TRIAZOLO[4,5-*f*]QUINOLINES DERIVED FROM 5-AMINO-(1*H*- and 2-METHYL-2*H*)-BENZOTRIAZOLES WITH β-DIKETONES AND 3-BUTEN-2-ONE

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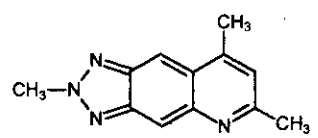
Abstract- 5-Aminobenzotriazole and its derivatives are good substrates for reactions with β-diketones and 3-buten-2-one to produce angular triazolo[4,5-*f*]quinolines. Interesting isomeric compounds were found in the case of reaction with non-symmetrical diketones, whereas an unusual cyclization takes place when 2-acetylcyclopentanone was used.

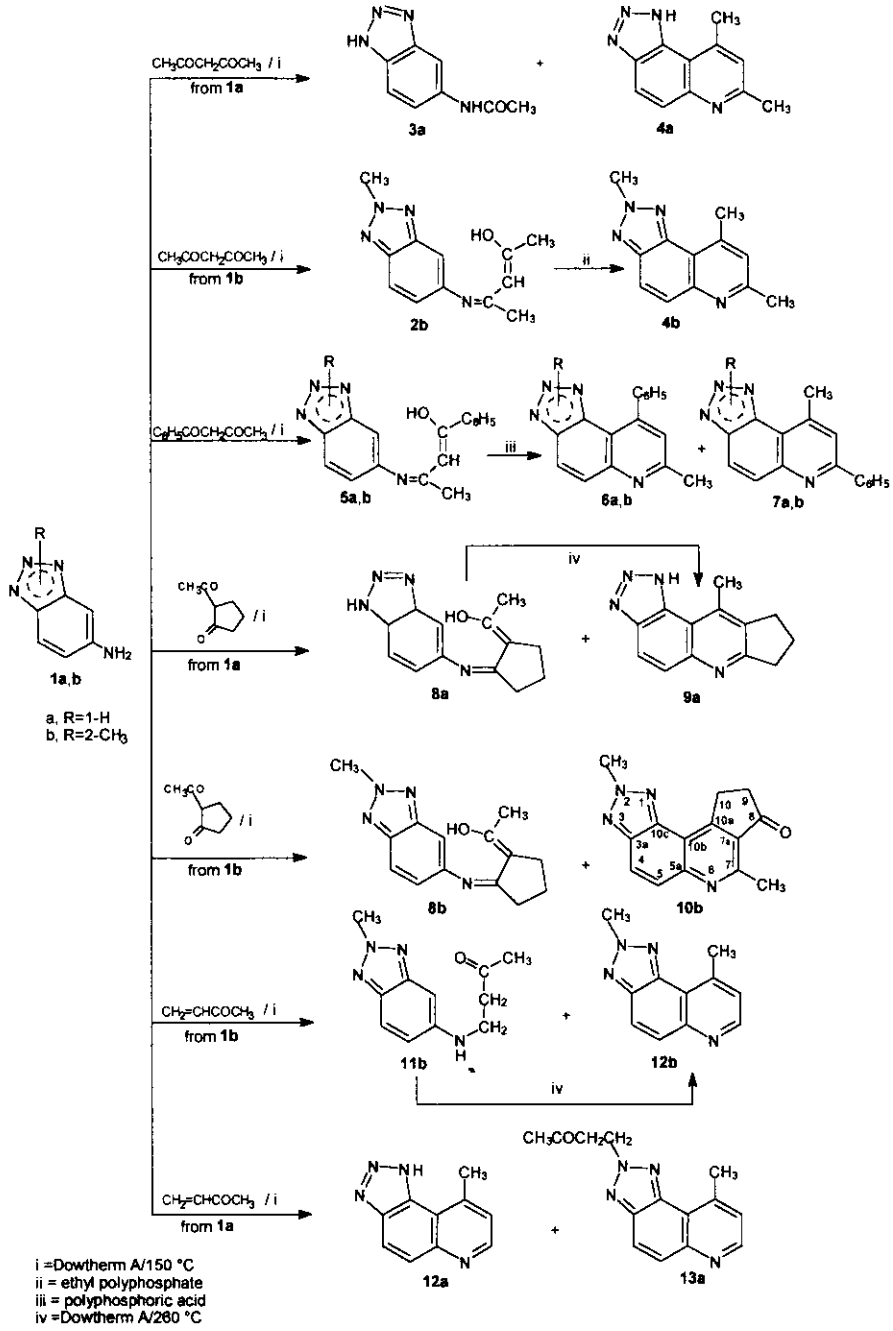
In previous reports in this area we have described the reactions of 5–aminobenzotriazole derivatives with β-keto esters,[1] acetylenic esters (dimethyl acetylendicarboxylate and methyl propiolate)[2,3] or Skraup's reagent[4] as novel routes to obtain new substituted triazolo[4,5-*f*]quinolines. These compounds were designed to be further functionalized for a pharmacological screening as both potential antimicrobial, antimalarial and anticancer intercalating agents. In this context we have found that some 1(2)-methyl-6-ethyl-9-oxo-1*H*(2*H*)-triazolo[4,5-*f*]quinoline-8-carboxylic acids[5] or 1(2)-methyl-4-ethyl-7-oxo-1*H*(2*H*)-triazolo[4,5-*h*]quinoline-6-carboxylic acids[6] related to oxolinic acid were endowed with antimicrobial Gram-negative activity, while some 2-methyl-9-dialkylaminoalkyl-2*H*-triazolo[4,5-*f*]quinolines exhibited interesting antitumor-antileukemia activity at NCI.[7] These promising results prompted us to continue our investigations in order to obtain linear or angular functionalized compounds of this type. Thus, we have examined the reaction of the 5-aminobenzotriazole with β-diketones on the basis that from this reaction when the 5-amino-2-methyl-2*H*-benzotriazole was treated with 2,4-pentanedione in Dowtherm A,[8] an *apparent linear cyclization to 2,6,8-trimethyl-2H-triazolo[4,5-g]quinoline* (Formula **A**) seemed to occur according to the ^{1}H-NMR spectrum run at 60 MHz.[9]



