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Pericyclic Domino Reactions with 3,6-Bis(trifluoromethyl)-1,2,4,5-tetrazine: A Convenient Entry into Azo Cage Compounds

Thilo Klindert, Peter von Hagel, Luzian Baumann and Gunther Seitz

Marburg, Pharmazeutisch-Chemisches Institut der Universität

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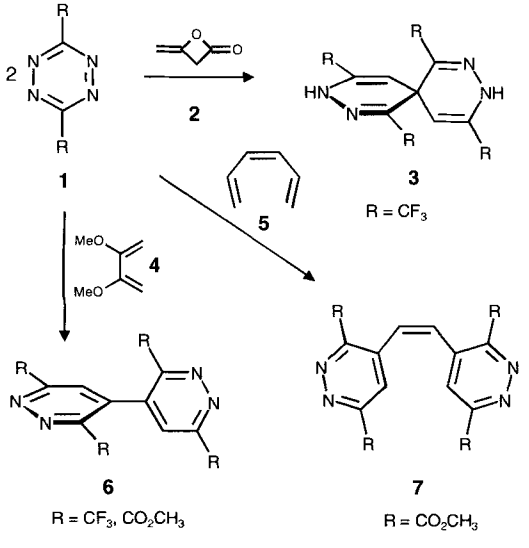
Abstract. 3,6-Bis(trifluoromethyl)-1,2,4,5-tetrazine (**1**) characterized by a highly reactive, electron deficient diazadiene system reacted with several cyclic and acyclic bis-dienophiles to yield the cage compounds **11**, **19a,b**, **31a,b** and **41** in a pericyclic homo-domino reaction in good yields. The first step of the domino reactions is an inverse electron demand intermolecular Diels–Alder addition followed by elimination of nitrogen to give 4,5-dihydropyridazines which then undergo a terminal ring closure to yield the cage compounds. The solvent employed and the reaction temperature is of crucial importance. Whereas in nitromethane and at elevated temperatures the main products are the cage compounds, at lower temperature and in dichloromethane as solvent the initially formed 4,5-dihydropyridazines are frequently converted to 1,4-dihydropyridazines by a 1,3-H-shift. Treatment of the tetrazine **1** with cyclooctatriene **23** did not lead to a cage compound in any case; instead *via* valence tautomeric species *octa*-1,3,5,7-tetraene **23a** and bicyclo[4.2.0]octa-2,4-diene **23b** the twofold pyridazine-substituted butadienes **24** and **26** together with the tricyclic cyclobuta[*f*]phthalazine **25** were formed.

As we have recently shown, diketene **2**, dimethoxy butadiene **4** and hexatriene **5** proved to be most suitable α,ω-bis-dienophiles [1–3] in the inverse electron demand Diels-Alder (IEDDA) cycloaddition [4]. Combining altogether at least four pericyclic processes they react stepwise with the *s-cis* fixed diazadiene system of 3,6-bis(trifluoromethyl)-1,2,4,5-tetrazine (**1**) [5] to yield differently constructed bispyridazines.



Thus treatment of **1** with the allene synthon **2** afforded the spiro compound **3** after a multistep reaction – including two cycloadditions, two retro-Diels–Alder reactions, extrusion of CO_2 and two tautomeric 1,3-*H*-shifts. A similar sequence of cycloadditions/cycloreversions was realized with the conjugated α,ω-carbodiene **4**, which reacted twice with the tetrazine **1** to yield the bipyridazinyl derivative **6**, after additional elimination of two molecules of methanol. The hexatriene **5** was found to furnish the tetraazastilbene **7** after α- and ω-cycloaddition, twofold N_2 extrusion and oxidation of the primarily formed tetrahydro derivative.

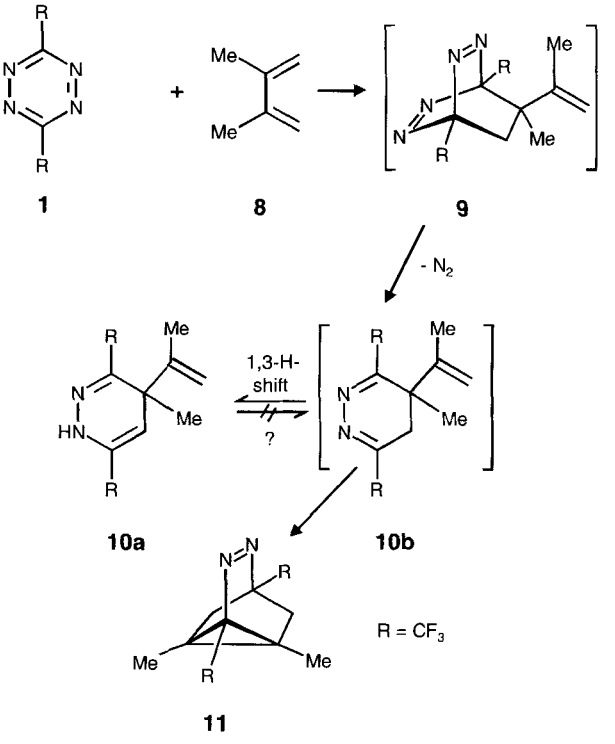
The polyenes **4** and **5** are substrates with two dienophilic functionalities, which undergo transformations individually in the same pot; thus these reactions do not meet the strict definition of a pericyclic domino reaction [6]. In contrast to this, the sequence of pericyclic bond forming and bond breaking transformations taking place during the reaction of the tetrazine **1** with diketene (**2**) can be considered as a domino reaction because the second dienophilic step occurs at a functionality generated by extrusion of CO_2 in the proceeding step. As is well known from the literature such combinations of a retro-Diels–Alder and a Diels–Al-

der reaction with a judiciously chosen bis dienophile has opened many attractive possibilities to use pericyclic domino reactions for the preparation of various interestingly constructed cage compounds [7]. However attempts to apply the profitable domino IEDDA reaction route to 1,2,4,5-tetrazines were only partially successful [7a,d]. The multistep route normally starts with an intermolecular [4+2] cycloaddition of an appropriate bis dienophile towards the electron-deficient diene of the tetrazine followed by a retro-Diels–Alder reaction. Extrusion of N_2 from the primary Diels–Alder adduct leads to a 4,5-dihydropyridazine with a reformed 4π-diazadiene system. This key intermediate tethered with a suitably placed side chain dienophile reacts in a terminal intra-molecular Diels–Alder ring closure – thus fulfilling the conditions for a pericyclic homo-domino reaction [6] – to yield compounds with most interesting cage skeletons. Unfortunately in most cases investigated the primarily formed 4,5-dihydropyridazine allows a competition between terminal intramolecular cycloaddition and tautomeric 1,3-hydrogen shift. Although intramolecular Diels–Alder reactions are often more facile than their intermolecular counterparts because of favourable entropic assistance, very often the competitive 1,3-hydrogen shift was observed to be more rapid. The intermediate 4,5-dihydropyridazine thus irreversibly rearranges to the corresponding 1,4-dihydropyridazine. This loss of conjugation of the azadiene double bonds precludes any further intramolecular cycloaddition and thus the pericyclic homo–domino reaction.

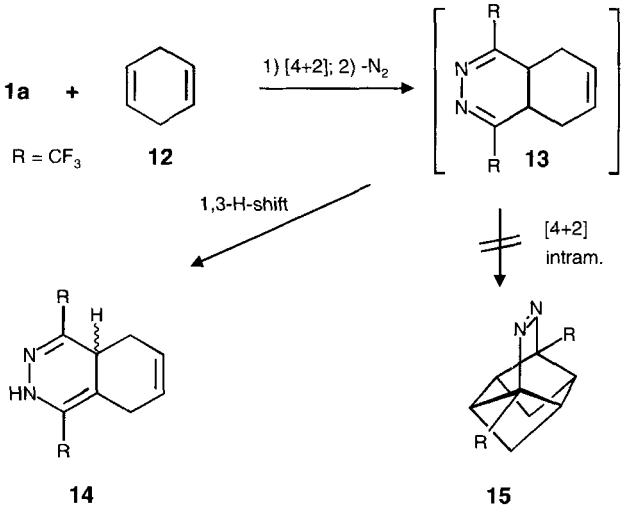
Results and Discussion

In the case of the reaction of the tetrazine **1** with 2,3-dimethyl-buta-1,3-diene (**8**) we observed for the first time, that the reaction pathway followed is solvent and temperature dependent.

