Fused Quinoline Heterocycles IX: First Example of a 3,4-Diamino-1*H*-pyrazolo[4,3-*c*]quinoline and a 3-Azido-1*H*-1,2,4,5,6,6a-hexaazabenzo[*a*]indacene

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Z. Naturforsch. **2009**, *64b,* 973 – 979; received April 3, 2009

4-Alkylamino-2-chloroquinoline-3-carbonitriles **4a** – **c** react with NaN_3 to give the corresponding tetrazolo[1,5-*a*]quinoline-4-carbonitriles **5a** – **c** which are converted into 2-amino-quinoline-3-carbonitriles **8a** – **c** by reaction with PPh_3 *via* an iminophosphorane and subsequent hydrolysis. On the other hand, the new 3,4-diamino-1*H*-pyrazolo[4,3-*c*]quinoline (**11**) was prepared by fusion of the aminoquinolines **8a** – **c** with hydrazine hydrate. Diazotization of **11** followed by reaction with NaN_3 yielded the novel tetracyclic ring system 3-azido-1*H*-1,2,4,5,6,6a-hexaazabenzo[*a*]indacene (**13**).

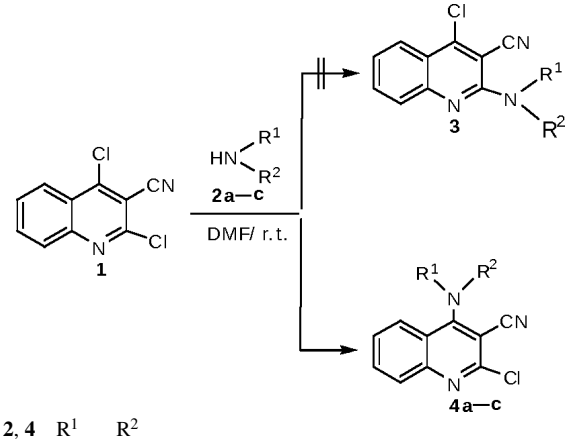
Key words: Aminoquinoline-3-carbonitriles, Heterocyclic Synthesis, 3,4-Diamino-1*H*-pyrazolo[4,3-*c*]quinoline

Introduction

Functionalized quinolines and their hetero-fused analogs represent an important class of organic molecules that have attracted a great deal of attention from synthetic as well as medicinal chemists because of their presence in numerous natural products along with the wide spectrum of physiological activities displayed by these compounds [1]. Thus, 2-aminoquinolines have recently been reported to be potent melanin-concentrating hormone 1 receptor (MCH1R) antagonists [2 – 5]. Pyrazole derivatives exhibit pharmacological activities such as hypotensive, antibacterial, anti-inflammatory and antitumor properties [6].

Of special interest, 3-aminopyrazoles have recently been reported to display significant biological activities, being inhibitors of CDK2/cyclin A as antitumor agents [7, 8] and strong anticonvulsants [9]. Thus, it is envisioned that 3,4-diaminopyrazolo[4,3-c]-quinolines, which contain both the 3-aminopyrazole and 2-aminoquinoline moieties, may afford unique biological activities.

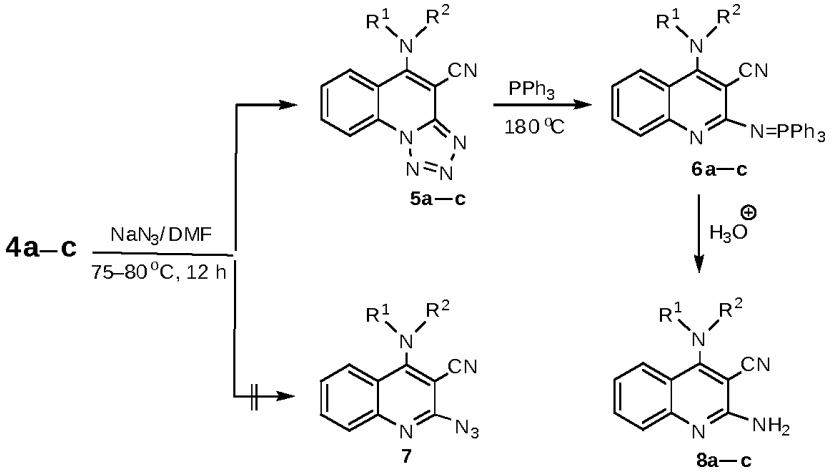
Although numerous elegant syntheses have been developed for pyrazolo[4,3-*c*]-quinoline derivatives, because of their great importance [10 – 21], to the best of our knowledge, 3,4-diamino-1*H*-pyrazolo[4,3-*c*]quinoline **11** is unknown, due to the difficulties encountered to synthesize this tricyclic diamino compound with two primary amino groups using the previously known methodologies, providing the impetus to synthesize this novel heterocyclic system.