A

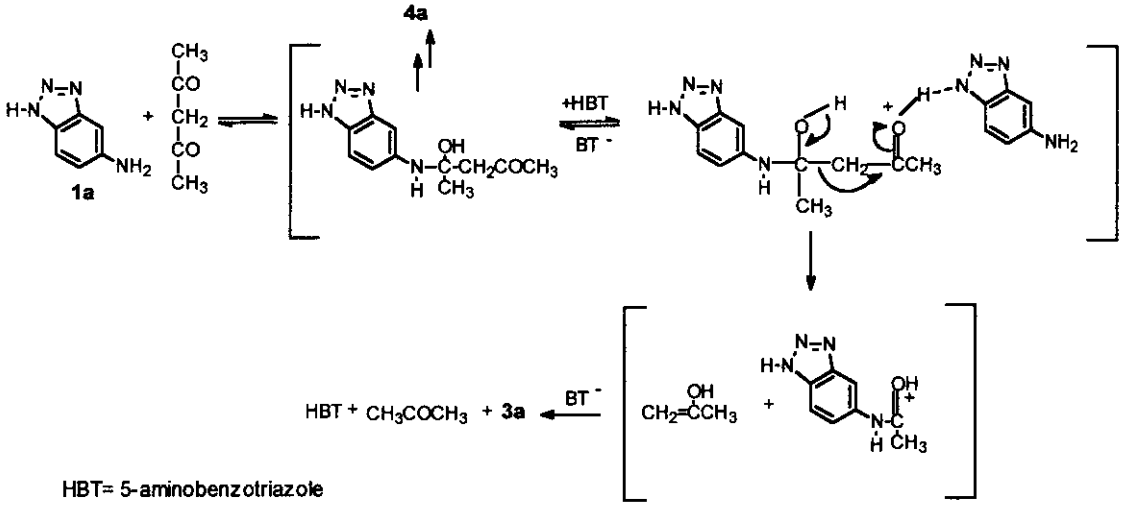
This result was in contrast with the usual behavior observed by us during the thermal cyclization of amide- and enamine-type derivatives of **1b**.[2] A similar case was described for the reaction of 2-naphthylamine with 2,4-pentanedione by Johnson and Mathews who claimed to have obtained a linear

tricyclic benzoquinoline carrying out the reaction in HF at room temperature.[10] The reaction of **1b** with 2,4-pentanedione was thus reinvestigated and the present results, based upon a detailed analysis of ^{1}H-NMR spectrum at 200 MHz, now show that the linear cyclisation never occurred and in this case, as well as in all other cases examined, [4,5-*f*] compounds were always isolated, as established from the appearance of an AB system for the H-4/H-5.



