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1,3-Diphenylpropane-1,3-diamines XI [1]. Conversion of a 3-Hydroxy-1,3-diphenylpropan-1-one to 1,3-Diphenylpropane-1,3-diamines

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Summary. Highly diastereoselective BH_3/*THF syn*-reduction of the 3-hydroxy-1,3-diphenylpropan-1-one/BBr_3 complex **3**/BBr_3 (cf. *Sarko*) afforded the *meso*-diol **4**, whereas racemate **5** was obtained by BH_3/*THF* reduction without complexation. Mesylation, exchange of mesylate by azide, and reduction with $SnCl_2$/thiophenol led to the diamines **10** and **11** which were also produced by reductive N-N cleavage of the 4,5-dihydropyrazole **13**.

Keywords. 1,3-Diphenylpropane-1,3-diamines; 3-Hydroxy-1,3-diphenylpropan-1-one; 3,5-Diphenyl-4,5-dihydropyrazole; *syn*-Reduction of β-hydroxyketones.

1,3-Diphenylpropan-1,3-diamine, 11. Mitt. [1]**: Umsetzung eines 3-Hydroxy-1,3-diphenylpropan-1-ons zu 1,3-Diphenlypropan-1,3-diaminen**

Zusammenfassung. Hochdiastereoselektive BH_3/*THF-syn*-Reduktion des 3-Hydroxy-1,3-diphenylpropan-3-on/BBr_3-Komplexes **3**/BBr_3 (vergl. *Sarko*) lieferte das *meso*-Diol **4**, wähend das Razemat **5** durch BH_3/*THF*-Reduktion ohne Komplexbildung entstand. Mesylierung, Ersatz von Mesylat durch Azid und $SnCl_2$/Thiophenol-Reduktion führte zu den Diaminen **10** und **11**, die auch durch reduktive N-N-Spaltung aus dem 4,5-Dihydropyrazol **13** erhalten wurden.

Introduction

The biochemical rational of our efforts to synthesize 1,3-diphenylpropane-1,3-diamines and their Pt(II) complexes, highly substituted by halogens in the phenyl rings, has been outlined in a preceding paper [1]. The synthesis of *meso*-1,3-*bis*(2,6-dichloro-4-methoxyphenyl)propane-1,3-diamine (**1**) and its racemic diastereomer **2** was impossible following *v. Auwers* route [2,3]; however, we were able to prepare the diamines **1** and **2** by Zn/HCl reduction [1] of 3,5-*bis*(2,6-dichloro-4-methoxyphenyl)-4,5-dihydropyrazole in a *meso*/racemate ratio of 1:4 as indicated by the ^1H NMR spectrum of the mixture. Preparative chromatography led to a *meso*/racemate ratio of 1:10 which is unfavourable for us because we are in need of both diastereomers for biochemical and pharmacological tests.

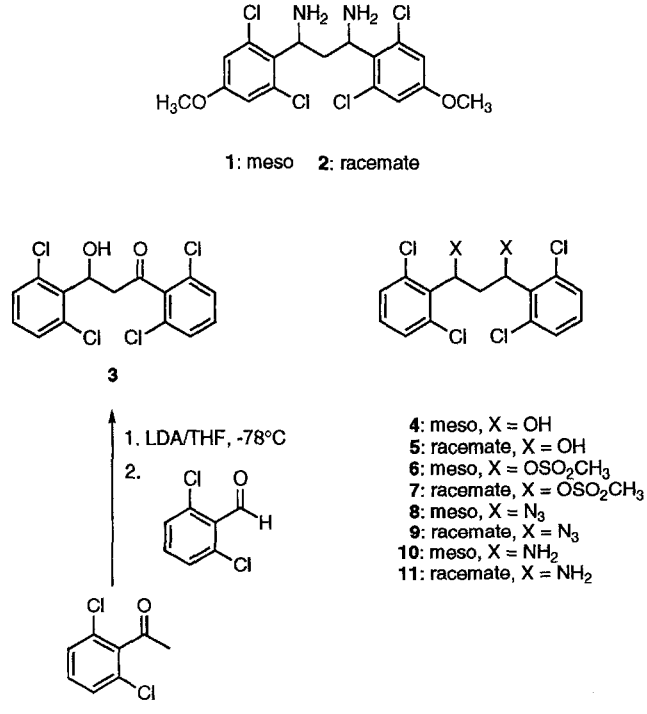
Dedicated to Prof. Dr. *G. Wurm*, Berlin, on the occasion of his 60th birthday