2, **4**	R^1	R^2
a	4-methylpiperidino	
b	CH_3	CH_3
c	Et	Et

Scheme 1.

We have previously reported a versatile method directed towards the synthesis of new polyfunctionally substituted pyrazolo[4,3-*c*]quinolines with poten-



5, 6, 8	R^1	R^2
a	4-methylpiperidino	
b	CH_3	CH_3
c	Et	Et

Scheme 2.

tial pharmaceutical activity [22–28]. In order to extend the synthetic scope of this method and in continuation of our search for more potent pyrazolo[4,3-*c*]quinolines, we planned to synthesize new pyrazolo [4,3-*c*]quinolines with a primary amino group with the expectation that the introduction of an NH_2 group into different positions of the basic pyrazoloquinoline system will increase its therapeutic index. In this paper, we wish to report the synthesis of the title compounds, using the conveniently available 2,4-dichloroquinoline-3-carbonitrile (**1**) [29] as starting material.

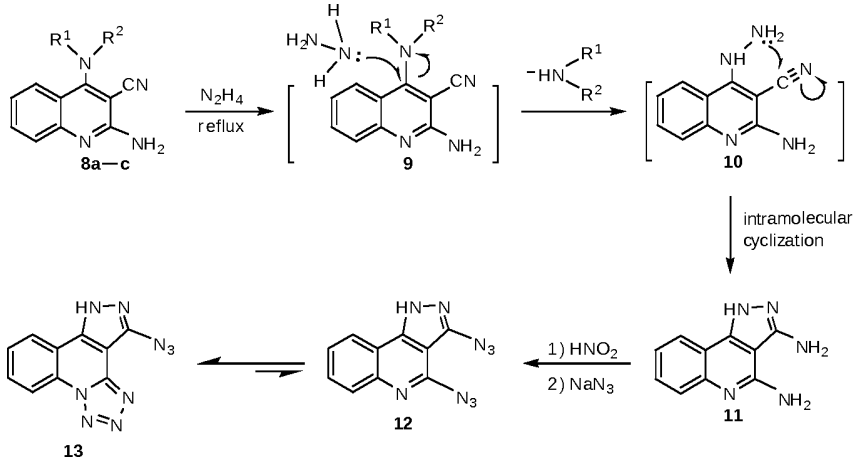
Results and Discussion

In our studies, compound **1** was reacted with secondary amines **2** in order to obtain the required key intermediates **4** for subsequent pyrazole ring closure. The reaction of **1** with an excess of the appropriate secondary amines **2a–c** in DMF solution at r. t. did not afford the 2-dialkylamino-4-chloroquinoline-3-carbonitriles **3**, but gave instead the expected isomeric 4-dialkylamino-2-chloroquinoline-3-carbonitriles **4a–c**, where the nucleophilic substitution first takes place at position 4 [29, 30] (Scheme 1). When the aminoquinolines **4a–c** were reacted with sodium azide in DMF at 75–80 °C the ring-closed tetrazolo[1,5-*a*]-quinolines **5a–c** were isolated as the only reaction products, instead of the tautomeric azidoquinolines **7** (Scheme 2). The IR spectra of **5a–c** have no azido band.

The Staudinger reaction [31] is one of the most common methods for reducing organic azides to the corresponding primary amines due to the chemoselectivity, mild reaction conditions and good yields [32]. Consequently, this reaction was applied in the present investigation to synthesize 2,4-diaminoquinoline-3-carbonitriles **8a–c**, which are considered to be very important intermediates for the synthesis of the desired pyrazolo-[4,3-*c*]quinolines **11**, by reduction of tetrazolo[1,5-*a*]quinoline-3-carbonitriles, *via* the formation of a phosphazene intermediate, in good yields.