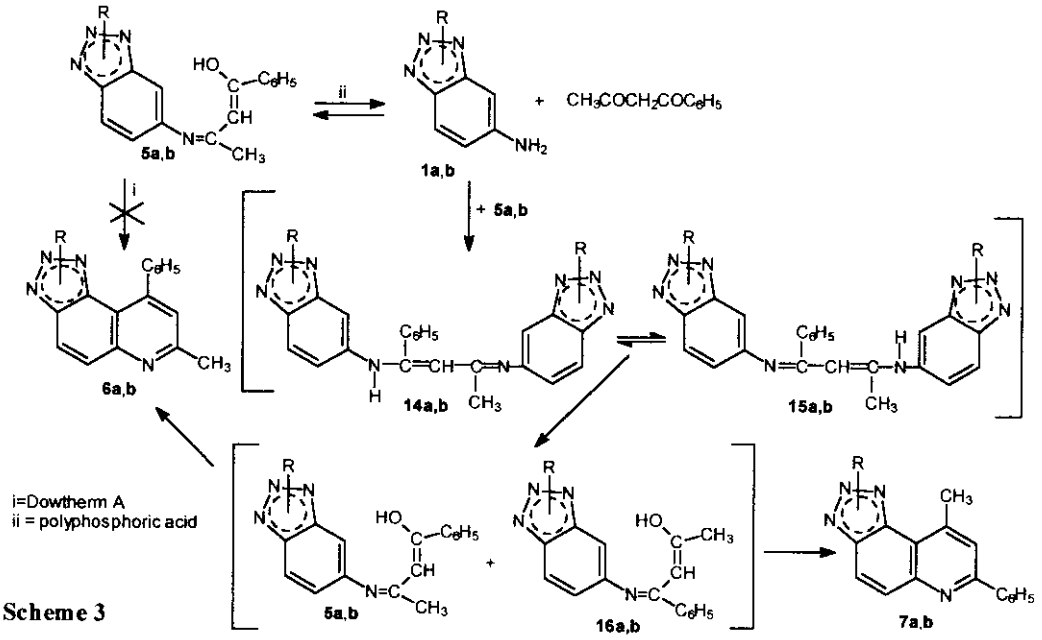
Scheme 1

According to Scheme 1 the reactions of 5-aminobenzotriazoles (**1a,b**) with β-diketones proceed *via* formation of a generally isolable imino intermediate, sometimes accompanied by the cyclization product. The iminic intermediate may be in turn converted into the desired triazolo[4,5-*f*]quinoline by thermal ring closure of its enolic form. The cyclization conditions have been optimized for each substrate using Dowtherm A, polyphosphoric acid (PPA) or ethyl polyphosphate (PPEt).[11] Thus, from the reaction of **1a** with 2,4-pentanedione we obtained the unexpected known monoacetyl compound (**3a**)[12] (34%) beside the triazoloquinoline (**4a**) (21%). It is our opinion that the formation of **3a** is due to partial decomposition of the amino alcohol intermediate assisted by a further addition of **1a** on the second carbonyl group followed by a concerted elimination of acetone (Scheme 2).



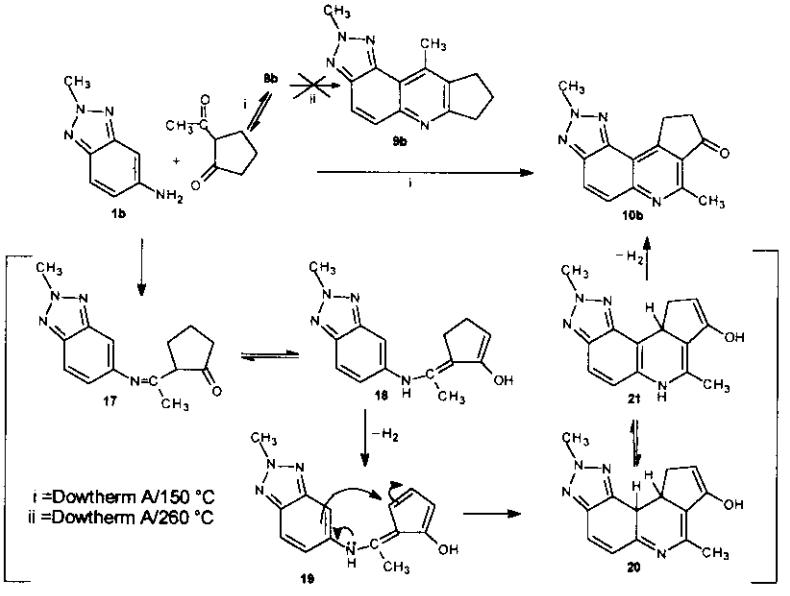
Scheme 2

The same reaction carried out on **1b** afforded the intermediate (**2b**), in 67% yield, which was then converted into **4b** (43%) by heating in PPEt. The reaction of **1a,b** with 1-phenyl-1,3-butanedione in Dowtherm A yielded the expected intermediates (**5a,b**) and no ring closure products were detected. Attempts at thermal cyclization of these intermediates in Dowtherm A failed but when PPA was used it was successful. The formation of mixtures of isomeric triazoloquinolines (**6a** and **7a** in 27% yield each) and (**6b** (48%) slightly prevailing on **7b** (41%)), as outlined in Scheme 3, suggests that during the heating in PPA a hydrolysis was taking place, soon followed by formation of the bis-condensation derivatives (**14a,b**) in tautomeric equilibrium with **15a,b**. The latter undergo a further acidic hydrolysis to give respectively the intermediates (**5a,b**) and (**16a,b**) which in turn easily cyclise into triazoloquinolines (**6a,b**) and (**7a,b**). Pure single isomers (**6a,b**) and (**7a,b**) were isolated by column chromatography accompanied with a certain amount of the amines (**1a,b**) thus confirming the mechanism suggested in Scheme 3.



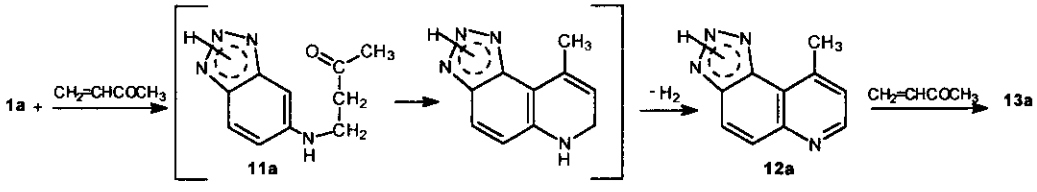
Scheme 3

Reaction of **1a,b** with 2-acetylcyclopentanone in Dowtherm A afforded the desired imines (**8a,b**) accompanied by small amounts of cyclization compounds (**9a**, **10b**). In the case of **1a** compound (**9a**) was isolated in 13% yield from the reaction mixture, while the attempted ring closure of **8a**, carried out in Dowtherm A at reflux, gave **9a** in lesser yield (7%). An anomalous behavior was observed in the case of **1b** where along with the mentioned **8b** (18%) we were able to isolate a small amount of **10b** (3%). This result was very intriguing and, as showed in Scheme 4, it appears clear that a competitive nucleophilic attack to give the two imino intermediates (**8b**) and (**17**) took place.