Running the reaction of the diene **1** and the bis-dienophile **8** in $CHCl_3$ at room temperature for 1 h the 1,3-hydrogen shift of the key intermediate **10b** is the only reaction pathway realized providing the 1,4-dihydropyridazine **10a** nearly quantitatively (95% yield). An unexpected change of the reaction route was enforced by employing nitromethane as solvent. Heating a solution of **1** and **8** for 12 h at 130 °C in this solvent the terminal intramolecular cycloaddition became the preferred reaction route of **10b** furnishing the novel cage compound **11** in 90% yield as the outcome of a pericyclic homo-domino reaction. Unfortunately, this finding could not be generalized. For example treatment of isoprene under the same conditions gave the corresponding 1,4-dihydro-3,6-bis(trifluoromethyl)-4-(1'-methylvinyl)-pyridazine as the only reaction product making no difference between the solvent used [2].

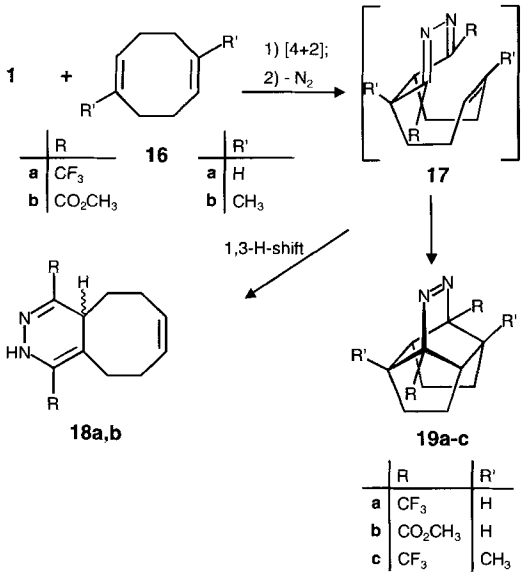


Interesting tetracycles characterized by an azo group were expected by a pericyclic homo-domino reaction with some cyclic α,ω-dienes.



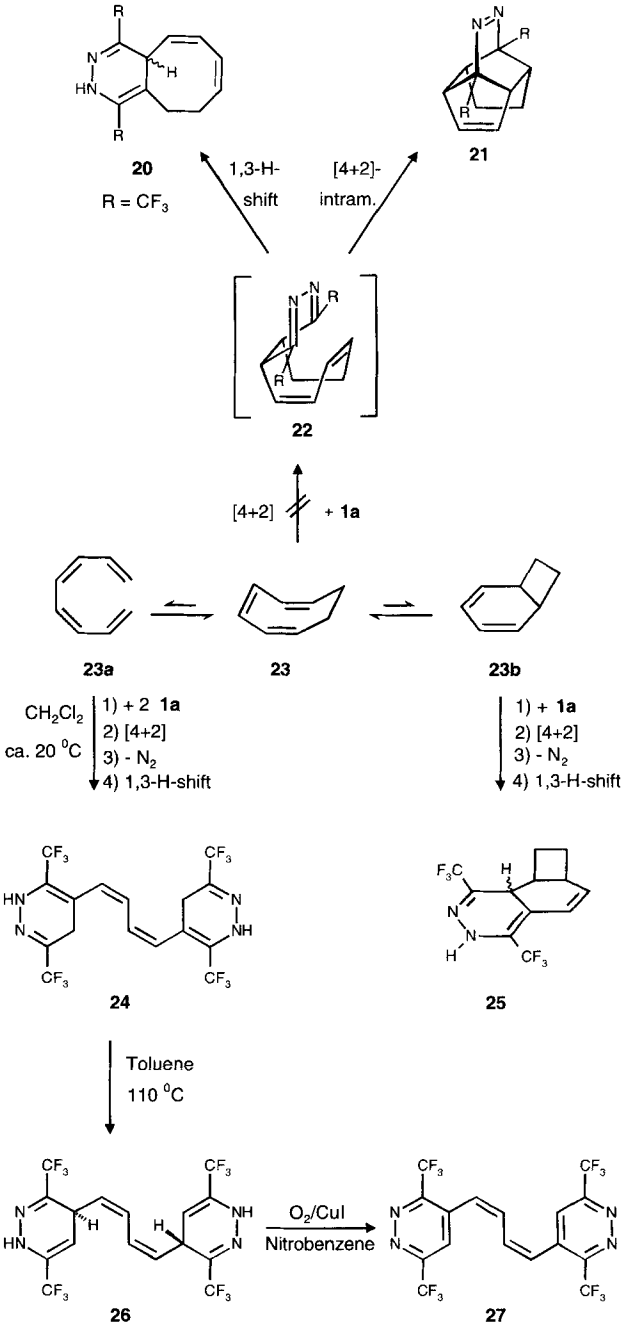
Treatment of **1a** with equimolar amounts of cyclohexa-1,4-diene (**12**) should furnish the tetracyclic azo compound **15**. Obviously steric effects render the terminal intramolecular [4+2] cycloaddition difficult, thus the primarily formed diazadiene **13** exclusively reacts by the undesired 1,3-hydrogen shift giving the phthalazine **14** nearly quantitatively. All attempts to effect the pericyclic domino reaction by varying the reaction conditions failed.

Cycloocta-1,5-diene (**16a**, COD) has already been treated with 3,6-bis(methoxycarbonyl)-1,2,4,5-tetrazine **1b** (R = CO_2CH_3). The results however are contradictory. In boiling toluene no cage compound like **19b** was obtained; the sole product isolated from the reaction of tetrazine **1b** with COD **16a** was the 1,4-dihydropyridazine **18b** arising from tautomerisation of the primarily formed adduct **17b** [7d]. However running the reaction in CH_2Cl_2 at 20 °C both possible reaction pathways are realized furnishing **18b** (yield 41%) as well as the cage compound **19b** (yield 37%) [7a].



In sharp contrast to these findings the highly reactive tetrazine **1a** gave the desired cage compound **19a** nearly quantitatively. Heating **1a** and COD **16a** in dry toluene for 5 h led to the initial Diels–Alder product; this can extrude nitrogen to give the 2,3-diaza-1,3-diene **17a**, from which the cage compound **19a** arises *via* intramolecular ring closure. There were no hints (TLC-control) for the formation of the annulated dihydropyridazine **18a**, even if the reaction was run at 0 °C. In the same fashion 1,5-dimethyl-1,5-COD (**16b**) reacted with **1a**, however under more drastic conditions (nitromethane, 130 °C, autoclave), furnishing the novel cage compound **19c** in 90% yield.

These successful transformations prompted us to extend our studies to the question whether cyclooctatriene **23** would be able to enter as bis-dienophile into the same type of pericyclic homo-domino reactions. We expected the final product to be the novel cage compound **21** formed from the primary intermediate **22** by intramolecular ring closure and distinguished from **19a** by an additional double bond. However treatment of cyclooctatriene **23** with the tetrazine **1a** in CH_2Cl_2 at room temperature for ten days resulted in the formation of two



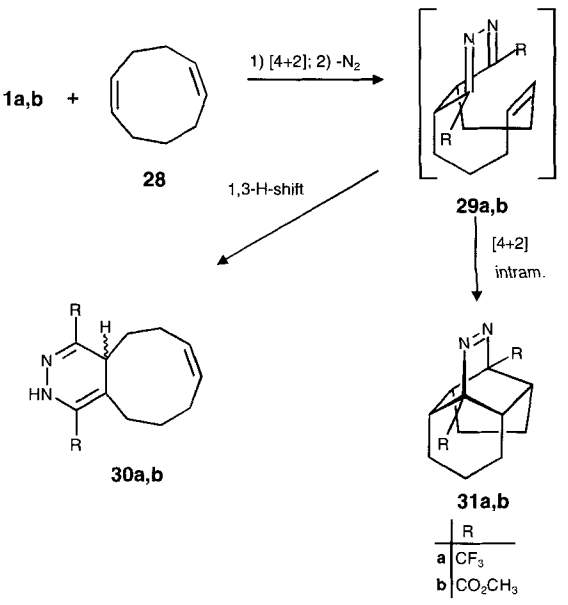
types of products, a 1:2 and a 1:1 cycloadduct (after N_2 extrusion). The all-*cis*-1,4-bispyridazinyl-buta-1,3-diene **24** was the major product (yield 75%) accompanied by the tricyclic cyclobuta[*f*]phthalazine **25** (yield 10%). Running the reaction of **23** and **1a** in boiling toluene for one hour the tricyclic compound **25** was the preferred reaction product (yield 58%); besides a second 1:2 cycloadduct, the 1,4-bispyridazinyl-buta-1,3-diene **26**, a tautomer of **24** (yield 14%), could be isolated and characterized.