In an attempt to synthesize 2,4-diaminoquinoline-3-carbonitriles **8a–c** from the tetrazoloquinolines **5a–c**, we investigated the ring opening of the tetrazolo ring in **5a–c** by reaction with triphenylphosphine to give the corresponding open-chain phosphazenes **6a–c** (Scheme 2). Refluxing tetrazoloquinolines **5a–c** with triphenylphosphine in bromobenzene, high stability was observed, and no phosphazenes **6a–c** were isolated, even upon heating for extended periods. Therefore, we repeated the reaction in a solvent of (some 20 °C) higher boiling point than bromobenzene, *viz.* 1,2-dichlorobenzene. Heating **5a–c** with triphenylphosphine in 1,2-dichlorobenzene at reflux temperature for 5 h afforded the phosphazenes **6a–c**, which could be hydrolyzed with a mixture of acetic acid/water (5 : 1) to the corresponding new 2,4-diaminoquinoline-3-carbonitriles **8a–c** (Scheme 2). Structural proof of **8a–c** rests on elemental analyses and spectroscopic data (see Experimental Section). An examination of other possible routes to the aminoquinoline-3-carbonitriles **8a–c** shows that the three-step sequence *via* the phosphazene **6** is a superior method. Aminoquinoline derivatives **8a–c** can not be prepared by direct amination due to numerous competing side reactions.

As the synthesis of the new pyrazolo[4,3-*c*]quinoline ring system is the main target of this program, we



Scheme 3.

decided to investigate the reaction of aminoquinolines **8a – c** with hydrazine hydrate with the hope of obtaining the interesting pyrazolo[4,3-*c*]quinoline ring system **11**. Thus, refluxing these amines **8a – c** with an excess of hydrazine hydrate (80 %) for 5 h produced a solid product in excellent yield which was identified as 3,4-diamino-1*H*-pyrazolo[4,3-*c*]quinoline (**11**) (Scheme 3). The structural assignment for **11** was established on the basis of consistent elemental and spectral data. The IR spectrum showed no cyano absorption at 2210 cm^{-1}, but absorption bands at 3330 and 3200 cm^{-1} which were assigned to NH and NH_2 amino functions. Moreover, the ^1H NMR spectrum revealed the absence of alkyl protons and the presence of signals for two amino protons at C-3, two amino protons at C-4, and a pyrazole NH proton in addition to aromatic protons in their expected positions. The mass spectrum showed a molecular ion at *m/z* = 199. Formation of the pyrazoloquinoline **11** can be rationalized as follows: the alkyl amino group at position 4 of 4-alkylaminoquinoline-3-carbonitriles **8a – c** undergoes a nucleophilic substitution reaction with one molecule of hydrazine to give the intermediate **10**. Subsequent intramolecular cyclization *via* the attack of the NH_2 of the hydrazino group at position 4 on the nitrile carbon in the intermediate **10** yields the pyrazolo-fused compound **11** (Scheme 3).

Organic azides are well known as compounds with a high level of biological activity and have proved valuable as one of the most important classes of drugs for the treatment of cardiovascular diseases [33]. Some heterocyclic azides were synthesized as antithrombotic and blood pressure-lowering agents [34]. Furthermore, they are among the most versatile organic synthetic intermediates, and they present a broad range of chemical reactivity [35]. We therefore are interested in investigating the introduction of the azido group into the newly synthesized 3,4-diamino-1*H*-pyrazolo[4,3-*c*]quinoline (**11**) with the expectation that the products would be of potential biological interest. Thus, when compound **11** was reacted with sodium nitrite in a 70 % solution of H_2SO_4 at −5 °C, followed by reaction of the non-isolated pyrazoloquinoline diazonium sulfate with an aqueous solution of sodium azide, a solid product was obtained for which the two valence-isomeric structures **12** and **13** can be written (see Scheme 3). It has been reported that tetrazoles fused with five-membered heterocycles are generally in the azide form while tetrazoles fused with six-membered heterocycles exist in the tetrazole form [36]. Thus, the previously unreported 3-azido-1*H*-1,2,4,5,6,6a-hexaazabenzo[*a*]indacene structure **13** is proposed for the isolated product. The structure of **13** was confirmed on the basis of its elemental analysis and spectral data. The IR spectrum of the reaction product showed an absorption band for the N_3 group at 2130 cm^{-1}. The ^1H NMR spectrum displayed no amino protons (NH_2) and the presence of a singlet at δ = 14.47 ppm, assignable to the pyrazole NH in addition to four aromatic protons at δ = 7.77 – 8.44 ppm. Furthermore, the structure assigned for this reaction product **13** was fully supported by its mass spectrum, which showed a molecular formula $C_{10}H_5N_9$ (*m/z* = 251, $[M]^+$).