Results and Discussion

Here we describe an alternative approach to analogous highly *ortho* substituted 1,3-diphenylpropane-1,3-diamines, starting from the properly chlorinated β-hydroxyketone **3** which in turn can be easily obtained by addition of the pertinent acetophenone anion to the corresponding benzaldehyde following the protocol of *Levenberg et al.* [4] (Scheme 1). In this case, we neglected the 4-methoxy substituents in both starting materials because the preparation of 2,6-dichloro-4-methoxybenzaldehyde (which is also a precursor of the corresponding acetophenone) is laborious [5] and the outcome of our syntheses is always strongly influenced by the four substituents in the *ortho* positions of the 1,3-diphenylpropane moiety, but not by the *para* substituents [3].

From the broad variety of reducing reagents, conceivable for β-hydroxyketone **3**, only the BH_3/*THE* complex in dichloromethane turned out to be useful because the chlorine substituents should not be eliminated reductively using this reagent. $LiAlH_4$ and $NaBH_4$ led to useless mixtures, even under mild conditions; with BH_3/*THF*, however, the racemate **5** was obtained in 32% yield after purification.

When we tried to reduce β-hydroxyketone **3** by an enantiomerically pure oxazaborolidine complex, obtained *in situ* from (*S*)-valinol and B_2H_6/*THF* [6], a mixture of 1,3-diols **4** and **5** was obtained in 85% chemical yield. ^{1}H NMR data [1] of the separated diol **5** correspond to those of an enantiomer of racemate **5**, but $[\alpha]_D = 1.3°$ points towards the racemate **5** itself – although not proving it because this value is still within the limits of error of the polarimeter (data not given).



Scheme 1

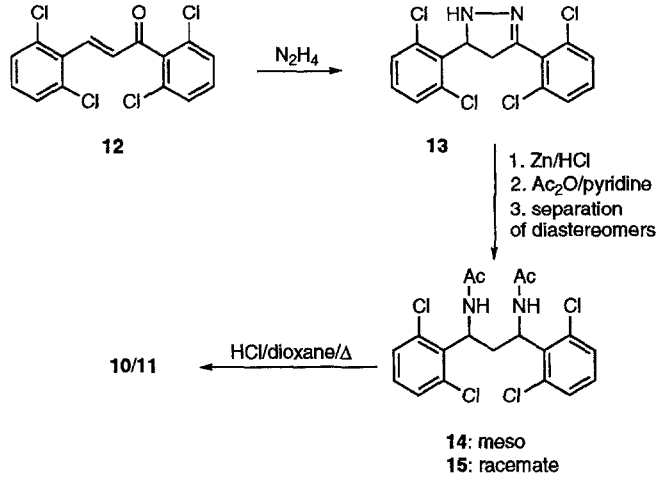
During our pertinent experiments, *Sarko et al.* [7] published their results concerning the reduction of Ti- or B-chelates of β-hydroxyketones with high *syn* selectivity. In our case, this procedure should favour the preparation of the *meso* diastereomer **10** which can also be obtained in far too low a yield, however, from the 4,5-dihydropyrazole **13** (see below). High *de* values were obtained by *Sarko* [7] if a boron-chelate with a short B–O bond (about 1.35 Å) was generated from BCl_3 and the β-hydroxyketone. For possible conformations and energy minima, cf. Ref. [7].