These findings could be reasonably explained taking into consideration the well established valence tau-

tomeric equilibria between cycloocta-1,3,5-triene (**23**), and all-*cis*-octa-1,3,5,7-tetraene (**23a**) on the one hand and between **23** and bicyclo[4.2.0]octa-2,4-diene (**23b**) on the other hand [8].

As parts of the valence tautomeric system **23a** ⇄ **23** ⇄ **23b** all of the three components were supposed to be able to react as dienophiles, however with different reactivity. At room temperature the tetraene **23a** proved to be most reactive displaying double cycloaddition to the diazadiene **1a**. After N_2 extrusions and subsequent 1,3-H-shifts the twofold pyridazine substituted butadiene **24** was isolated as major reaction product. The competition between both the dienophilic **23a** and **23b** for the diazadiene system of **1a** is plausibly dominated by **23a**, because at room temperature the equilibrium **23** ⇄ **23b** is immobile [8a]. Thus only minor amounts of **25** are formed.

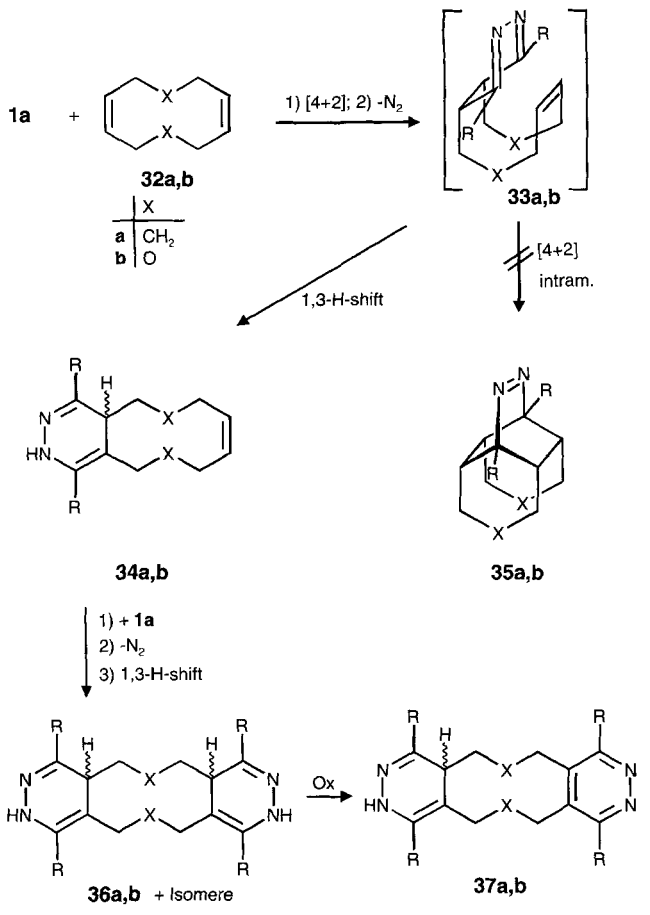
However running the reaction at temperatures where the equilibrium **23** ⇄ **23b** is mobile (*e.g.* in boiling toluene) the cycloaddition of the most reactive dienophile **23b** becomes the preferred reaction pathway furnishing now **25** as the main reaction product. Obviously **23** itself is the least reactive dienophile compared with the other two valence tautomers **23a** and **23b** because there are no hints (TLC control) indicating the formation of cycloaddition products like **20** or **21**. The 1:2 and 1:1 nature (minus 2 or 1 mol of N_2) of **24**, **25** and **26** was shown by mass spectrometry and elemental analysis. The structures of the three compounds were mainly assigned on the basis of their ^1H- and ^{13}C NMR spectra (see Experimental). The ^{13}C NMR-spectra of **24** and **26** are characterized each by 8 signals only, thus both butadienes must be specimens with a centre of symmetry. In addition the two double bonds preserved their *Z* geometry, indicated by the coupling constants $^3J_{HH}$= 10 Hz or 9 Hz resp. for the olefinic protons of the butadiene systems. The stereochemistry of **25** could not be elucidated definitively. Dehydrogenation of **26** with O_2/CuI in boiling nitrobenzene led to the corresponding oxidation product **27**, confirming the constitution of **26**. As a logical extension of the successful homo-domino reaction with COD **16** we examined several other cyclic bis dienophiles. For instance cyclononadiene **28** was employed as starting material. Indeed, the multistep reaction with diazadiene **1a** started with the intermolecular IEDDA cycloaddition. Extrusion of N_2 from the primary Diels–Alder adduct reformed the diazadiene system **29a**, which in the terminal intramolecular Diels–Alder reaction led to the novel cage compound **31a** with 77% yield as sole reaction product. The corresponding tetracyclic azo compound from **28** and **1b** was received with 55% yield. Under the conditions employed, dihydropyridazines like **30** could not be detected, showing that the intramolecular cycloaddition in these cases was much faster than the tautomeric 1,3-H-shift.



Novel cage compounds of type **35a,b** (X = CH_2, O) were expected from the homo-domino reactions of **1a** with the cyclodecadienes **32a,b**. With these ten-membered cyclic bis-dienophiles as starting materials we tried to investigate the effect of increasing distances between the two olefinic double bonds. It was conceivable that in these cases the intramolecular trapping might be less effective. The results achieved were disappointing.

Refluxing a solution of the cyclodeca-1,6-diene **32a** in dioxane for 10 h led to a mixture of products, which could be separated by column chromatography. Major product was the cyclodeca-dihydropyridazine **34a** (49%), representing the tautomerization product of the primarily formed intermediate **33a**. Attempts to convert the 1,4-dihydropyridazine **34a** to **35a** by treatment with trifluoroacetic acid (compare *e.g.* [7a,b]) were not successful. Besides a mixture of twofold pyridazine-fused cyclodecanes of type **36a** were separated (36%) arising by a second attack of the diazadiene **1a** at the intermediate **33a**. The mixture of isomeric compounds like **36a** could be transformed by excess dichloro-dicyano-*p*-benzoquinone to yield racemic **37a** as sole oxidation product in 28% yield. Obviously in this case 1,3-hydrogen shift and/or the subsequent second intermolecular cycloadditon with **1a** occured at a much faster rate than the desired intramolecular ring closure of **33a**, leading to the cage compound **35a**.

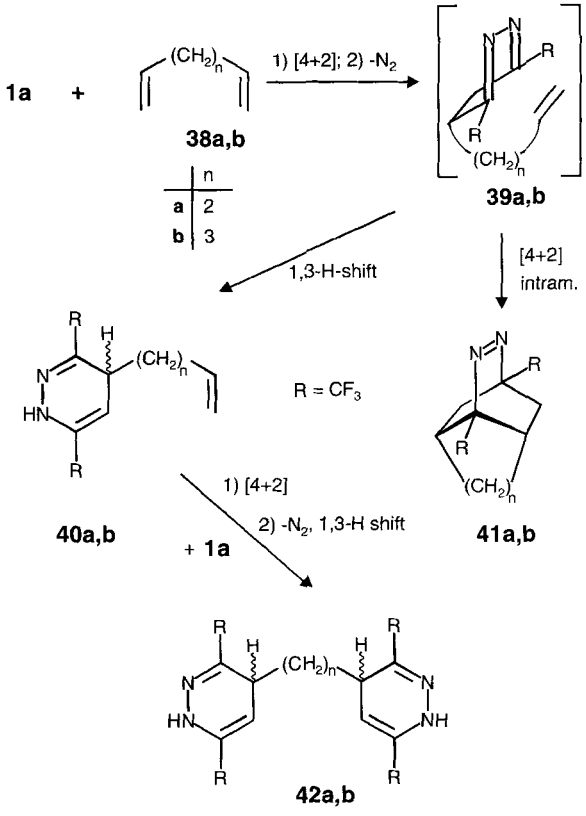
The 1,6-dioxa-cyclodeca-3,8-diene **32b** reacted in a similar way. Surprisingly, the *preferential* reaction pattern in this case only involves a second intermolecular cycloaddition at the tetrazine azadiene moiety with the remaining double bond of the probable intermediate **33b**, leading to a mixture of the twofold annulated di-



oxa-cyclodecadienes like **36b**, which were easily oxidized to furnish racemic **37b** (86% yield). An appreciable conversion of **33b** leading to the cage compound **35b** was again not achieved.