In summary, the work described in this paper shows for the first time the synthesis of two previously unreported tricyclic systems, namely 3,4-diamino-1*H*-pyrazolo[4,3-*c*]quinoline (**11**), with both amino groups as primary amines, and 3-azido-1*H*-1,2,4,5,6,6a-hexa-

azabenzo[*a*]indacene (**13**), which are difficult to obtain by alternative routes, with the purpose of investigating in the future their biological activity.

Experimental Section

All melting points were measured on a Gallenkamp apparatus and are uncorrected. IR spectra were obtained with a Shimadzu 470 spectrophotometer as dispersions in KBr. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker Avance II spectrometer at 400 MHz for ^{1}H and 100 MHz for ^{13}C with [D_6]DMSO as solvent and TMS as an internal standard. Chemical shifts (δ) are reported in ppm. Mass spectra were performed on a Shimadzu GCMS-QP 2010 mass spectrometer at 70 eV. Microanalyses were performed by the Microanalytical Data Unit at Cairo University, and analytical values obtained were within ±0.4 % of the calculated values. All reagents were of commercial quality or were purified before use, and the organic solvents were of analytical grade or purified by standard procedures.

*General procedure for the preparation of 4-alkylamino-2-chloroquinoline-3-carbonitriles **4a – c***

The appropriate sec. amines **2a – c** (2.25 mmol) were added to a solution of **1** (0.250 g, 1.12 mmol) in DMF (3 mL). The reaction mixture was stirred for 30 min at r. t. and was then poured into water (10 mL). The precipitated solid product was isolated by suction and recrystallized from ethanol.

*2-Chloro-4-(4-methylpiperidino)quinoline-3-carbonitrile (**4a**)*

M. p. 160 – 161 °C. Yield: 96 %. – IR: ν = 3050 (arom. CH), 2928, 2850 (aliph. CH), 2210 (CN) cm^{-1}. – ^{1}H NMR (400 MHz, [D_6]DMSO): δ = 1.02 (d, 3H, J = 6.4 Hz, CH_3), 1.46 (m, 2H, CH_2), 1.71 (m, 1H, H aliph.), 1.76 (m, 2H, CH_2), 3.50 (m, 2H, CH_2), 3.88 (m, 2H, CH_2), 7.65 (m, 1H Ar), 7.86 (m, 2H Ar), 8.04 (d, 1H, J = 8.5 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 21.9 (CH_3), 30.0 (aliph. CH), 34.6 ($2CH_2$), 53.4 ($2CH_2$), 95.5 (C-3), 116.8 (CN), 122.1 (C-4a), 125.7, 127.1, 129.0, 133.2 (Ar-C), 148.2 (C-8a), 149.8 (C-2), 162.8 (C-4). – MS (EI, 70 eV): *m/z* (%) = 287 (36) [M, ^{37}Cl]$^+$, 285 (100) [M, ^{35}Cl]$^+$. – $C_{16}H_{16}ClN_3$ (285.8): calcd. C 67.25, H 5.64, Cl 12.41, N 14.70; found C 67.44, H 5.78, Cl 12.26, N 14.82.

*2-Chloro-4-(dimethylamino)quinoline-3-carbonitrile (**4b**)*

M. p. 187 – 188 °C. Yield: 92 %. – IR: ν = 3050 (arom. CH), 2928, 2850 (aliph. CH), 2210 (CN) cm^{-1}. – ^{1}H NMR (400 MHz, [D_6]DMSO): δ = 3.41 (s, 6H, $2CH_3$), 7.60 (m, 1H Ar), 7.83 (m, 2H Ar), 8.18 (d, 1H, J = 8.5 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 45.2 (2 CH_3), 93.7 (C-3), 117.0 (CN), 121.4 (C-4a), 126.5, 126.6, 128.9, 132.9 (Ar-C), 148.1(C-8a), 149.9 (C-2), 162.7 (C-4). – MS (EI, 70 eV): *m/z* (%) = 233 (27) [M, ^{37}Cl]$^+$, 231 (82) [M, ^{35}Cl]$^+$. – $C_{12}H_{10}ClN_3$ (231.7): calcd. C 62.21, H 4.35, Cl 15.30, N 18.14; found C 62.36, H 4.19, Cl 15.27, N 18.19.