Following *Sarko*'s ideas [7] for the reduction of the β-hydroxyketone **3**, we obtained the *meso* diastereomer **4** in 71% chemical yield with *de* > 99 : 1 after CC (^{1}H NMR). Recrystallization from dichloromethane/*n*-hexane afforded 62% stereochemically pure 1,3-diol **4**. In this case, the chelate complex is formed quickly, but again the *ortho* substituents slow down the reduction which was complete only after 6 h.

The stereochemistry of the diastereomers can be determined by ^{1}H NMR spectroscopy [8] of the CH_2 protons. Because the racemate **5** shows C_2-symmetry, these protons are homotopic. They do not resonate, however, as a t, but as a dd ($\delta = 2.47$ ppm, $J_1 = 5$ Hz, $J_2 = 2$ Hz, see Experimental) in accordance with *Roos* [9] who also describes a dd for 1,3-diphenylpropane-1,3-diol but cites only one *J* value (5.7 Hz). In contrast to **5**, the *meso* diastereomer **4** has magnetically non-equivalent CH_2 protons which give rise to two dt at $\delta = 3.10$ and 2.23 ppm ($J_1 = 9$ Hz, $J_2 = 7$ Hz).

In the next step, the OH groups of diols **4** and **5** had to be replaced by N-functions suitable as precursors of the amino groups. For this aim, tosylates are often recommended, but we used the less bulky mesylates on account of the *ortho* substituents. The experimental procedure was established using the mixture of diastereomers **4** and **5**. The dimesylates **6** and **7** were obtained following *Crossland* [10]. Their conversion to the diazides is a stereochemically critical step, because S_N1 conditions at the benzylic positions had to be impeded (*vide infra*). When we tried to convert the dimesylates into the diazides in MeOH/water according to *Wiley* [11], we obtained a mixture of components showing a strong OH absorption in its IR spectrum besides a weak N_3 band. This points towards water having acted as a nucleophile. Consequently, we worked with NaN_3 in absol. *DMF* under N_2, all the more so since the aprotic polar nature of *DMF* does not favour S_N1 reactions.

The pure diastereomers **4** and **5** were converted into their dimesylates **6** and **7** (63 and 75% yield, respectively) which could not be fully characterized on account of their lability (decomposition in contact with air). Their IR spectra show mesylate absorptions at 1368 and 1171 cm^{-1}. **6** and **7** were transformed into the corresponding diazides **8** and **9**. This substitution seems to be of considerable stereochemical homogeneity, because we did not observe the formation of racemic diazide **9** starting from *meso* dimesylate **6**, and the *meso* diastereomer **8** was not obtained from racemic mesylate **7**. Clean inversion during substitution reactions at benzylic positions is well known [12]. In the ^{1}H NMR spectrum the *meso*-diazide **8** shows two multiplets at 2.58–2.70 and 2.78–2.90 ppm, whereas the homotopic CH_2 protons of **9** resonate as a dd at 2.55 ppm ($J_1 = 7$ Hz, $J_2 = 4$ Hz) in accordance with the data of the corresponding diols **4** and **5**. The reduction of the diazides **8** and **9** to the diamines **10** and **11** worked smoothly when we used $SnCl_2$/thiophenol



Scheme 2

according to *Bartra* [13]. These diamines can also be obtained by N-N cleavage of the corresponding 4,5-dihydropyrazole **13** (see also Ref. [1]), but the overall yields are better starting from *β*-hydroxyketone **3**, especially for the *meso* diastereomer **10**.

4,5-Dihydropyrazole **13** was obtained from hydrazine hydrate and 1,3-*bis*(2,6-dichlorophenyl)-2-propen-1-one (**12**) which in turn was obtained by condensation of 2,6-dichlorobenzaldehyde and 2,6-dichloroacetophenone (Scheme 2).

Experimental

General remarks: see Ref. [1]. In order to avoid confusion due to the complex isotope pattern, mass spectral data are calculated for ^{35}Cl only.