Similarly disappointing results were obtained when the open-chain α,ω-carbodienes **38a,b** were used in place of the cyclodienes *e.g.* like **32**. When the bis-dienophile **38a** was allowed to react with the tetrazine **1a** at room temperature in dichloromethane the dihydropyridazine **40a** was isolated in 97% yield as the outcome of sequential reactions involving an intermolecular cycloaddition followed by N_2 elimination from the primary adduct and a terminal tautomeric 1,3-H-shift of **39a**. Interestingly, a different reaction course was observed, when nitromethane was used instead of dichloromethane. Heating the solution at reflux for 4 d again the dihydropyridazine **40a** was formed as the main product however together with 28% of the cage compound **41a** as the result of a pericyclic homo–domino reaction via the intermediate **39a**. Obviously under these drastic reaction conditions, more polar solvent and elevated temperature, the intramolecular trapping becomes more effective allowing a competition between 1,3-H-shift and terminal intramolecular ring closure.

Even under more drastic reaction conditions (nitromethane, 140 °C, sealed tube), hepta-1,6-diene **38b** did not react in the desired sense to yield the cage compound **41b**. Obviously increasing chain-length prevented the intramolecular cycloaddition or rendered it less effective. Thus in the reaction of **38b** with **1a** the 1,3-*H* shift is the main reaction course of **39b** observed, furnishing the dihydropyridazines **40b** (80%) and **42b** (4%). Running the reaction of **38b** with two equivalents of **1a** in dichloromethane at room temperature for 1 h **42b** is obtained in 90% yield.



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Experimental

General procedures: Standard vacuum techniques were used in handling of air sensitive materials. – Melting points are uncorrected: "Leitz-Heiztischmikroskop" HM-Lux. – Solvents were dried and freshly distilled before use according to literature procedures. – IR: Perkin Elmer 257, 398 and FT-IR spectrometer 510-P (Nicolet). Liquids were run as films, solids

as KBr pellets. ^{1}H NMR and ^{13}C NMR: JeolJNM-GX 400 and LA500; δ/ppm=0 for tetramethylsilane, 7.26 for chloroform. – MS: Vacuum Generators 7070 (70 eV; ^{11}B). – Column chromatography: Purifications were carried out on Merck silica gel 60 (70–260 or 200–400 mesh), flash chromatography. – Reactions were monitored by thin-layer chromatography (TLC) by using plates of silica gel (0.063–0,200 mm, Merck) or silicagel-60-F_{254} microcards (Riedel de Häen). – Optical rotations: Mod. Dip-370 polarimeter (Jasco). – UV: UV/Vis scanning spectrophotometer UV-2101 PC (Shimadzu).

1,4-Dihydro-4-methyl-3,6-bis(trifluoromethyl)-4-(1'-methylvinyl)-pyridazine (**10a**)

A solution of 164 mg (2.0 mmol) of 2,3-dimethylbuta-1.3-diene and 436 mg (2.0 mmol) of **1** in 10 ml of $CHCl_3$ was stirred at room temperature for 1 h. After this time the red color of **1** disappeared. The solvent was removed *in vacuo* and the resulting solid purified by recrystallisation from diethyl ether/*n*-hexane 1:1. Yield 515 mg (95%), colorless crystals, *m.p.* 48 °C. – IR (KBr): ν/cm^{-1} = 3340 (NH), 1627 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 290 (3.139), 228 (3.440). – ^{1}H NMR ($CDCl_3$): δ/ppm = 7.77 (bs, 1H, N-H), 5.00 (dt, 1H, ^2J = 1.19 Hz, $^4J_{allyl}$ = 1.25 Hz, 2'-H), 4.96 (d, 1H, ^2J = 1.2 Hz, 2'-H), 4.84 (s, 1H, 5-H), 1.79 (q, 3H, $^5J_{CF}$ = 0.7 Hz, 4-methyl-H), 1.50 (d, 3H, ^4J = 1.24 Hz, methyl-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 146.56 (CH, C-5), 135.60 (q, ^2J = 31.51 Hz, C-3), 127.27 (q, $^2J_{CF}$ = 35.1 Hz, C-6), 121.46 (q, $^1J_{CF}$ = 275.9 Hz, CF_3), 120.05 (q, $^1J_{CF}$ = 272.4 Hz, CF_3), 112.70 (CH_2, C-1'), 108.59 (C-2'), 39.86 (C-4), 24.81, 20.05 (2 $\underline{C}H_3$). – MS (70 eV, 20 °C): *m/z* (%); 272 (2) [M$^+$], 256 (14) [M–CH_3], 73 (100).

$C_{10}H_{10}F_6N_2$	calcd.:	C 44.13	H 3.70
(272.2)	found:	C 43.87	H 3.72.

1,7-Dimethyl-2,5-bis(trifluoromethyl)-3,4-diaza-tricyclo [3.2.1.0^{2,7}] oct-3-ene (**11**)

A solution of 260 mg (2.0 mmol) of 2,3-dimethyl-buta-1,3-diene and 436 mg (2.0 mmol) of **1** in 10 ml of nitromethane was heated for 12 h at 130 °C in a 50 ml autoclave. After cooling at room temperature the solvent is removed *in vacuo* and the brown oily residue purified by column chromatography (silica gel, 15×3 cm, eluant: *n*-hexane/10% ethyl acetate). Yield 490 mg (90%), colorless crystals, *m.p.* 85 °C. – IR (KBr): ν/cm^{-1} = 2951, 1360, 1142, 1061, 973, 943, 846, 800, 744, 670, 575, 516, 502. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 351 (1.628), 211 (3.030). – ^{1}H NMR ($CDCl_3$): δ/ppm = 1.97 (d, 2H, ^2J = 12.95 Hz, 6-H u. 8-H), 1.45 (s, 6H, methyl-H), 0.96 (d, 2H, ^2J = 12.63 Hz, 6-H . 8-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 125.3 (q, $^1J_{CF}$ = 277.0 Hz, CF_3), 125.14 (q, $^1J_{CF}$ = 275.0 Hz, CF_3), 75.7 (q, $^2J_{CF}$ = 29.4 Hz, C-5), 63.9 (q, $^2J_{CF}$ = 31.8 Hz, C-2), 35.4 (C-1 u. C-7), 30.65 (CH_2, C-6 u. C-8), 10.13 ($\underline{C}H_3$), 10.10 ($\underline{C}H_3$). – MS (70 eV, 30 °C); *m/z* (%): 272 (3) [M$^+$], 244 (12) [M–N_2], 229 (62) [244-CH_3], 209 (100).

$C_{10}H_{10}F_6N_2$	calcd.:	C 44.13	H 3.70	N 10.29
(272.2)	found:	C 44.10	H 3.94	N 9.85.

1,4-Bis(trifluoromethyl)-2-4a,5,8-tetrahydro-phthalazine (**14**)

A solution of 160 mg (2.0 mmol) of cyclohexa-1,4-diene **12** and 36 mg (2.0 mmol) of **1** in 5 ml of CH_2Cl_2 was stirred at room temperature for 12 h. During this time the red color of the reaction mixture disappeared. After evaporating of the solvent *in vacuo* the residue was purified by column chromatography (silica gel, 10×2 cm, eluant: *n*-hexane/ethyl acetate 9:1). Yield 535 mg (95%), colorless crystals, *m.p.* 118 °C. – IR (KBr): ν/cm^{-1} = 3378 (NH). – ^{1}H NMR ($CDCl_3$): δ/ppm = 7.60 (bs, 1H, N-H), 5.68 (m, 2H, 6-H and 7-H), 3.31 (m, 1H, 4a-H), 3.01 (d, 1H, ^3J = 19.4 Hz, 8-H), 2.81 (d, 1H, ^3J = 19.4 Hz, 8-H), 2.42 (m, 2H, 5-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 151.03 (q, $^2J_{CF}$ = 32.97 Hz, C-4), 151.02 (q, $^2J_{CF}$ = 33.38 Hz, C-1), 136.61 (C-8a), 121.51, 121.40 (2q, $^1J_{CF}$ = 276.8 Hz, CF_3), 121.12, 121.08 (2 CH, C-6 and C-7), 38.51 (CH, C-4a), 24.42, 24.36 (2 CH_2, C-5 and C-8). – MS (70 eV, 30 °C); *m/z* (%): 270 (11) [M$^+$], 268 (100).

$C_{10}H_8F_6N_2$	calcd.:	C 44.46	H 2.98	N 10.37
(270.18)	found:	C 44.63	H 2.83	N 10.66.