*2-Chloro-4-(diethylamino)quinoline-3-carbonitrile (**4c**)*

M. p. 134 – 136 °C. Yield: 93 %. – IR: ν = 3050 (arom. CH), 2976, 2928, 2885 (aliph. CH), 2210 (CN) cm^{-1}. – ^{1}H NMR (400 MHz, [D_6]DMSO): δ = 1.17 (t, 6H, J = 7.0 Hz, $2CH_3$), 3.73 (q, 4H, J = 7.0 Hz, $2CH_2$), 7.67 (m, 1H Ar), 7.90 (m, 2H Ar), 8.11 (d, 1H, J = 8.4 Hz, 1 Ar). – ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 13.3 (2 CH_3), 47.4 (2 CH_2), 99.4 (C-3), 116.3 (CN), 123.6 (C-4a), 125.9, 127.4, 129.0, 133.3 (Ar-C), 148.3 (C-8a), 149.3 (C-2), 163.4 (C-4). – MS (EI, 70 eV): *m/z* (%) = 261 (15) [M, ^{37}Cl]$^+$, 259 (46) [M, ^{35}Cl]$^+$. – $C_{14}H_{14}ClN_3$ (259.7): calcd. C 64.74, H 5.43, Cl 13.65, N 16.18; found C 64.56, H 5.59, Cl 13.77, N 16.09.

*General procedure for the preparation of 5-substituted tetrazolo[1,5-a]quinoline-4-carbonitriles **5a – c***

Sodium azide (5.25 mmol) was added to a solution of 4**a – c** (1.75 mmol) in DMF (15 mL). The reaction mixture was stirred at 75 – 80 °C for 12 h. After cooling, the reaction mixture was poured into cold water, and the precipitated product was filtered, washed well with water, dried and recrystallized from DMF to afford the tetrazoloquinolines **5a – c**.

*5-(4-Methylpiperidino)-tetrazolo[1,5-a]quinoline-4-carbonitrile (**5a**)*

M. p. 243 – 244 °C. Yield: 94 %. – IR: ν = 2951, 2865 (aliph. CH), 2210 (CN) cm^{-1}. – ^{1}H NMR (400 MHz, [D_6]DMSO): δ = 1.05 (d, 3H, J = 6 Hz, CH_3), 1.54 (m, 2H, CH_2), 1.77 (m, 1H aliph.), 1.86 (m, 2H, CH_2), 3.52 (m, 2H, CH_2), 3.89 (m, 2H, CH_2), 7.83 (t, 1H, J = 8 Hz, 1H Ar), 8.05 (t,1H, J = 8 Hz, 1H Ar), 8.18 (d, 1H, J = 8.2 Hz, 1H Ar), 8.56 (d, 1H, J = 8.2 Hz, 1H Ar). – MS (EI, 70 eV): *m/z* (%) = 293 (13) [M+1]$^+$, 292 (63) [M]$^+$. – $C_{16}H_{16}N_6$ (292.3): calcd. C 65.74, H 5.52, N 28.75; found C 65.86, H 5.74, N 28.88.

*5-(Dimethylamino)-tetrazolo[1,5-a]quinoline-4-carbonitrile (**5b**)*

M. p. 208 – 209 °C. Yield: 81 %. – IR: ν = 3088 (arom. CH), 2951, 2928 (aliph. CH), 2210 (CN) cm^{-1}. – ^{1}H NMR (400 MHz, [D_6]DMSO): δ = 3.44 (s, 6H, $2CH_3$), 7.79 (t, 1H, J = 8 Hz, 1H Ar), 8.02 (t, 1H, J = 8 Hz, 1H Ar), 8.31 (d, 1H, J = 8.5 Hz, 1H Ar), 8.51 (d, 1H, J = 8.5 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 45.2 ($2CH_3$), 79.7 (C-4), 115.4 (CN), 117.0 (Ar-C), 120.5 (C-5a), 127.8, 128.9 (Ar-C), 131.6 (C-9a), 133.9 (Ar-C), 148.3 (C-3a), 159.8 (C-5). – MS (EI, 70 eV): *m/z* (%) = 239 (6) [M+1]$^+$,

238 (37) $[M]^+$. – $C_{12}H_{10}N_6$ (238.3): calcd. C 60.50, H 4.23, N 35.27; found C 60.61, H 4.09, N 35.19.