1,3-Bis(2,6-dichlorophenyl)-3-hydroxypropan-1-one (**3**)

To a solution of 0.4 ml of diisopropylamine in 15 ml of absol. tetrahydrofuran (*THF*), 2 ml of *n*-BuLi solution (1.6 *M* in *n*-hexane) are added under N_2 within 5 min at −78°C. After stirring for 15 min, 480 mg (2.5 mmol) of 2,6-dichloroacetophenone (Lancaster) in 4 ml of absol. *THF* are added dropwise. After having reached 0°C, the solution is cooled again to −78°C, and 440 mg of 2,6-dichlorobenzaldehyde (Merck) in 4 ml of absol. *THF* are slowly added. After stirring for 1 h, the reaction is stopped by addition of 10 ml of satd. NH_4Cl solution.

When the mixture has reached room temp., it is extracted 3 times with 15 ml of Et_2O each, the org. phase is washed with brine (3x), dried (Na_2SO_4), and evaporated *in vacuo* affording a yellow oil which is purified by CC (SiO_2/CH_2Cl_2). Recrystallization (CH_2Cl_2/*n*-hexane 1:3) gives colourless crystals.

Yield: 500 mg (55%); m.p.: 74–76°C; IR (KBr): $\nu = 3500$ (OH, br), 3079 (C-H arom), 1705 (C=O), 1580, 1560, 1429 (C=C), 1086 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 3.19$–3.27 (dt; $^4J = 4$ Hz, $^2J = 3$ Hz, 2H, CH_2), 3.86–3.97 (dd; $^3J = 9$ Hz, $^4J = 4$ Hz, 1H, OH, exch.), 6.20–6.27 (m; 1H, CH), 7.12–7.33 (m; 6H, arom) ppm; EI-MS (70 eV): *m/z* (%) = 362 (5, $M^+\cdot$), 344 (10,

$(M - H_2O)^{+\cdot}$), 327 (12, $(M - \cdot Cl)^+$), 309 (35, $(344 - \cdot Cl)^+$) or $(327 - H_2O)^+$), 173 (100, $(C_6H_3Cl_2\text{-}C{=}O)^+$); $C_{15}H_{10}Cl_4O_2$ (364.0); calcd.: C 49.49, H 2.77; found: C 49.48, H 2.92.

1,3-Bis(2,6-dichlorophenyl)propane-1,3-diols **4** and **5** *(mixture of diastereomers)*

a) Reduction with BH_3/*THF*

At −15°C, 7.5 ml (7.5 mmol) of a 1 *M* solution of BH_3/*THF* are added dropwise to a solution of 1.8 g (5 mmol) of 3-hydroxypropanone **3** in 30 ml of absol. CH_2Cl_2. The solution is stirred at room temp. overnight. After cooling to 0°C, 30 ml of 1 *N* HCl are slowly added (evolution of H_2!), and the mixture is stirred for 30 min at this temperature. After separation of the phases, the aqueous layer is extracted twice with 20 ml of CH_2Cl_2 each, the combined org. phases are washed with water and twice with brine, dried (Na_2SO_4), and evaporated *in vacuo* affording a colourless oil which is purified by CC (SiO_2; CH_2Cl_2/MeOH 9:1).

Yield: 1.6 g (87%); IR (film): ν = 3600 – 3200 (OH, br), 3069 (C-H arom), 2919 (C-H aliphat.), 1595, 1574, 1562, 1472 (C=C), 1082 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 2.44–2.50 (dd; ^3J = 7 Hz, ^2J = 2 Hz, 1H, CH_2), 2.18–2.27 and 3.04–3.18 (m; 1H, CH_2) diastereomers (1:1), 3.04 (d; ^3J = 5 Hz, 1H, OH, exch.), 3.40 (d; ^3J = 5 Hz, 1H, OH, exch.), 5.66–5.75 (m; 1H, CH), 5.85–5.94 (m; 1H, CH), 7.11–7.31 (m; 6H, arom) ppm; FI/FD-MS (CH_2Cl_2): *m/z* (%) = 364 (70, $M^{+\cdot}$).