Scheme 4

This latter is in equilibrium with its enol-enamine tautomer (**18**), which by dehydrogenation was then converted into the most conjugate enamine (**19**), which suffering both electrocyclic ring closure to **20** and oxidation of the dihydroquinoline (**21**) yields **10b**. Evidence for this structure is mainly achieved by its ^{13}C-NMR spectrum which shows a signal at δ 162.70 characteristic for a carbonyl group, thus confirming the absorption at 1720-1710 cm^{-1} in the IR spectrum. The attempted cyclization of **8b** in Dowterm A unexpectedly failed, affording only a small amount of unreacted **8b** (10%) together with **1b** (30%). In the end we have investigated the reaction of **1a,b** with 3-buten-2-one that in the case of **1a** yielded compounds (**12a**) (31%) and (**13a**) (18%). Formation of these compounds can be attributed to both easy cyclization and aromatization of the non isolable intermediate (**11a**), followed by a further addition of the unsaturated ketone on the triazole ring, analogously to that by us previously observed[4] (Scheme 5). In the case of **1b** an identical reaction as above gave **11b** (51%) together with its cyclic derivative (**12b**) (14%). The attempted conversion of **11b** into **12b** under refluxing Dowtherm A yielded the cyclic derivative in low yield (12%) thus indicating that an equilibrium exists between the cyclization reaction and a retro-Michael reaction, as evidenced from the formation of **1b** (16%). This behavior seems to be general in most of the cyclizations presently studied, the formation of amines (**1a,b**) indeed shows that an equilibrium between these with their imino-intermediates is generally present. In conclusion, in the light of our results we can say that a linear cyclization from these reactions can be excluded and its orientation is under control of the electron-withdrawing triazole moiety.



Scheme 5

EXPERIMENTAL

Melting points were determined in a Kofler hot stage or Digital Electrothermal apparatus, and are uncorrected. IR spectra are for nujol mulls and were recorded using a Perkin-Elmer 781 spectrophotometer. UV spectra are qualitative and were recorded in nm for solutions in ethanol with a Perkin-Elmer Lambda 5 spectrophotometer. ^{1}H- and ^{13}C-NMR spectra were recorded on a Varian XL-200 (200 MHz for ^{1}H and 50 MHz for ^{13}C) instrument, using TMS as internal standard. MS spectra were recorded on a combined HP 5790–HP 5970 GC/MS apparatus. TLC was performed on Merck silica gel 60-F_{254} precoated plates (Merck). Column chromatography was carried out with Merck silica gel 60 (230-400 mesh). Light petroleum refers to the fraction with bp 40-60°C. Dowtherm A was prepared from

diphenyl ether and biphenyl as reported in literature.[8] Polyphosphoric acid (PPA) was purchased from Aldrich Co., while ethyl polyphosphate (PPEt) was prepared according to a literature method.[11] Elemental analyses were performed at the Laboratorio di Microanalisi, Dipartimento di Scienze Farmaceutiche, University of Padua (Italy).

Reaction of 5-amino-1*H*-benzotriazole (1a) with 2,4-pentanedione. A mixture of **1a** (1.30 g, 9.7 mmol) and 2,4-pentanedione (1.10 g, 11 mmol) in Dowtherm A (15 mL) was stirred at 130-140 °C for 20 h. On cooling to rt, a precipitate was collected by filtration and the mother liquors were diluted with hexane (150 mL). From the resulting solution after an additional 1 h stirring further 0.41 g of crude **4a** was collected. The combined precipitates were purified by chromatography on silica gel, eluting with mixtures of ether-acetone containing percent increase of acetone, to give in succession: **7,9-dimethyl-1*H*-triazolo[4,5-*f*]quinoline (4a)**: (0.4 g, 21%); mp 295-297 °C (acetone); IR: 3300, 1610, 1580 cm^{-1}; UV: λ_{max} 320, 307, 286 sh, 278 sh, 249, 218 nm; ^{1}H-NMR (DMSO-d_6): δ 8.06 (d, 1H, J = 9.2 Hz, H-4), 7.86 (d, 1H, J = 9.2 Hz, H-5), 7.45 (s, 1H, H-8), 3.04 (s, 3 H, CH_3-7), 2.63 (s, 3H, CH_3-9); MS: *m/z* 198 (M^+). Anal. Calcd for $C_{11}H_{10}N_4$: C, 66.65; H, 5.09; N, 28.27. Found: C, 66.81; H, 4.98; N, 27.94. **5-Acetamido-1*H*-benzotriazole (3a)**: (0.58 g, 34%); mp 242-243 °C (lit.,[12] 241 °C); and unreacted **1a** (0.23 g, 18%).

Reaction of 5-amino-2-methyl-2*H*-benzotriazole (1b) with 2,4-pentanedione. In an identical manner as above a mixture of **1b** (1.65 g, 11 mmol) and 2,4-pentanedione (1.10 g, 11 mmol), after cromatography eluting with a mixture of benzene-acetone (95:5), yielded **(*Z*)-4-[(2-methyl-2*H*-benzotriazol-5-yl)imino]-2-penten-2-ol (2b)**: (1.70 g, 67%); mp 125-127 °C (Et_2O); IR: 3450-3300, 1650, 1560 cm^{-1}; UV: λ_{max} 336, 318, 288 infl, 254, 217 nm; ^{1}H-NMR ($CDCl_3$): δ 12.62 (s, 1H, OH), 7.81 (d, 1H, J = 9 Hz, H-7'), 7.54 (d, 1H, J = 2 Hz, H-4'), 7.15 (dd, 1H, J = 9 and 2 Hz, H-6'), 5.25 (s, 1H, CH=C), 4.51 (s, 3H, CH_3-N), 2.13 (s, 3H, CH_3), 2.07 (s, 3H, CH_3); MS: *m/z* 230 (M^+). Anal. Calcd for $C_{12}H_{14}N_4O$: C, 62.59; H, 6.13; N, 24.33. Found: C, 62.24; H, 6.02; N, 24.17; and unreacted **1b** (0.32 g, 19%).