*5-(Diethylamino)-tetrazolo[1,5-a]quinoline-4-carbonitrile (**5c**)*

M. p. 168 – 169 °C. Yield: 96 %. – IR: ν = 3070 (arom. CH), 2976, 2910 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 1.23 (t, 6H, J = 7.0 Hz, $2CH_3$), 3.75 (q, 4H, J = 7.0 Hz, $2CH_2$), 7.83 (t, 1H, J = 8 Hz, 1H Ar), 8.05 (t, 1H, J = 8 Hz, 1H Ar), 8.25 (d, 1H, J = 8 Hz, 1H Ar), 8.56 (d, 1H, J = 8 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D$_6$]DMSO): δ = 13.1 ($2CH_3$), 47.5 ($2CH_2$), 86.7 (C-4), 114.8 (CN), 117.1 (Ar-C), 122.0 (C-5a), 128.2, 128.3 (Ar-C), 131.8 (C-9a), 134.0 (Ar-C), 147.8 (C-3a), 159.8 (C-5). – MS (EI, 70 eV): *m/z* (%) = 267 (6) $[M+1]^+$, 266 (28) $[M]^+$. – $C_{14}H_{14}N_6$ (266.3): calcd. C 63.14, H 5.30, N 31.56; found C 63.26, H 5.39, N 31.47.

*General procedure for the preparation of 4-substituted-2-[(triphenylphosphoranylidene)-amino]quinoline-3-carbonitriles **6a – c***

A mixture of **5a – c** (1.72 mmol) and triphenylphosphine (1.72 mmol) in 1,2-dichloro-benzene was heated under reflux for 5 h. After concentration and cooling to r. t., the resulting solid product was filtered off, washed with a small amount of MeOH, dried and recrystallized from DMF to give compounds **6a – c**.

*4-(4-Methylpiperidino)-2-[(triphenylphosphoranylidene) amino]quinoline-3-carbonitrile (**6a**)*

M. p. 230 – 231 °C. Yield: 89 %. – IR: ν = 3040 (arom. CH), 2912, 2848 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 1.01 (d, 3H, J = 6.3 Hz, CH_3), 1.43 (m, 2H, CH_2), 1.66 (m, 1H aliph.), 1.77 (m, 2H, CH_2), 3.37 (m, 2H, CH_2), 3.58 (m, 2H, CH_2), 7.10 (t, 2H, J = 8 Hz, 2H Ar), 7.39 (t, 1H, J = 7.5 Hz, 1H Ar), 7.55 – 7.63 (m, 9H Ar), 7.70 (d, 1H, J = 8.2 Hz, 1H Ar), 7.89 – 7.94 (m, 6H Ar). – MS (EI, 70 eV): *m/z* (%) = 527 (19) $[M+1]^+$, 526 (68) $[M]^+$. – $C_{34}H_{31}N_4P$ (526.6): calcd. C 77.55, H 5.93, N 10.64; found C 77.64, H 5.79, N 10.72.

*4-(Dimethylamino)-2-[(triphenylphosphoranylidene)amino] quinoline-3-carbonitrile (**6b**)*

M. p. 206 – 208 °C. Yield: 72 %. – IR: ν = 3070 (arom. CH), 2912, 2850 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 3.22 (s, 6H, $2CH_3$), 7.05 (m, 2H Ar), 7.35 – 7.38 (m, 1H Ar), 7.53 – 7.63 (m, 9H Ar), 7.77 (d, 1H, J = 8.4 Hz, 1H Ar), 7.89 – 7.94 (m, 6H Ar). – ^{13}C NMR (100 MHz, [D$_6$]DMSO): δ = 44.3 ($2CH_3$), 92.8 (C-3), 118.3 (CN), 119.3 (C-4a), 121.1, 125.3, 126.2, 128.4, 128.7, 128.8, 128.9 (Ar-C), 131.0 (C-8a), 132.3, 133.0, 133.1 (Ar-C), 149.6 (C-2), 162.4 (C-4). – MS (EI, 70 eV): *m/z* (%) = 473 (12) $[M+1]^+$, 472 (53) $[M]^+$. – $C_{30}H_{25}N_4P$ (472.5): calcd. C 76.26, H 5.33, N 11.86; found C 76.37, H 5.20, N 12.02.

