*-diethylpyridine-2-carboxamide* (**12**). $AlCl_3$ (14.95 g, 0.112 mol) was suspended in dry toluene (500 ml) and Et_2NH (16.4 g, 0.224 mol) added dropwise while maintaining the temp. at 28–32° (ice-bath). The resulting yellow soln. was stirred for 1 h at r.t., then solid **11** (5 g, 18.7 mmol) was added in one portion under vigorous mechanical stirring. The mixture was heated at 40° for 15 h, then hydrolyzed with H_2O (300 ml). The org. layer was separated and the aq. phase extracted with CH_2Cl_2 (3 × 200 ml). The combined org. phase was dried (Na_2SO_4) and evaporated and the crude solid purified by CC (Al_2O_3, CH_2Cl_2), then crystallized from CH_2Cl_2/MeOH/hexane 45:5:50: 4.92 g (89%) of **12**. Pale yellow crystals. TLC (Al_2O_3, CH_2Cl_2/MeOH 99.5:0.5): R_f 0.19. M.p. 223–224°. IR (KBr): 3310*vs* (NH); 3080*w*, 3060*w* (C=CH); 2980*m*, 2940*m*, 2880*vw* (sat. CH); 1640*vs* (CO); 1590*vs*, 1565*vs*, 1525*m*, 1490*s* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 1.20 (*t*, ^3J = 7, 3 H); 1.31 (*t*, ^3J = 7, 3 H); 3.33 (*q*, ^3J = 7, 2 H); 3.61 (*q*, ^3J = 7, 2 H); 7.25 (*m*, 2 H); 7.50 (*dd*, ^3J = 8, ^4J = 1, 1 H); 7.52 (*m*, 1 H); 7.84 (*m*, 1 H); 7.88 (*t*, ^3J = 8, 1 H); 8.40 (*dd*, ^3J = 8, ^4J = 1, 1 H); 10.6 (*s*, 1 H). EI-MS (70 eV): 294 (M^+), 194 ($[M - CONEt_2]^+$).

*6-[1-(3,5-Dimethoxybenzyl)-1H-benzimidazol-2-yl]-*N,N*-diethylpyridine-2-carboxamide* (**13**). NaH (60% in oil; 0.236 g, 5.9 mmol) was added to a soln. of **12** (1.15 g, 3.9 mmol) in THF (140 ml) at 0°. The mixture was allowed to stand at r.t. for 1 h, and 3,5-dimethoxybenzyl bromide (1.36 g, 5.9 mmol) in THF (40 ml) was added dropwise. The soln. was refluxed for 15 h and the solvent evaporated. The crude residue was partitioned between CH_2Cl_2 (250 ml) and H_2O (200 ml), the aq. phase extracted with CH_2Cl_2 (3 × 100 ml), the combined org. phase dried (Na_2SO_4) and evaporated, and the crude solid purified by CC (Al_2O_3, CH_2Cl_2/MeOH 100:0→99.3:0.7) and crystallization from CH_2Cl_2/hexane: 1.53 g (88%) of **13**. Pale yellow prisms. TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1): R_f 0.42. M.p. 130–131°. IR (KBr): 3030*w* (C=CH); 2990*m*, 2940*m*, 2840*m* (sat. CH); 1640*vs* (CO); 1625*vs*, 1595*vs*, 1570*vs* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 0.85 (*t*, ^3J = 7, 3 H); 1.15 (*t*, ^3J = 7, 3 H); 3.07 (*q*, ^3J = 7, 2 H); 3.49 (*q*, ^3J = 7, 2 H); 3.63 (*s*, 6 H); 5.97 (*s*, 2 H); 6.20 (*d*, ^4J = 2, 2 H); 6.26 (*t*, ^4J = 2, 2 H); 7.2–7.4 (*m*, 3 H); 7.52 (*dd*, ^3J = 8, ^4J = 1, 1 H); 7.85 (*m*, 1 H); 7.92 (*t*, ^3J = 8, 1 H); 8.44 (*dd*, ^3J = 8, ^4J = 1, 2 H). EI-MS (70 eV): 444 (M^+), 344 ($[M - CONEt_2]^+$).

6-[1-(3,5-Dimethoxybenzyl)-1H-benzimidazol-2-yl]pyridine-2-carboxylic Acid (**6**). A mixture of **13** (1 g, 2.25 mmol), K(*t*-BuO) (1.52 g, 13.5 mmol) and H_2O (80 mg, 4.4 mmol) was refluxed in dry THF (150 ml) until complete disappearance of **13** (*ca.* 45 min; TLC (Al_2O_3, CH_2Cl_2/MeOH 99:1) monitoring). The dark mixture was hydrolyzed with H_2O (200 ml) and THF evaporated under vacuum. The resulting aq. layer was filtered over *Celite* and the filtrate neutralized to pH 3 with 2M HCl. The precipitate was collected by filtration, washed with H_2O (3 × 100 ml) and dried under vacuum: 760 mg (87%) of **6**. White powder. TLC (silica gel, MeOH): R_f 0.62. M.p. 211° (dec.). IR (KBr): 3320*m* (OH); 3060*m*, 3005*m* (C=CH); 3200–2300*m* (OH); 2940*m*, 2840*m* (sat. CH); 1710*vs* (CO); 1610*vs*, 1585*vs* (C=C, C=N). ^{1}H-NMR (300 MHz, $CDCl_3$): 3.69 (*s*, 6 H); 5.70 (*s*, 2 H); 6.23 (*d*, ^4J = 2, 2H); 6.36 (*t*, ^4J = 2, 2 H); 7.3-7.4 (*m*, 3 H); 7.9–8.0 (*m*, 1 H); 8.06 (*t*, ^3J = 8, 1 H); 8.22 (*dd*, ^3J = 8, ^4J = 1.5, 1 H); 8.63 (*dd*, ^3J = 8, ^4J = 1.5, 2 H). EI-MS (70 eV): 389 (M^+).

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