Analogous processing of **3** in absol. *THF* diminished the yield to 55%.

meso-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diol (**4**); *reduction with* BH_3/*THF and* BBr_3

Under N_2, 300 mg (0.83 mmol) of **3** are dissolved in 10 ml of absol. CH_2Cl_2. This solution is cooled to −78°C and carefully mixed with 0.8 ml (0.83 mmol) of BBr_3 dissolved in 3 ml of absol. CH_2Cl_2. After stirring for 10 min, 1.5 ml (1.5 mmol) of a 1 *M* solution of BH_3/*THF* are added at −78°C. After stirring for 6 h at this temp., 4 ml of absol. MeOH are added carefully. After warming to room temp., the solvents are removed *in vacuo* affording an orange suspension which is stirred with 15 g of SiO_2 and 15 ml of absol. MeOH overnight at room temp. After filtration, the cake is washed with 20 ml of absol. MeOH and absol. CH_2Cl_2 each, and the filtrate is evaporated *in vacuo*. The solid residue is purified by flash chromatography (SiO_2; CH_2Cl_2, then CH_2Cl_2/ethyl acetate 9:1) giving colourless crystals from CH_2Cl_2/*n*-hexane.

Yield: 187 mg (62%); *de*: 99:1 (^1H NMR); m.p.: 109–109.5°C; IR (KBr): ν = 3600–3300 (OH, br), 3079 (C-H arom), 2977, 2875 (C-H aliphat), 1582, 1563, 1437 (C=C), 1090 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 2.18–2.28 (dt; ^3J = 9 Hz, ^2J = 7 Hz, 1H, *H*CH), 3.05–3.18 (dt; ^3J = 9 Hz, ^2J = 7 Hz, 1H, HC*H*), 3.40 (d; ^3J = 4 Hz, 2H, CHO*H*, exch.), 5.66–5.75 (m; 2H, C*H*OH), 7.10–7.31 (m; 6H, arom) ppm; $C_{15}H_{12}Cl_4O_2$ (366.1); calcd.: C 49.22, H 3.30; found: C 48.92, H 3.57.

rac-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diol (**5**)

At −78°C, a solution of 500 mg of (*S*)-valinol [7] in 5 ml of absol. *THF* is mixed with 5 ml (5 mmol) of a 1 *M* solution of BH_3/*THF*. Then the mixture is stirred at room temp. overnight and cooled again to 0°C. A solution of 300 mg (0.83 mmol) of **4** in 4 ml of absol. *THF* is added dropwise. After stirring for 1 h at 0°C and overnight at room temp., 10 ml of 1 *N* HCl are slowly added at 0°C. After work-up (see above), the 1,3-diols **5** and **6** are obtained as a mixture of diastereomers which is separated by CC (SiO_2; CH_2Cl_2/ethyl acetate 9:1).

5: Colourless crystals, yield: 96 mg (32%); m.p.: 125–126°C; IR (KBr): ν = 3422 (OH, br), 3050 (C-H arom), 2919 (C-H aliphat), 1582, 1560, 1437 (C=C), 1088 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): δ = 2.44–2.50 (dd; ^3J = 5 Hz, ^2J = 2 Hz, 2H, CH_2), 3.04 (d; ^3J = 5 Hz, 2H, OH), 5.85–5.95 (m; 2H, CH), 7.10–7.32 (m; 6H, arom) ppm; $C_{15}H_{12}Cl_4O_2$ (366.1); calcd.: C 49.22, H 3.30; found: C 49.39, H 3.57.