*4-(Diethylamino)-2-[(triphenylphosphoranylidene)amino] quinoline-3-carbonitrile (**6c**)*

M. p. 210 – 211^{o}C. Yield: 96 %. – IR: ν = 3056 (arom. CH), 2976 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 1.09 (t, 6H, J = 7.0 Hz, $2CH_3$), 3.53 (q, 4H, J = 7.0 Hz, $2CH_2$), 7.08 – 7.16 (m, 2H Ar), 7.39 (m, 1H Ar), 7.53 – 7.64 (m, 9H Ar), 7.77 (d, 1H, J = 7.5 Hz, 1H Ar), 7.90 – 7.95 (m, 6H Ar). – ^{13}C NMR (100 MHz, [D$_6$]DMSO): δ = 13.3 ($2CH_3$), 46.7 ($2CH_3$), 98.2 (C-3), 118.7 (CN), 120.3 (C-4a), 121.6, 124.7, 126.1, 128.3, 128.7, 128.9, 129.3 (Ar-C), 131.2 (C-8a), 132.3, 133.0, 133.1 (Ar-C), 149.6 (C-2), 161.7 (C-4). – MS (EI, 70 eV): *m/z* (%) = 501 (10) $[M+1]^+$, 500 (42) $[M]^+$. – $C_{32}H_{29}N_4P$ (500.6): calcd. C 76.78, H 5.84, N 11.19; found C 76.59, H 5.72, N 11.04.

*General procedure for the preparation of 4-substituted-2-aminoquinoline-3-carbonitriles **8a – c***

A solution of compounds **6a – c** (0.950 mmol) in a mixture of AcOH (5 mL) and H_2O (1 mL) was refluxed for 3 – 5 h. After concentration and cooling to r. t., the resulting solid product was collected by filtration, washed well with MeOH to remove Ph_3PO, dried and recrystallized from EtOH to give compounds **8a**, **c**. In the case of **8b**, the reaction mixture was heated in a water bath at 60 °C for 40 h, and then it was worked up as described for **8a**, **c**.

*2-Amino-4-(4-methylpiperidino)quinoline-3-carbonitrile (**8a**)*

M. p. 218 – 219 °C. Yield: 75 %. – IR: ν = 3456, 3296, 3120 (NH_2), 2940, 2848 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 1.01 (d, 3H, J = 6.4 Hz, CH_3), 1.43 (m, 2H, CH_2), 1.67 (m, 1H aliph.), 1.79 (m, 2H, CH_2), 3.38 (m, 2H, CH_2), 3.66 (m, 2H, CH_2), 6.54 (s, 2H, NH_2), 7.19 (t, 1H, J = 8 Hz, 1H Ar), 7.42 (d, 1H, J = 8 Hz, 1H Ar), 7.54 (t, 1H, J = 8 Hz, 1H Ar), 7.76 (d, 1H, J = 8 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D$_6$]DMSO): δ = 22.0 (CH_3), 30.3 (aliph. CH), 34.6 ($2CH_2$), 52.9 ($2CH_2$), 84.6 (C-3), 117.7 (CN), 118.2 (C-4a), 121.7, 124.8, 126.5, 131.9 (Ar-C), 150.3 (C-8a), 157.6 (C-4), 162.6 (C-2). – MS (EI, 70 eV): *m/z* (%) = 267 (18) $[M+1]^+$, 266 (98) $[M]^+$. – $C_{16}H_{18}N_4$ (266.3): calcd. C 72.15, H 6.81, N 21.04; found C 72.27, H 6.69, N 21.15.

*2-Amino-4-(dimethylamino)quinoline-3-carbonitrile (**8b**)*

M. p. 208 – 209 °C. Yield: 69 %. – IR: ν = 3400, 3300, 3150 (NH_2), 2920 (aliph. CH), 2220 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D$_6$]DMSO): δ = 3.25 (s, 6H, $2CH_3$), 6.66 (s, 2H,

NH_2), 7.19 (t, 1H, J = 7.8 Hz, 1H Ar), 7.49 (d, 1H, J = 8 Hz, 1H Ar), 7.56 (t, 1H, J = 7.8 Hz, 1H Ar), 7.83 (d, 1H, J = 8 Hz, 1H Ar). – MS (EI, 70 eV): *m/z* (%) = 213 (18) $[M+1]^+$, 212 (100) $[M]^+$. – $C_{12}H_{12}N_4$ (212.3): calcd. C 67.90, H 5.70, N 26.40; found C 67.78, H 5.88, N 26.53.