1,10-Bis(trifluoromethyl)11,12-diazatetra-cyclo [7.3.0^{2,9}.0^{5,6}]dodec-11-ene (**19a**)

A solution of 432 mg (2.0 mmol) of 1,5-COD **16a** and 436 mg (2.0 mmol) of **1a** in 15 ml of dry toluene was refluxed for ca. 5 h until the red color of **1a** disappeared. The solvent was evaporated *in vacuo* and the crystalline residue purified by recrystallization from *tert*-butyl-methyl-ether. Yield 570 mg (95%) colorless needles, *m.p.* 122 °C. – IR (KBr): ν/cm^{-1} = 3028, 1593, 1575, 1300, 1082. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 354 (2.298). – ^{1}H NMR ($CDCl_3$): δ/ppm = 2.67 (d, 4H, ^2J = 10.38 Hz, ^3J = 1.6 Hz, methylene-H), 2.19 (d, 4H, ^3J = 1.60 Hz, methine-H), 1.94 (brd., 4H, ^2J = 10.75 Hz, methylene-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 128.45 (q, $^1J_{CF}$ = 281.2 Hz, CF_3), 80.57 (q, $^2J_{CF}$ = 24.8 Hz, C-1a, C-10), 40.37 (CH, C-2, C-5, C-6 and C-9), 23.82 (CH_2, C-3, C-4, C-7 and C-8). – MS (70 eV, 30 °C); *m/z* (%): 298 (56) [M$^+$], 135 (100).

$C_{12}H_{12}F_6N_2$	calcd.:	C 48.33	H 4.06	N 9.39
(298.2)	found:	C 48.25	H 4.16	N 9.39.

2,6-Dimethyl-1,10-bis(trifluoromethyl)-11,12-diaza-tetracyclo[7.3.0^{2,9}.0^{5,6}]dodec-11-ene (**19c**)

A solution of 544 mg (4.0 mmol) 1,5-dimethyl-1,5-COD (**16b**) and 436 mg (2.0 mmol) of **1a** in 15 ml of dry nitromethane was heated in an autoclave (50 ml) for 12 h at 130 °C. After cooling at room temperature the solvent was evaporated in vacuo and the brownish residue purified by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 9+1). After evaporation of the solvent a colorless oil was obtained, which crystallizes stored for 3 d at 5 °C. Yield 585 mg (90%) colorless needles, *m.p.* 102 °C. – IR (KBr): ν/cm^{-1} = 2939, 1640, 1481, 1387, 1308, 1148, 1067, 897, 733. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 360 (2.230). – ^{1}H NMR ($CDCl_3$): δ/ppm = 2.42–2.18 (m, 4H, methylene-H), 1.95–1.88 (m, 2H, methylene-H), 1.83–1.75 (m, 2H, methylene-H), 1.70 (d, 2H, ^3J = 6.31 Hz, 5-H and 9-H), 0.91 (s, 6H, methylene-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 128.06 (q, $^1J_{CF}$ = 283.5 Hz, CF_3), 83.37 (q, $^2J_{CF}$ = 23.2 Hz, C-1 and C-10), 50.34 (C-2 and C-6), 49.14 (CH, C-5 and C-9), 32.38, 23.80 (2 CH_2, C-3, C-4, C-7 and C-8), 22.86 (CH_3, methylene-C). – MS (70 eV, 30 °C); *m/z* (%): 326 (43) [M$^+$], 231 (100).

$C_{12}H_{12}F_6N_2$	calcd.:	C 51.54	H 4.94	N 8.59
(325.3)	found:	C 51.28	H 4.93	N 8.44.

Reaction of 1a with cyclooctatriene (23)

A solution of 424 mg (4.0 mmol) of **23** and 436 mg (2.0 mmol) of **1a** in 10 ml of dry CH_2Cl_2 was stirred magnetically for 10 d. After this time the red color of **1a** disappeared. The solvent was evaporated *in vacuo* and the oily residue worked up by column chromatography (silica gel, 30×3 cm, eluant: *n*-hexane/ethyl acetate 9+1). Compound **24** was isolated as colorless crystals, compound **25** as colorless oil.

1,4-Bis(1,4-dihydro-3,6-bis(trifluoromethyl)-pyridazine-5-yl)-buta-1,3-diene (**24**)

Yield 180 mg (75%), colorless crystals, *m.p.* 236 °C ($CHCl_3$). – IR (KBr): ν/cm^{-1} = 3431 (NH), 1387, 1310, 1272. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 234 (4.062). – ^{1}H NMR ($CDCl_3$): δ/ppm = 10.14 (br.s, 2H, N-H), 6.61 (d, 2H, ^3J = 10.1 Hz, 1-H and 4-H), 6.37 (br.d, 2H, ^3J = 10.1 Hz, 2-H and 3-H), 3.42 (br.s, 4H, 4'-H and 4''-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 131.01 (q, $^2J_{CF}$ = 35.63 Hz, C-3' and C-3''), 130.05 (CH, C-1 and C-4), 127.91 (q, $^2J_{CF}$ = 32.54 Hz, C-6' and C-6''), 125.89 (CH, C-2 and C-3), 122.26 (q, $^1J_{CF}$ = 271.87 Hz, CF_3), 122.06 (q, $^1J_{CF}$ = 274.19 Hz, CF_3), 107.50 (C-5' and C-5''), 25.70 (CH_2, C-4' and C-4''). – MS (70 eV, 30 °C); *m/z* (%): 486 (100) [M$^+$].

$C_{16}H_{10}F_{12}N_4$	calcd.:	C 39.52	H 2.07	N 11.52
(486.3)	found:	C 39.29	H 1.97	N 11.54.

2a,2b,5,8a-Tetrahydro-3,6-bis(trifluoromethyl)-cyclobuta[f]phthalazine (**25**)

Yield 62 mg (10%) colorless crystals after sublimation (50 °C, 1 Torr), *m.p.* 78 °C. – IR (KBr): ν/cm^{-1} = 3361 (NH), 2944 (CH), 1635, 1486, 1369. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 330 (3.44). – ^{1}H NMR ($CDCl_3$): δ/ppm = 7.62 (br.s, 1H, N-H), 6.42 (dm, 1H, ^3J = 9.8 Hz, 7-H), 5.93 (dd, 1H, ^3J = 9.8 Hz, ^3J = 3.8 Hz, 8-H), 3.51 (d, 1H, J = 10.1 Hz, 2b-H), 3.08 (mc, 1H, 1-H), 2.83 (mc, 1H, J = 10.1 Hz, 2a-H), 2.36 (m, 1H, 2-H), 2.14 (m, 1H, 1-H), 1.94 (m, 2H, 1-H and 2-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 135.18 (d, C-3), 133.58 (q, C-8, $^2J_{CF}$ = 33 Hz), 121.63 (q, $^1J_{CF}$ = 274 Hz, CF_3), 121.14 (q, C-5, $^2J_{CF}$ = 33 Hz), 120.88 (q, $^1J_{CF}$ = 275 Hz, CF_3), 120.85 (d, C-4), 110.22 (q, C-4a, J_{CF} = 2 Hz), 38.84 (d, 8b-C), 35.18 (d, 2a-C), 33.68 (d, 8a-C), 27.08 (t, 2-C), 24.68 (tq, 1-C, J_{CF} = 4 Hz). – MS (70 eV, 20 °C); *m/z* (%): 296 (29) [M$^+$], 267 (100).

$C_{12}H_{10}F_6N_2$	calcd.:	C 48.66	H 3.40	N 9.46
(296.2)	found:	C 48.54	H 3.38	N 9.48.