1,3-Bis(2,6-dichlorophenyl)propane-1,3-diol bismethanesulfonates **6** *and* **7** *(mixture of diastereomers)*

700 mg (1.9 mmol) of a mixture of **4** and **5** are dissolved in 15 ml of absol. CH_2Cl_2; the solution is cooled to −15°C and mixed with 300 mg (3 mmol) of Et_3N. Within 5 min, 350 mg (2.3 mmol) of freshly distilled methanesulfonyl chloride are added dropwise under stirring. After further stirring for 20 min, 30 ml of absol. CH_2Cl_2 are added, the org. phase is washed with 20 ml of ice water, 25 ml of 2*N* HCl, satd. Na_2CO_3 solution, and brine, dried (Na_2SO_4), and the solvent is evaporated *in vacuo*. A weakly yellow oil is obtained which is dried for 3 h at the oil pump (660 mg; 66%) and used without purification.

IR (film): $\nu = 3042$, 3021 (C-H arom), 2936 (C-H aliphat.), 1582, 1564, 1441 (C=C), 1368, 1171 (SO_2) cm^{-1}.

meso-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diol bismethanesulfonate (**6**)

From 364 mg (1 mmol) of **4** as described for the mixture of **6** and **7**; 400 mg (77%).

rac-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diol bismethanesulfonate (**7**)

From 360 mg (1 mmol) of **5** as described for the mixture of **6** and **7**; 410 mg (80%).

1,3-Bis(2,6-dichlorophenyl)propane-1,3-diazides **8** *and* **9** *(mixture of diastereomers)*

Under N_2, 251 mg (0.5 mmol) of the above mixture of **6** and **7**, dissolved in 5 ml of absol. *DMF*, are stirred with 400 mg (6.1 mmol) of NaN_3 for 24 h at 60°C. After cooling the mixture is carefully poured into 25 ml of ice water and extracted five times with 15 ml of Et_2O each. The Et_2O phase is washed with brine, 1 *N* HCl, and brine again (two times each), dried (Na_2SO_4), and evaporated *in vacuo*. Drying at the oil pump affords 126 mg (63%) of a mixture of **8** and **9**.

IR (film): $\nu = 3062$ (C-H arom), 2101 (N_3), 1580, 1562, 1435 (C=C), 1082 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 2.50$ (dd; $J = 4$ Hz, $J = 7$ Hz, 1H, *H*CH), 2.58–2.90 (m; 1H, HC*H*), 5.42 and 5.80 (dd; $J = 4$ Hz, $J = 7$ Hz, 2H, CHN_3), 7.15–7.40 (m; 6H, arom) ppm.

meso-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diazide (**8**)

From 498 mg (0.95 mmol) of **6** as described for the mixture of **8** and **9**.

Yield: 270 mg (68%); colourless crystals (Et_2O/*n*-hexane); m.p.: 95–96°C (dec.); IR (KBr): $\nu = 3079$ (C-H arom), 2932 (C-H aliphat), 2099 (N_3), 1580, 1562, 1501 (C=C) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 2.58$–2.90 (m; 2H, CH_2), 5.42 (dd; $J = 3.8$ Hz, $J = 6.9$ Hz, 2H, CHN_3), 7.18–7.38 (m; 6H, arom) ppm; $C_{15}H_{10}Cl_4N_6$ (416.1); calcd.: C 43.30, H 2.42, N 20.20; found: C 43.69, H 2.85, N 19.80.

rac-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diazide (**9**)

From 502 mg (0.96 mmol) of **7** as described for the mixture of **8** and **9**.

Yield: 300 mg (75%); colourless crystals (Et_2O/*n*-hexane); m.p.: 124–124.5°C (dec.); IR (KBr): $\nu = 3060$ (C-H arom), 2957 (C-H aliphat), 2101 (N_3), 1580, 1562, 1435 (C=C) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 2.55$ (dd; $J = 4$ Hz, $J = 7$ Hz, 2H, CH_2), 5.79 (dd; $J = 4$ Hz, $J = 7$ Hz, 2H, CHN_3), 7.37–7.17 (m; 6H, arom) ppm; $C_{15}H_{10}Cl_4N_6$ (416.1); calcd.: C 43.30, H 2.42, N 20.20; found: C 43.59, H 2.67, N 19.76.

meso-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diamine (**10**)

From 150 mg (0.36 mmol) of **8** as described for racemate **11**.