2,7,9-Trimethyl-2*H*-triazolo[4,5-*f*]quinoline (4b). To ethyl polyphosphate (5.0 g) heated at 160 °C compound (**2b**) (0.5 g, 2.2 mmol) was added in small portions and the mixture was stirred for 90 min. After cooling, the mixture was diluted with iced water (30 mL), the pH was adjusted to 5-6 by addition of conc. ammonia solution and the basic solution extracted with chloroform. The combined extracts, dried on Na_2SO_4, on evaporation gave a residue which was purified by chromatography on silica gel and benzene as eluent, affording **4b**: (0.20 g, 43%), mp 150-151 °C (Et_2O); IR: 1605, 1585 cm^{-1}; UV: λ_{max} 323, 308, 298 sh, 261, 222 nm; ^{1}H-NMR ($CDCl_3$+CF_3COOD): δ 8.08 (d, 1H, J = 9.2 Hz, H-4), 7.88 (d,

1H, J = 9.2 Hz, H-5), 7.35 (s, 1H, H-8), 4.45 (s, 3H, CH_3-N), 3.04 (s, 3 H, CH_3-7), 2.70 (s, 3H, CH_3-9); MS: *m/z* 212 (M^+). Anal. Calcd for $C_{12}H_{12}N_4$: C, 67.90; H, 5.70; N, 26.40. Found: C, 67.70; H, 5.60; N, 26.61.

Reaction of 5-amino-1*H*-benzotriazole (1a) with 1-phenyl-1,3-butanedione. A mixture of compounds **1a** (1.67 g, 12.4 mmol) and 1-phenyl-1,3-butanedione (2.0 g, 12.4 mmol) in Dowtherm A (17 mL) was heated at 140-150 °C for 20 h. After cooling the reaction mixture was diluted with hexane (170 mL) and the stirring continued for an additional 1 h. The resulting crude precipitate was filtered off and purified by chromatography on silica gel, using a mixture of ether-acetone (95:5) as eluent, to give **(*Z*)-3-[(1*H*-benzotriazol-5-yl)imino]-1-phenyl-1-buten-1-ol (5a)**: (1.9 g, 55%); mp 191-192 °C (acetone); IR: 3400, 3310, 1600, 1590 cm^{-1}; UV: λ_{max} 357, 333, 202 nm; ^{1}H-NMR (DMSO-d_6): δ 13.26 (s, 1H, OH), 7.96 (m, 3H, H-7' + phenyl H), 7.85 (s, 1H, H-4') 7.52 (m, 3H, phenyl H), 7.37 (d, 1H, J = 8.8 Hz, H-6'), 6.16 (s, 1H, CH=C), 2.25 (s, 3H, CH_3); MS: *m/z* 278 (M^+). Anal. Calcd for $C_{16}H_{14}N_4O$: C, 69.05; H, 5.07; N, 2013. Found: C, 68.85; H,5.23; N, 19.85; and unreacted **1a** (0.50 g, 30%).

7-Methyl-9-phenyl-1*H*-triazolo[4,5-*f*]quinoline (6a) and **9-methyl-7-phenyl-1*H*-triazolo[4,5-*f*]-quinoline (7a)**. Compound (**5a**) (1.25 g, 4.5 mmol) was slowly added under stirring to polyphosphoric acid (12.5 g) pre-heated at 100 °C. After the addition was complete the temperature was raised to 160 °C for 2 h. On cooling, the mixture was poured in crushed ice and the stirring continued for an additional 30 min. The solid formed in suspension was filtered off and the aqueous mother liquors were made neutral (pH=7) by addition of conc. ammonia solution and extracted with chloroform. On evaporation of the solvent the residue was combined with the previous precipitate and chromatographed on silica gel, using as eluent a mixture of ether-light petroleum (7:3). The first eluate gave **6a** (0.31 g, 27%); mp 248-251 °C (Et_2O); IR: 3380, 1610, 1580 cm^{-1}; UV: λ_{max} 316 infl, 267, 203 nm; ^{1}H-NMR ($CDCl_3$): δ 8.24 (m, 2H, H-4 + H-5), 8.02 (m, 3H, H-8 + phenyl H), 7.52 (m, 3H, phenyl H), 3.23 (s, 3H, CH_3); MS: *m/z* 260 (M^+). Anal. Calcd for $C_{16}H_{12}N_4$: C, 73.83; H, 4.65; N, 21.53. Found: C, 73.95; H, 4.72; N, 21.18. The second eluate gave **7a** (0.31 g, 27%); mp 268-270 °C; IR: 3380, 1630, 1610, 1580 cm^{-1}; UV: λ_{max} 324 sh, 255, 204 nm; ^{1}H-NMR (DMSO-d_6): δ 8.06 (d, 1H, J = 9 Hz, H-4), 7.96 (d, 1H, J = 9 Hz, H-5), 7.52 (s, 5H, phenyl H), 7.39 (s, 1H, H-8), 2.76 (s, 3H, CH_3); MS: *m/z* 260 (M^+). Anal. Calcd for $C_{16}H_{12}N_4$: C, 73.83; H, 4.65; N, 21.53. Found: C, 73.57; H, 4.94; N, 21.58. Eventually the aqueous mother liquors were made alkaline (pH=9-10) with conc. ammonia solution and further extracted with chloroform to give, after evaporation of the organic layer, **1a** (0.05, 4%).