Reaction of 1a with Cyclooctatriene (23) in Toluene

A solution of 530 mg (5.0 mmol) of **23** and 1090 mg (5.0 mmol) of **1a** in dry toluene was refluxed for 1 h under argon. After cooling at room temperature the solvent was evaporated *in vacuo* and the residue worked up by column chromatography (silica gel, 30×3 cm, eluant: CH_2Cl_2). Fraction 1: **25**, yield 531 mg (58%), proved to be identical with the minor product running the reaction in CH_2Cl_2., fraction 2: **26**.

cis,cis-Buta-1,3-diene-1,4-di[4'-(dihydro-3',6'-bis(trifluoromethyl)-pyridazine)] (**26**)

Yield 164 mg (14%), colorless crystals, *m.p.* 216 °C (dec., *n*-hexane). – IR (KBr): ν/cm^{-1} = 3330 (NH), 3140, 3050, 2970 (CH), 1640 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 260 (4.31). – ^{1}H NMR ([D$_6$]-Aceton): δ/ppm = 10.02 (bs, 2H, NH), 6.42 (d, 2H, 2-H/3-H, ^3J = 9 Hz), 5.47 (dd, 2H, 1-H/4-H, ^3J = 9 Hz, ^3J = 10 Hz), 5.40 (d, 2H, 5'-H, ^3J = 6. Hz), 4.53 (dd, 2H, 4'-H, ^3J = 10 Hz, ^3J = 6 Hz). – ^{13}C NMR ([D$_6$]-Aceton): δ/ppm = 131.65 (q, 2×C-3', $^2J_{CF}$ = 34 Hz), 130.48 (d, C-1/C-4), 130.14 (q, 2× C-6', $^2J_{CF}$ =35 Hz), 124.60 (d, C-2/C-3), 122.37 (q, $2CF_3$, $^1J_{CF}$ = 273 Hz), 121.32 (q, $2CF_3$, $^1J_{CF}$ = 271 Hz), 101.37 (dq, 2×C-5', $^3J_{CF}$ = 5 Hz), 29.95 (d, 2×C-4'). – MS (70 eV, 90 °C); *m/z* (%): 486 (5) [M$^+$], 217 (100).

$C_{16}H_{10}F_{12}N_4$	calcd.:	C 39.52	H 2.07	N 11.52
(486.3)	found:	C 39.37	H 2.23	N 11.54.

cis,cis-Buta-1,3-diene-1,4-di([4']-3'-6'-bis(trifluoromethyl)-pyridazine) (**27**)

A suspension of 300 mg (1.6 mmol) of CuI in a solution of 34 mg (0.07 mmol) of **26** in 1.0 ml of nitrobenzene was refluxed for 45 min. After cooling at room temperature the solvent was removed *in vacuo* by Kugelrohrdistillation, the residue dissolved in 3 ml of CH_2Cl_2, filtered and the solvent evaporated *in vacuo*. The residue was worked up by column chromatography (silica gel, 10 cm×1 cm, eluant: beginning with *n*-hexane/CH_2Cl_2 9:1, in order to remove residual nitrobenzene, than CH_2Cl_2). The solvent was removed and the residue recrystallized from *n*-hexane to yield 21 mg (62%) of a pale yellow powder, *m.p.* 226 °C. – IR (KBr): ν/cm^{-1} = 3070, 2960 (CH), 1605, 1590 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 336 (4.37). – ^{1}H NMR ([D$_6$]-Aceton): δ/ppm = 8.81 (s, 2H, 5'-H), 8.18 (mc, 2H, 2-H and 3-H), 7.34 (mc, 2H, 1-H and 4-H). – MS (70 eV, 90 °C); *m/z* (%): 482 (100) [M$^+$].

$C_{16}H_6F_{12}N_4$ calcd.: 482.04007; found: 482.03881 (MS).

1,11-Bis(trifluoromethyl)-12,13-diaza-tetracyclo[8.3. 0.0.$^{2.10}$ O$^{5.6}$]tridec-12-ene (**31a**)

A solution of 240 mg (1.1 mmol) of **1a** and 265 mg (2.2 mmol) of cyclonona-1.5-diene (**28**) in 7 ml of dry dioxane was refluxed (101 °C) for 1 h; during this time the red color of **1a** disappeared. After cooling the solvent was removed and the residue purified by column chromatography (silica gel, 20× 2 cm, eluant: *n*-hexane/ethyl acetate 1:1). Yield 259 mg (77%) colorless prisms, *m.p.* 121 °C. – IR (KBr): ν/cm^{-1} = 2969, 1591, 1311, 1181. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 359 (2.22). – ^{1}H NMR (400 MHz, $CDCl_3$): δ/ppm = 2.19–2.12 (br.d, 2H), 2.11–1.99 (mc, 6H), 1.93–1.84 (mc, 2H), 1.83–1.76 (mc, 2H), 1.68–1.57 (mc, 2H). – ^{13}C NMR (100,5 MHz, $CDCl_3$): δ/ppm = 127.16 (q, $^1J_{CF}$ = 286 Hz, CF_3), 126.78 (q, $^1J_{CF}$ = 281.9 Hz, CF_3), 82.04 (q, $^2J_{CF}$ = 24.8 Hz, $\underline{C}CF_3$), 73.74 (q, $^2J_{CF}$ = 24.4 Hz, $\underline{C}CF_3$), 38.63 (2 *tert.* C), 31.03 (2 *tert.* C), 24.58 and 24.56 ($2CH_2$), 20.74 and 20.69 ($2CH_2$), 14.89 (C-8). – MS (70 eV, 30 °C): *m/z* (%): 312 (20) [M$^+$], 256 (45), 243 (94), 79 (100).

$C_{13}H_{14}N_2F_6$	calcd.:	C 50.00	H 4.52	N 8.97
(312.3)	found:	C 49.47	H 4.39	N 8.92.

1,11-Bis(methoxycarbonyl)-12,13-diaza-tetracyclo[8.3.0. 0.$^{2.10}$0$^{5.6}$]tridec-12-ene (**31b**)

Under the same conditions employed for the synthesis of **31a**, **31b** was obtained from 327 mg (1.65 mmol) of **1b** and 403 mg (3.3 mmol) of **28**. – Yield 317 mg (53%), colorless crystals, *m.p.* 159 °C (*tert.* butyl-methyl-ether). – IR (KBr): ν/cm^{-1} = 2959 (CH), 1707 (CO_2CH_3). – UV (CH_2Cl_2): λ_{max}/nm (lg ε)

= 362 (2.289), 356 (2.141). – ^{1}H NMR (400 MHz, $CDCl_3$): δ/ppm = 3.94 (s, 3H, OCH_3), 3.92 (s, 3H, OCH_3), 2.34 (m, 2H), 2.05–1.77 (m, 10H), 1.62–1.50 (m, 1H), 1.48–1.36 (m, 1H). – ^{13}C NMR (100,5 MHz, $CDCl_3$): δ/ppm = 172.68 (carbonyl-C), 172.53 (carbonyl-C), 85.70 (C-1), 78.60 (C-11), 53.04 (OCH_3), 52.77 (OCH_3), 39.71 (2 *tert.* C), 32.02 (2 *tert.* C), 24.50 ($2CH_2$), 22.07 ($2CH_2$), 15.32 (C-8). – MS (70 eV, 120 °C); *m/z* (%): 292 (1.6) [M$^+$], 233 (12), 204 (15), 173 (33), 145 (100).

$C_{15}H_{20}N_2O_4$	calcd.:	C 61.63	H 6.89	N 9.58
(292.3)	found:	C 61.97	H 6.88	N 9.64.

Reaction of Tetrazine 1a with cyclodeca-1,6-diene (32a)

A solution of 326 mg (1.49 mmol) of **1a** and 204 mg (1.5 mmol) of cyclodeca-1,6-dien (**32a**) in 10 ml of dry dioxane was refluxed for 10 h under argon. After removal of the solvent *in vacuo* the residue was worked up by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 9:1) furnishing two fractions. Fraction 1:

1,4-Bis(trifluoromethyl)-2,4a-dihydro-cyclodeca[d]pyridazine-8-ene (**34a**)

Yield 273 mg (49%), colorless crystals *m.p.* 72 °C. – IR (KBr): ν/cm^{-1} = 3337 (NH), 2933 (CH), 1491, 1365. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 286 (3.27), 233 (3.60), 209 (4.00). – ^{1}H NMR (400 MHz, $CDCl_3$): δ/ppm = 7.76 (br.s, 1H, NH), 5.58 (br. sext, 1H, H-7 or H-8, $^3J_{HH}$ = 8.4 Hz), 5.44 (oct., 1H, C-7 or C-8, $^3J_{HH}$ = 1.1 Hz, $^3J_{HH}$ = 9 Hz), 3.40 (d, 1H, H-11a, $^3J_{HH}$ = 7.6 Hz), 2.71 (m, 1H, H-5), 2.38–2.15 (m, 4H), 2.04 (m, 1H, H-5'), 1.95–1.55 (m, 4H), 1.5–1.3 (m, 2H). – ^{13}C NMR (100.5 MHz, $CDCl_3$): δ/ppm = 135.3 (q, $^2J_{CF}$ =34.6 Hz, $\underline{C}CF_3$), 131.2 (C-7 or C-8), 128.67 (C-7 or C-8), 125.72 (q, $^2J_{CF}$ = 33 Hz, $\underline{C}CF_3$), 121.35 (q, $^1J_{CF}$ = 274.5 Hz, CF_3), 121.25 (q, $^1J_{CF}$ = 272.9 Hz, CF_3), 118.48 (C-4a), 33.32 (C-4), 30.25 (CH_2), 28.07 (C-11), 26.89 (CH_2), 25.59 (CH_2), 24.73 (CH_2), 23.77 (CH_2). – MS (70 eV, 20 °C); *m/z* (%): 326 (21) [M$^+$], 283 (36), 257 (73) [M$^+$–CF_3], 243 (69), 230 (100).