Yield: 93 mg (71%); colourless oil; IR (film): $\nu = 3395–3100$ (NH, br), 3070 (C-H arom), 1580, 1561 (C=C), 1079 (C-Cl, arom) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 2.20$ (s, br; 4H, NH_2), 2.45–2.56 (m; 1H, *H*CH), 2.63–2.72 (m; 1H, HC*H*), 4.74 (dd; $^3J = 6.4$ Hz, $^2J = 1.6$ Hz, 2H, C*H*NH_2), 7.03–7.32 (m; 6H, arom) ppm; FAB-MS (glycerol/H_2O): *m/z* (%) = 363 (MH^+ of free diamine).

rac-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diamine (**11**)

Under N_2, 189 mg (1 mmol) of $SnCl_2$ are dissolved in 5 ml of absol. *THF*, mixed with 0.5 ml of PhSH and 5 ml on Et_3N, and stirred for 5–10 min. Then, 150 mg (0.36 mmol) of racemate **9** are added at once. After stirring for 40 min at room temp., the solvent is evaporated. The yellow residue is stirred with 2 *N* NaOH and CH_2Cl_2 (20 ml each) until the yellow colour disappears. The phases are separated, and the aqueous layer is extracted twice with CH_2Cl_2. The combined org. phases are washed twice with brine, dried (Na_2SO_4), and evaporated. The remaining yellow oil is dissolved in 30 ml of 2 *N* HCl; the acidic solution is extracted three times with 20 ml of Et_2O each (discarded), the aqueous phase is alkalized with conc. NH_3 and extracted three times with Et_2O (20 ml each). The org. phase is washed with brine, dried, and evaporated *in vacuo*.

Yield: 100 mg (76%); colourless oil; IR (film): $\nu = 3400–3200$ (NH, br), 3069 (C-H, arom), 1580, 1560, 1435 (C=C), 1078 (C-Cl, arom) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 2.05–2.40$ (s, br; 4H, NH_2), 2.45 (t; $^3J = 6$ Hz, 2H, CH_2), 5.15 (t; $^3J = 6$ Hz, 2H, C*H*NH_2), 6.92–7.55 (m; 6H, arom) ppm.

(E)-1,3-Bis(2,6-dichlorophenyl)-2-propen-1-one (**12**)

Under vigorous stirring, a solution of 5.1 g of NaOH (130 mmol) in 500 ml of EtOH/H_2O 1/1 is mixed simultaneously with 17.5 g (100 mmol) of 2,6-dichlorobenzaldehyde and 18 g (100 mmol) of 2,6-dichloroacetophenone. After stirring for 12 h, the solution is cooled to 0°C and stirred for 60 min at this temperature. The crude chalcone is sucked off, washed with 50 ml of cold EtOH/H_2O 1/1, dried, and recrystallized from EtOH 99%.

Colourless crystals; yield: 31.1 g (90%); m.p.: 124–125°C; IR (KBr): $\nu = 3073$ (C-H arom), 1665 (C=O) 1578, 1560, 1431 (C=C) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 7.10$ (d; $^3J = 16$ Hz, 1H, =CH), 7.36 (d; $^3J = 16$ Hz, 1H, =CH), 7.15–7.50 (m; 6H, arom) ppm; $C_{15}H_8Cl_4O$ (346.0); calcd.: C 52.07, H 2.23; found: C 51.49, H 2.53.

3,5-Bis(2,6-dichlorophenyl)-4,5-dihydropyrazole (**13**)

13 was prepared using the protocol given in Ref. [1], starting from 3.5 g (10 mmol) of **12**.