*2-Amino-4-(diethylamino)quinoline-3-carbonitrile (**8c**)*

M. p. 149 – 150 °C. Yield: 73 %. – IR: ν = 3408, 3328, 3152 (NH_2); 2960 (aliph. CH), 2210 (CN) cm^{-1}. – ^1H NMR (400 MHz, [D_6]DMSO): δ = 1.11 (t, 6H, J = 6.8 Hz, $2CH_3$), 3.57 (q, 4H, J = 6.8 Hz, $2CH_2$), 6.65 (s, 2H, NH_2), 7.20 (t, 1H, J = 7.3 Hz, 1H Ar), 7.47 (d, 1H, J = 8.2 Hz, 1H Ar), 7.57 (t, 1H, J = 7.3 Hz, 1H Ar), 7.82 (d, 1H, J = 8.2 Hz, 1H Ar). – ^{13}C NMR (100 MHz, [D_6]DMSO): δ = 13.3 ($2CH_3$), 46.9 ($2CH_2$), 89.2 (C-3), 117.2 (CN), 119.8 (C-4a), 121.9, 125.0, 126.4, 132.0 (Ar-C), 150.5 (C-8a), 157.4 (C-4), 162.4 (C-2). – MS (EI, 70 eV): *m/z* (%) = 241 (14) $[M+1]^+$, 240 (80) $[M]^+$. – $C_{14}H_{16}N_4$ (240.3): calcd. C 69.97, H 6.71, N 23.32; found C 70.13, H 6.59, N 23.47.

*3,4-Diamino-1H-pyrazolo[4,3-c]quinoline (**11**)*

A mixture of **8a** – **c** (1.25 mmol) and hydrazine hydrate (5 mL; 80 %) was refluxed for 5 h, until TLC showed the disappearance of the starting compounds. After cooling, the mixture was evaporated to dryness *in vacuo*. Water (3 mL) was added to the remaining oily residue with scratching. The resulting product was isolated by suction, washed with H_2O, dried and recrystallized from DMF. The product was obtained in 80 – 86 % yield.

M. p. 326 – 328 °C (decomp.). – IR: ν = 3330, 3200 (NH, NH_2) cm^{-1}. – ^1H NMR (400 MHz, [D_6]DMSO): δ = 5.87 (s, 2H, NH_2), 7.64 (m, 2H Ar), 8.01 (d, 1H, J = 7 Hz, 1H Ar), 8.25 (d, 1H, J = 7 Hz, 1H Ar), 9.11 (s, 2H, NH_2), 12.82 (br s, 1H, NH). – MS (EI, 70 eV): *m/z* (%) = 200 (14) $[M+1]^+$, 199 (36) $[M]^+$. – $C_{10}H_9N_5$ (199.2): calcd. C 60.29, H 4.55, N 35.16; found C 60.40, H 4.37, N 35.32.

*3-Azido-1H-1,2,4,5,6,6a-hexaazabenzo[a]indacene (**13**)*

A solution of **11** (0.3 g, 1.51 mmol) in H_2SO_4 (4 mL, 70 %) was cooled until the temperature of the solution was −5 °C and treated with sodium nitrite (0.313 g, 4.53 mmol) in water (1 mL). To the resulting solution of the diazonium salt was added sodium azide (0.295 g, 4.53 mmol) in water (1 mL) and the mixture maintained at 0 to −5 °C. Stirring was then continued for 1 h at r. t. The resulting solid product was collected by filtration and dissolved in H_2O. The solution was neutralized with dil. Na_2CO_3 solution, and the precipitated solid product was collected by filtration, washed well with H_2O, dried and recrystallized from acetone to afford compound **13**.

M. p. 196 – 197 °C (decomp.). Yield: 75 %. – IR: ν = 3200 (NH), 3008 (arom. CH), 2130 (N_3) cm^{-1}. – ^1H NMR (400 MHz, [D_6]DMSO): δ = 7.77 (t, 1H, J = 7.5 Hz, 1H Ar), 7.87 (t, 1H, J = 7.5 Hz, 1H Ar), 8.25 (d, 1H, J = 8.0 Hz, 1H Ar), 8.44 (d, 1H, J = 8.0 Hz, 1H Ar), 14.47 (s, 1H, pyrazole NH). – MS (EI, 70 eV): *m/z* (%) = 251 (7) $[M]^+$. – $C_{10}H_5N_9$ (251.2): calcd. C 47.81, H 2.01, N 50.18; found C 48.02, H 1.89, N 50.34.

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