$C_{14}H_{13}N_2F_6$	calcd.:	C 51.45	H 4.94	N 8.58
(326.3)	found:	C 51.83	H 4.84	N 8.47.

Fraction 2: Mixture of isomers of type **36**, yield 276 mg (36%), not characterized by analytical and spectral data.

Reaction of Tetrazine 1a with 1,6-dioxa-3,8-cyclodecadiene (32b)

A solution of 428 mg (1.95 mmol) of **1a** and 550 mg (3.9 mmol) of **32b** in 10 ml of dry dioxane were refluxed for 14 h under argon, until the red color of **1a** disappeared. The solution was cooled to room temperature, the solvent evaporated *in vacuo* and the residue separated by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 1:1) to give two fractions: 1) 428 mg (66%) of a mixture of isomers **36b** not characterized by analytical and spectral data; 2) 260 mg of recovered starting material **32b**.

9,11a-Dihydro-1,4,8,11-tetra(trifluoromethyl)-pyridazino[8.9-d]cyclodeca[d]pyridazine (**37a**)

60 mg (0.12 mmol) of **36** and 158 mg (0.69 mmol) of dichlorodicyano-*p*-benzoquinone were dissolved in 8 ml of dry dioxane and the mixture refluxed for 8 h. After cooling the suspension was filtered and the filtrate evaporated *in vacuo*. The residue was worked up twice by column chromatography (silica gel, 20×2 cm, eluant: 1) *n*-hexane/ethyl acetate 1:1, 2) *n*-hexane/ethyl acetate 9:1) furnishing 17 mg (28%) of a colorless powder, *m.p.* 134 °C. – IR (KBr): ν/cm^{-1} = 3419 (NH), 2927 (CH), 1485, 1358, 1016, 753. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 277 (3.35), 209 (4.11). – ^{1}H NMR (400 MHz,$CDCl_3$): δ/ppm = 8.35 (br.s, 1H, NH), 3.35 (m, 1H, H-11a), 3.18–2.60 (m, 5H), 2.05–2.30 (m, 3H), 1.65–1.30 (m, 3H). – ^{13}C NMR (100,5 MHz, $CDCl_3$): δ/ppm = 151.69 (q, $^2J_{CF}$ = 32.9 Hz, CCF_3, arom.), 151.64 (q, $^2J_{CF}$ = 32.5 Hz, $\underline{C}CF_3$, arom.), 142.07 (C-4a or C-14a), 141.88 (C-4a or C-14a), 133.39 (q, $^2J_{CF}$ = 35.3 Hz, $\underline{C}CF_3$), 128.73 (q, $^2J_{CF}$ = 33.0 Hz, $\underline{C}CF_3$), 121.79 (q, $^1J_{CF}$ = 276.1 Hz, CF_3), 121.74 (q, $^1J_{CF}$ = 276.0 Hz, CF_3), 120.93 (q, $^1J_{CF}$ = 274.3 Hz, CF_3), 120.87 (q, $^1J_{CF}$ = 273.3 Hz, CF_3), 113.54 (C-7a), 38.67 (C-4a), 31.40 (CH_2), 26.80 (CH_2), 26.62 (C-5 and C-14a), 24.89 (CH_2). – MS (70 eV, 105 °C); *m/z*(%): 515 (6.5), [M$^+$ + H], 514 (1.8) [M$^+$], 446 (4.5) [M$^+$ + H –CF_3], 243 (100).

$C_{18}H_{14}N_4F_{12}$	calcd.:	C 42.04	H 2.74	N 10.89
(514.3)	found:	C 42.26	H 2.94	N 10.78.

9,11a-Dihydro-1,4,8,11-tetra(trifluoromethyl)-pyridazino[8.9-d]-6,13-dioxa-cyclodeca[d]-pyridazine (**37b**)

A solution of 203 mg (0.39 mmol) of the isomers of **36b** and 442 mg (1.95 mmol) dichloro-dicyano-*p*-benzoquinone in dry dioxane was refluxed for 14.5 h. The mixture was cooled to room temperature, filtered and the filtrate evaporated *in vacuo* and the residue purified by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 1:1). Yield 174 mg (86%), *m.p.* 242 °C, colorless crystals. – IR (KBr): ν/cm^{-1} = 3322 (NH), 2995 (CH), 1507, 1450, 1388. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 286 (3.50), 226 (3.83), 194 (4.18). – ^{1}H NMR ([D$_6$]-acetone): δ/ppm = 10.8 (br.s, 1H, NH), 5.61 (d, 1H, CH_2, $^2J_{HH}$ = 12.5 Hz), 5.31 (d, 1H, CH_2, $^2J_{HH}$ =12.5 Hz), 4.86 (dd, 1H, CH_2, $^2J_{HH}$ = 13.1 Hz, $^4J_{HH}$ = 1.5 Hz), 4.78 (dd, 1H, CH_2, $^2J_{HH}$ = 12.2 Hz, $^4J_{HH}$ = 1.3 Hz), 4.67 (dd, 1H, CH_2, $^2J_{HH}$ = 14.6 Hz, $^4J_{HH}$ = 1.6 Hz), 4.46 (dd, 1H, H-8, $^3J_{H8/8a}$ = 4.7 Hz, $^2J_{H8/H8'}$ = 11.6 Hz), 4.38 (dd, 1H, CH_2, $^2J_{HH}$ = 14.6 Hz, $^4J_{HH}$ = 1.7 Hz), 3.59 (dd, 1H, H-8a, $^3J_{H8a/8}$ = 4.8 Hz, $^3J_{H8a/8'}$ = 11.6 Hz), 3.45 (t, 1H, H-8', $^3J_{H8/8a}$) = 11.6 Hz, $^2J_{H8/8'}$ = 11.6 Hz). – ^{13}C NMR ([D$_6$]-acetone): δ/ppm = 151.0 (q, $^2J_{CF}$ = 32.6 Hz, $CCF_{3,aromat.}$), 150.5 (q, $^2J_{CF}$ = 32.4 Hz, $\underline{C}CF_{3,aromat.}$), 139.8 ($2C_{aromat.}$), 128.67 (q, $^2J_{CF}$ = 36.1 Hz, CCF_3), 128.44 (q, $^2J_{CF}$ = 33.4 Hz, $\underline{C}CF_3$), 121.8 (q, $^1J_{CF}$ = 275.5 Hz, CF_3), 121.75 (q, $^1J_{CF}$ = 275.6, CF_3), 121.21 (q, $^1J_{CF}$ = 271.5 Hz, CF_3), 121.13 (q, $^1J_{CF}$ = 274.4 Hz, CF_3), 109.4 (C-4a), 68.4 (CH_2–O), 64.8 (CH_2–O), 63.9 (CH_2–O), 30.2 (C-8a). – MS (70 eV, 220 °C); *m/z* (%): 519 (1.4) [M$^+$ + H], 499 (4) [M$^+$– F], 449 (1.3), [M$^+$– CF_3], 289 (96), 245 (100).

$C_{16}H_{10}F_{12}N_4O_2$	calcd.:	C 37.08	H 1.94	N 10.81
(518.3)	found:	C 37.08	H 1.89	N 10.59.

Reaction of Tetrazine 1a with Hexa-1,5-diene (38a)

A solution of 164 mg (2,0 mmol) of **38a** and 436 mg (2.0 mmol) of **1a** in 5 ml of dry nitromethane was refluxed for 4 d during that time the red color of **1a** disappeared. The solvent was evaporated *in vacuo* and the brownish oily residue worked up by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 9+1). Two fractions were obtained: a) the dihydropyridazine **40**; b) the cage compound **41**.