Colourless crystals; yield: 2.5 g (70%); decomposes upon contact with air (brownish discolouration); IR (film): $\nu = 3347$ (NH, br), 3050 (C-H arom) 1582 (C=N), 1560 and 1429 (C=C), 1086 (C-Cl arom) cm^{-1}; ^1H NMR ($CDCl_3$): $\delta = 3.07–3.35$ (dd; $^3J = 12$ Hz, $^2J = 5$ Hz 2H, CH_2), 5.70 (t; $^3J = 12$ Hz, 1H, CHN) 6.90–7.17 (m; 6H, arom) ppm; EI-MS (70 eV): *m/z* (%) = 358 (50, $M^{+\cdot}$), 323 (15, $(M - \cdot Cl)^+$), 288 (10, $(323 - \cdot Cl)^{+\cdot}$).

N,N′-Bisacetyl-1,3-bis(2,6-dichlorophenyl)propane-1,3-diamines (**14** *and* **15**)

These diastereomers were prepared from 2 g (5.5 mmol) of **13** according to Ref. [1].

meso-N,N′-Bisacetyl-1,3-bis(2,6-dichlorophenyl)propane-1,3-diamine (**14**)

Colourless crystals; yield: 74 mg (3%); m.p.: 115–117°C; (absol. MeOH); IR (KBr): $\nu = 3301$ (NH, br), 3071 (C-H arom), 2932 (C-H aliphat), 1655 (C=O), 1580, 1560, 1541 and 1437 (C=C), 1040

(C-Cl arom) cm^{-1}; ^1H NMR (*DMSO*-d_6): $\delta = 1.76$ (s; 6H, $COCH_3$), 2.03–2.15 (m; 1H, *H*CH), 2.34–2.45 (m; 1H, CH*H*), 5.25–5.34 (m; 1H, C*H*NH), 5.58–5.67 (m; 1H, C*H*NH), 7.24–7.69 (m; 6H, arom), 8.08 (d; $J = 8$ Hz, 1H, N*H*$COCH_3$), 8.15 (d; $J = 8$ Hz, 1H, N*H*$COCH_3$) ppm; $C_{19}H_{18}Cl_4N_2O_2$ (448.2); calcd.: C 50.90, H 4.04, N 6.25; found: C 50.55, H 4.34, N 5.95.

rac-N,N′-Bisacetyl-1,3-bis(2,6-dichlorophenyl)propane-1,3-diamine (**15**)

Colourless crystals; yield: 700 mg (28%); m.p.: 129–131°C (MeOH/$CHCl_3$ 1:1); IR (KBr): $\nu = 3444$ (NH, br), 3067 (C-H arom), 2930 (C-H aliphat), 1665 (C=O), 1580, 1562 and 1438 (C=C), 1036 (C-Cl arom) cm^{-1}; ^1H NMR (*DMSO*-d_6): $\delta = 1.81$ (s; 6H, $COCH_3$), 2.33–2.69 (m; 2H, CH_2, partially overlapped by the solvent signal), 5.29 (dd; $J = 7$ Hz, $J = 14.1$ Hz, 1H, C*H*NH), 5.65 (dd; $J = 7$ Hz, $J = 14.1$ Hz, 1H, C*H*NH), 7.19–7.40 (m; 6H, arom) 8.53 (d; $J = 6$ Hz, 2H, N*H*$COCH_3$) ppm; EI-MS (70 eV): *m/z* (%) = 411 (70, $(M - \cdot Cl)^+$, *ortho*-effect); $C_{19}H_{18}Cl_4N_2O_2$ (448.2); calcd.: C 50.90, H 4.04, N 6.25; found: C 50.59, H 4.45, N 5.95.

meso-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diamine (**10**)

Prepared from **14** (224 mg, 0.5 mmol) following the protocol given in Ref. [1]; yield: 123 mg (68%); data see above.

rac-1,3-Bis(2,6-dichlorophenyl)propane-1,3-diamine (**11**)

Prepared from **15** (426 mg, 0.95 mmol); yield: 254 mg (73%); data see above.

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