Reaction of 5-amino-2-methyl-2*H*-benzotriazole (1b) with 1-phenyl-1,3-butanedione. According to the procedure previously reported for the reaction of **1a** with 1-phenyl-1,3-butanedione, from **1b** (2.0 g,

13.5 mmol) and 1-phenyl-1,3-butanedione (2.4 g, 14.8 mmol), after chromatography of the crude reaction product (silica gel, using ether as eluent) **(*Z*)-3-[(2-methyl-2*H*-benzotriazol-5-yl)-imino]-1-phenyl-1-buten-1-ol** (**5b**) was obtained: (1.95 g, 50%); mp 112-114 °C (Et_2O-hexane 1:1); IR: 3450, 1600, 1560, 1550 cm^{-1}; UV: λ_{max} 360, 280, 242 infl, 203 nm; ^{1}H-NMR ($CDCl_3$): δ 13.25 (s, 1H, OH), 7.93 (m, 2H, phenyl H), 7.84 (d, 1H, J = 8.8 Hz, H-7'), 7.61 (d, 1H, J = 1.8 Hz, H-4'), 7.46 (m, 3H, phenyl H), 7.22 (dd, 1H, J = 8.8 and 1.8 Hz, H-6'), 5.96 (s, 1H, CH=C), 4.51 (s, 3H, CH_3-N), 2.21 (s, 3H, CH_3); MS: *m/z* 292 (M^+). Anal. Calcd for $C_{17}H_{16}N_4O$: C, 69.84; H, 5.52; N, 19.17. Found: C, 69.88; H, 5.53; N, 19.43. Unreacted **1b** (0.32 g, 30%) was also recovered from the top chromatography column.

2,7-Dimethyl-9-phenyl-2*H*-triazolo[4,5-*f*]quinoline (**6b**) and **2,9-dimethyl-7-phenyl-2*H*-triazolo[4,5-*f*]quinoline** (**7b**). Compound (**5b**) (0.6 g, 2.05 mmol) was submitted to cyclization under the conditions above described for **5a**. Purification of the crude material by chromatography (silica gel, using ether-light petroleum (7:3) and secondly only ether) gave in succession: **6b** (0.27 g, 48%), mp 200-202 °C (chloroform); IR: 1610, 1580, 1570 cm^{-1}; UV: λ_{max} 320 sh, 270, 234, 214, 202 nm; ^{1}H-NMR ($CDCl_3$+CF_3COOD): δ 8.49 (d, 1H, J = 9.2 Hz, H-4), 8.23 (d, 1H, J = 9.2 Hz, H-5), 8.15 (s, 1H, H-8), 7.93 (m, 2H, phenyl H-2+H-6), 7.70 (m, 3H, phenyl H-3+H-4+H-5), 4.73 (s, 3H, CH_3-N), 3.45 (s, 3H, CH_3); MS: *m/z* 274 (M^+). Anal. Calcd for $C_{17}H_{14}N_4$: C, 74.43; H, 5.14; N, 20.43. Found: C, 74.49; H, 5.01; N, 20.23; **7b** (0.23 g, 41%), mp 129-131 °C (Et_2O); IR: 1610, 1580, 1570 cm^{-1}; UV: λ_{max} 322, 260, 201 nm; ^{1}H-NMR ($CDCl_3$+CF_3COOD): δ 8.47 (d, 1H, J = 9.2 Hz, H-4), 8.12 (d, 1H, J = 9.2 Hz, H-5), 7.67 (s, 1H, H-8), 7.62 (m, 5H, phenyl H), 4.44 (s, 3H, CH_3-N), 3.04 (s, 3H, CH_3); MS: *m/z* 274 (M^+). Anal. Calcd for $C_{17}H_{14}N_4$: C, 74.43; H, 5.14; N, 20.43. Found: C, 74.72; H, 5.09; N, 20.67; and **1b** (3%), detected by its ^{1}H-NMR and MS spectra.

Reaction of 5-amino-1*H*-benzotriazole (**1a**) **with 2-acetylcyclopentanone**. A mixture of compound (**1a**) (1.5 g, 11.2 mmol) and 2-acetylcyclopentanone (1.55 g, 12.3 mmol) in Dowtherm A (20 mL) was stirred at 140-150 °C for 20 h. After cooling, the mixture was diluted with 200 mL of hexane, stirring continued for an additional 30 min and the precipitate was collected by filtration. This crude product chromatographed on silica gel column, eluting with mixtures of ether-acetone containing percent increase of acetone, afforded in the order: **10-methyl-1,7,8,9-tetrahydrocyclopenta[*b*]triazolo[4,5-*f*]quinoline** (**9a**) (0.33 g, 13%), mp 313-315 (decomp) °C (acetone); IR: 1610, 1550 cm^{-1}; UV: λ_{max} 323, 309, 290, 300, 253, 218 nm; ^{1}H-NMR ($CDCl_3$+CF_3COOD): δ 8.42 (d, 1H, J = 9 Hz, H-4), 8.21 (d, 1H, J = 9 Hz, H-5), 3.60 (t, 2H, J = 8 Hz, CH_2-7), 3.42 (m, 5H, CH_3 + CH_2-9), 2.56 (m, 2H, CH_2-8); MS: *m/z* 224 (M^+). Anal. Calcd for $C_{13}H_{12}N_4$: C, 69.62; H, 5.39; N, 24.99. Found: C, 69.73; H, 5.27; N, 25.34. **1-{[2-(1*H*-Benzotriazol-5-yl)imino]cyclopentylidene}-1-ethanol** (**8a**): (0.7 g, 26%); mp 226-228 °C (ethanol); IR:

3320, 3140, 1700, 1670, 1620, 1610, 1560 cm^{-1}; UV: λ_{max} 300, 291, 229, 204 nm; ^{1}H-NMR (acetone-d_6+DMSO-d_6): δ 10.16 (s, 1H, OH), 8.45 (d, 1H, J = 1.2 Hz, H-4'), 7.87 (d, 1H, J = 8.8 Hz, H-7'), 7.42 (dd, 1H, J = 8.8 and 1.2 Hz, H-6'), 2.50 (t, 2H, J = 7 Hz, CH_2), 2.40 (t, 2H, J = 7 Hz, CH_2), 2.10 (s, 3H, CH_3), 1.60 (m, 2H, CH_2); MS: *m/z* 242 (M^+). Anal. Calcd for $C_{13}H_{14}N_4O$: C, 64.44, H, 5.82; N, 23.13. Found: C, 64.50; H, 6.02; N, 22.89. Eventually unreacted **1a** was recovered (0.27 g, 18%).

10-Methyl-1,7,8,9-tetrahydrocyclopenta[b]triazolo[4,5-*f*]quinoline (9a). Compound (**8a**) (0.6 g, 2.47 mmol) was added, under stirring, to Dowtherm A (6.0 g) heated to reflux temperature and stirring continued for an additional 1 h. After cooling the reaction mixture was diluted with hexane (100 mL) and stirred for an additional 30 min. A dark precipitate was filtered off and extracted in Soxhlet with ethanol to give a crude solid (0.45 g) which was chromatographed as above reported, affording **9a** (0.04 g, 7%) identical to compound previously described, and unreacted **8a** (0.27 g, 45%).

Reaction of 5-amino-2-methyl-2*H*-benzotriazole (1b) with 2-acetylcyclopentanone. According to the procedure previously reported for the reaction of **1a** with 2-acetylcyclopentanone, starting from **1b** (2.4 g, 16.2 mmol) and 2-acetylcyclopentanone (2.05 g, 16.2 mmol), after purification of the crude product by chromatography (eluent ether-acetone 9:1) **1-{2-[(2-methyl-2*H*-benzotriazol-5-yl)imino]cyclopentylidene}-1-ethanol (8b)** was obtained: (0.78 g, 19%); mp 91-92 °C (Et_2O); IR: 3450-3300, 1710, 1620, 1570 cm^{-1}; UV: λ_{max} 362, 280, 226 nm; ^{1}H-NMR ($CDCl_3$): δ 11.64 (s, 1H, OH), 7.77 (d, 1H, J = 8.8 Hz, H-7'), 7.46 (d, 1H, J = 1.2 Hz, H-4'), 7.12 (dd, 1H, J = 8.8 and 1.2 Hz, H-6'), 4.48 (s, 3H, CH_3-N), 2.90 (t, 2H, J = 7.4 Hz, CH_2), 2.71 (t, 2H, J = 7.4 Hz, CH_2), 2.16 (s, 3H, CH_3), 1.99 (m, 2H, CH_2); MS: *m/z* 256 (M^+). Anal. Calcd for $C_{14}H_{16}N_4O$: C, 65.60; H, 6.29; N, 21.86. Found: C, 65.34; H, 6.39; N, 21.96. **2,7-Dimethyl-2,8,9,10-tetrahydrocyclopenta[c]triazolo[4,5-*f*]quinolin-8-one (10b)**: (0.12 g, 3%); mp 241-242 °C (Et_2O); IR: 1720, 1710, 1570 cm^{-1}; UV: λ_{max} 318, 288, 280 sh, 242, 220 nm; ^{1}H-NMR ($CDCl_3$): δ 8.13 (d, 1H, J = 9.2 Hz, H-4), 7.96 (d, 1H, J = 9.2 Hz, H-5), 4.60 (s, 3H, CH_3-N), 3.72 (dd, 2H, J = 6 and 3.2 Hz, CH_2-9), 3.01 (s, 3H, CH_3), 2.90 (dd, 2H, J = 6 and 3.2 Hz, CH_2-10); ^{13}C-NMR (DMSO-d_6): δ 162.70 (s, CO), 156.24 (s, C-7), 149.44 (s, C-10a), 141.79 (s, C-3a), 134.40 (s, C-10c), 128.83 (d, CH-5), 128.31 (s, C-7a), 122.62 (d, CH-4), 116.01 (s, C-5a), 104.20 (s, C-10b), 43.27 (q, CH_3-N), 36.43 (t, CH_2-9), 26.56 (t, CH_2-10), 21.67 (q, CH_3-7); MS: *m/z* 252 (M^+). Anal. Calcd for $C_{14}H_{12}N_4O$: C, 66.65; H, 4.79; N, 22.21. Found: C, 66.98; H, 4.78 N, 22.28, and eventually **1b** (0.36 g, 15%).