4-(But-3'-enyl)-1,4-dihydro-3,6-bis(trifluoromethyl)-pyridazine (**40a**)

Yield 350 mg (64%), colorless oil, obtained by Kugelrohr-distillation, *b.p.* 70 °C/1 Torr. – IR (Film): ν/cm^{-1} = 3343 (NH), 3085, 2931, 2861 (CH), 1642 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 276 (2.87), 229 (3.22). – ^{1}H NMR ([D$_6$]acetone): δ/ppm = 10.12 (bs, 1H, N–H), 5.87–5.79 (m, 1H, $^3J_{trans}$ = 17.06 Hz, $^3J_{cis}$ = 10.38 Hz, 3'-H), 5.56 (dq, 1H, ^3J = 4.82 Hz, $^4J_{HF}$ = 1.11 Hz, 5-H), 5.07 (dt, 1H, $^3J_{trans}$ = 17.05 Hz, ^4J = 1.50 Hz, 4-H), 4.97 (dt, 1H, $^3J_{cis}$ = 10.20 Hz, ^4J = 1.50 Hz, 4-H), 4.48 (pseudo-*t*, 1H, ^3J = 4.64 Hz, 4-H), 2.13–2.11 (m, 2H, methylene-H), 1.64–1.57 (m, 2H, methylene-H). – ^{13}C NMR ([D$_6$]acetone): δ/ppm = 138.30 (CH, C-5), 133.55 (q, $^2J_{CF}$ = 34.08 Hz, C-3), 131.46 (q, $^2J_{CF}$ = 34.85 Hz, C-6), 122.34 (q, $^1J_{CF}$ = 271.09 Hz, CF_3), 122.56 (q, $^1J_{CF}$ = 272.65 Hz, CF_3), 115.71 (CH_2, C-4'), 102.34 (CH, C-3'), 33.58, 29.80 ($2CH_2$, C-1' and C-2'), 30.56 (CH, C-4). – MS (70 eV, 20 °C); *m/z* (%): 272 (100) [M$^+$].

$C_{10}H_{10}F_6N_2$	calcd.:	C 44.13	H 3.70	N 10.29
(272.2)	found:	C 45.01	H 3.92	N 9.85.

Running the reaction in dichloromethane (instead of nitromethane) at room temp., 530 mg (97%) of the specimen **40a** were obtained after identical work up.

1,7-Bis(trifluoromethyl)-8.9-diaza-tricyclo[4.3.1.0]dec-8-ene (**41a**)

Yield 150 mg (28%), colorless crystals, *m.p.* 95 °C. – IR (KBr): ν/cm^{-1} = 2914 (CH), 1641, 1575, 1491, 1209, 1062. – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 357 (1.83), 230 (2.25). – ^{1}H NMR ([D$_6$]acetone): δ/ppm = 2.27 (m, 4H, 6-H and 7-H), 1.78–1.76 (m, 2H, 5-H and 8-H), 1.69–1.63 (m, 4H, 9-H and 10-H). – ^{13}C NMR ([D$_6$]acetone): δ/ppm = 127.78 (q, $^1J_{CF}$ = 279.7 Hz, CF_3), 127.0 (q, $^1J_{CF}$ = 278.3 Hz, CF_3), 81.44 (q, $^2J_{CF}$ = 26.13 Hz, C-7), 71.19 (q, $^2J_{CF}$ = 28.3 Hz, C-1), 33.77 (CH, C-2 and C-5), 32.42 (CH_2, C-3 and C-4), 30.87 (t, C-6 and C-10). – MS (70 eV, 20 °C); *m/z* (%): 272 (1) [M$^+$], 244 (2) [M$^+$–N_2], 175 (16) [244-CF_3], 135 (100).

$C_{10}H_{10}F_6N_2$	calcd.:	C 44.13	H 3.70	N 10.29
(272.2)	found:	C 43.76	H 3.49	N 10.11.

Reaction of Tetrazine 1a with Hepta-1,6-diene (**38b**)

A solution of 380 mg (4.0 mmol) of **38b** and 436 mg (2,0 mmol) of **1a** in 5 ml of dry nitromethane were heated in a 50 ml sealed tube at 140 °C for 3 d. After cooling at room temp. the solvent was evaporated *in vacuo* and the oily residue worked up by column chromatography (silica gel, 20×2 cm, eluant: *n*-hexane/ethyl acetate 9+1). Two fractions were obtained: a) the dihydropyridazine **40b**; b) the bis-dihydropyridazine **42b**.

1.4-Dihydro-4-(pen-4'-enyl)-3,6-bis(trifluoromethyl)-pyridazine (**40b**)

Yield 460 mg (80%), colorless oil, obtained by Kugelrohr-distillation, *b.p.* 80 °C/1 Torr. – IR (Film): ν/cm^{-1} = 3399 (NH), 3173, 2923 (CH), 1680, 1658 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 279 (3.17), 228 (3.42). – ^{1}H NMR ($CDCl_3$): δ/ppm = 7.78 (bs, 1H, N–H), 5.82–5.71 (m, 1H, $^3J_{trans}$ = 10.38 Hz, $^3J_{cis}$ = 3.53 Hz, 4'-H), 5.38 (dq, 1H, ^3J = 4.82 Hz, $^4J_{CF}$ = 1.11 Hz, 5-H), 4.98 (dd, 1H, $^3J_{cis}$ = 3.52 Hz, ^2J = 1.49 Hz, 5'-H), 4.98 (dd, 1H, $^3J_{trans}$ = 10.38 Hz, ^2J = 1.48 Hz, 5'-H), 3.34 (m, 1H, ^3J = 4.82 Hz, 4-H), 2.09–2.03 (m, 2H, methylene-H), 1.54–1.38 (m, 4H, methylene-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 137.85 (CH, C-5), 134.38 (q, $^2J_{CF}$ = 34.08 Hz, C-3), 130.31 (q, $^2J_{CF}$ = 35.63, C-6), 121.10, 119.98 (2q, $^1J_{CF}$ = 271.8 Hz, CF_3), 115.01 (CH_2, C-5'), 101.76 (CH, C-4'), 33.24, 32.79, 23.87 (3 CH_3, methylene-C), 30.21 (CH, C-4). – MS (70 eV, 20 °C); *m/z* (%): 286 (1) [M$^+$], 217 (100).

$C_{11}H_{12}F_6N_2$	calcd.:	C 46.16	H 4.23	N 9.79
(286.2)	found:	C 45.45	H 3.97	N 9.38.

1,4,1'',4''-Tetrahydro-4-propyl-3'(pyridazin-4''-yl)-3,6,3'',6''-tetrakis(trifluoromethyl)-pyridazine (**42b**)

Yield 40 mg (4%), colorless crystals, *m.p.* 149 °C. – IR (KBr): ν/cm^{-1} = 3351 (NH), 2936 (CH), 1643 (C=N). – UV (CH_2Cl_2): λ_{max}/nm (lg ε) = 278 (3.40), 229 (3.69). – ^{1}H NMR ($CDCl_3$): δ/ppm = 10.08 (bs, 2H, N–H), 5.56 (d, 2H, ^3J = 5.93 Hz, 5'-H and 5''-H), 3.50 (m, 2H, ^3J = 6.0 Hz, 4'-H and 4''-H), 1.55–1.41 (m, 6H, methylene-H). – ^{13}C NMR ($CDCl_3$): δ/ppm = 133.50 (q, $^2J_{CF}$ = 33.3 Hz, C-3 and C-3''), 130.88 (q, $^2J_{CF}$ = 34.85 Hz, C-6 and C-6''), 122.48 (q, $^1J_{CF}$ = 272.64 Hz, CF_3), 121.26 (q, $^1J_{CF}$ = 271.09 Hz, CF_3), 102.46 (CH, C-5 and C-5''), 34.08 (CH_2, C-1' and C-3'), 30.85 (CH, C-4 and C-4''), 20.48 (CH_2, C-2'). – MS (70 eV, 20 °C); *m/z* (%): 476 (2) [M$^+$], 217 (100).

$C_{15}H_{12}F_{12}N_4$	calcd.:	C 37.83	H 2.54	N 11.76
(476.3)	found:	C 38.00	H 2.66	N 11.47.

From 95 mg (1,0 mmol) **38b** and 436 mg (2,0 mmol) of **1a** (CH_2Cl_2, roomtemp., 1 h) 245 mg (90%) of **42b** were obtained.

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Korrespondenzanschrift:
Professor Dr. G. Seitz
Institut für Pharmazeutische Chemie
der Universität
Marbacher Weg 6
D-35032 Marburg/Lahn
FAX: 06421/286652
e-mail: seitz@pharmazie.uni-marburg.de