Reaction of 5-amino-1*H*-benzotriazole (1a) with 3-buten-2-one. A mixture of **1a** (1.6 g, 12 mmol) and 3-buten-2-one (2.2 g, 31.4 mmol) in Dowtherm A (15 g) was stirred at 75-80 °C for 20 h. After cooling the reaction mixture was diluted with hexane and stirred for an additional 30 min. A solid in suspension

was collected by filtration and purified by chromatography on silica gel column, eluting first with ether and then with a mixture of ether-acetone containing percent increase of acetone, to give: **9-methyl-1*H*-triazolo[4,5-*f*]quinoline** (**12a**): (0.68 g, 31%); mp >350 °C (DMSO-H_2O); IR: 3330, 1700, 1670, 1620,1560 cm^{-1}; UV: λ_{max} 317, 304, 276 sh, 246, 217 nm; ^{1}H-NMR (DMSO-d_6): δ 8.93 (d, 1H, J = 5 Hz, H-7), 8.25 (d, 1H, J = 9.2 Hz, H-4), 8.03 (d, 1H, J = 9.2 Hz, H-5), 7.45 (d, 1H, J = 5 Hz, H-8), 3.18 (s, 3 H, CH_3); MS: *m/z* 184 (M^+). Anal. Calcd for $C_{10}H_8N_4$: C, 65.20; H, 4.38; N, 30.42. Found: C, 65.19; H, 4.35; N, 30.73. Unreacted **1a** (0.24 g, 15%), and eventually: **4-(9-methyl-2*H*-triazolo[4,5-*f*]quinolin-2-yl)-2-butanone** (**13a**): (0.54 g, 18%); mp 134-135 °C (acetone); IR: 1715, 1600, 1570 cm^{-1}; UV: λ_{max} 319, 306, 288, 279, 245, 218 nm; ^{1}H-NMR ($CDCl_3$): δ 8.83 (d, 1H, J = 4.6 Hz, H-7), 8.14 (d, 1H, J = 9.2 Hz, H-4), 7.91 (d, 1H, J = 9.2 Hz, H-5), 7.45 (d, 1H, J = 4.6 Hz, H-8), 4.94 (t, 2H, J = 6.8 Hz, CH_2-N), 3.35 (t, 2H, J = 6.8 Hz, CH_2-CO), 3.24 (s, 3H, CH_3), 2.22 (s, 3H, CH_3-CO); MS: *m/z* 254 (M^+). Anal. Calcd for $C_{14}H_{14}N_4O$: C, 66.12; H, 5.55; N, 22.04. Found: C, 65.89; H, 5.83; N, 21.78.

Reaction of 5-amino-2-methyl-2*H*-benzotriazole (1b) with 3-buten-2-one. A mixture of **1b** (2.0 g, 13.5 mmol) and 3-buten-2-one (1.26 g, 18 mmol) was treated in an identical manner described in the case of **1a** and this ketone. The work-up of the crude product after chromatography (silica gel, light petroleum-ether 7:3), gave: **(*Z*)-4-[(2-methyl-2*H*-benzotriazol-5-yl)-amino]-butan-2-one** (**11b**): (1.49 g, 51%); mp 85-87 °C (Et_2O-hexane); IR: 3360, 1720, 1700, 1670, 1630, 1565 cm^{-1}; UV: λ_{max} 340, 230 nm; ^{1}H-NMR ($CDCl_3$): δ 7.67 (d, 1H, J = 9 Hz, H-7'), 6.75 (dd, 1H, J = 9 and 1.2 Hz, H-6'), 6.65 (d, 1H, J = 1.2 Hz, H-4'), 4.40 (s, 3H, CH_3-N), 3.43 (t, 2H, J = 6.8 Hz, CH_2-N), 2.74 (t, 2H, J = 6.8 Hz, CH_2-CO), 2.20 (s, 3H, CH_3); MS: *m/z* 218 (M^+). Anal. Calcd for $C_{11}H_{14}N_4O$: C, 60.53; H, 6.47; N, 25.67. Found: C, 60.24; H, 6.59; N, 25.69. **2,9-Dimethyl-2*H*-triazolo[4,5-*f*]quinoline** (**12b**): (0.38 g, 14%); mp 127-129 °C (Et_2O); IR: 1700, 1670, 1610, 1580, 1570 cm^{-1}; UV: λ_{max} 318, 304, 288 sh, 253, 218 nm; ^{1}H-NMR ($CDCl_3$): δ 8.79 (d, 1H, J = 4.6 Hz, H-7), 7.98 (d, 1H, J = 9 Hz, H-4), 7.92 (d, 1H, J = 9 Hz, H-5), 7.37 (d, 1H, J = 4.6 Hz, H-8), 4.55 (s, 3H, CH_3-N), 3.04 (s, 3H, CH_3); MS: *m/z* 198 (M^+). Anal. Calcd for $C_{11}H_{10}N_4$: C, 66.65; H, 5.09; N, 28.26. Found: C, 66.46; H, 5.18; N, 28.20. Eventually 0.07 g (3.5%) of unreacted **1b** was recovered.

2,9-Dimethyl-2*H*-triazolo[4,5-*f*]quinoline (**12b**). **11b** (0.7 g, 3.2 mmol) was slowly added, under stirring, to Dowtherm A (7 g) previously heated to reflux temperature and stirring was continued for an additional 45 min. After cooling, the reaction mixture was diluted with hexane (120 mL). An oil was collected by decantation and purified by chromatography eluting with a mixture of light petroleum-ether 7:3, to give in sequence **11b** (0.04 g, 6%), **12b** (0.10 g, 16%) identical to compound above described, and **1b** 0.06 (13%).

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Received, 15th April, 1999