# 121. Synthesis of 1*H*-Cyclopropa[*g*]quinoline *via* Trapping of an *ortho*-Quinodimethane

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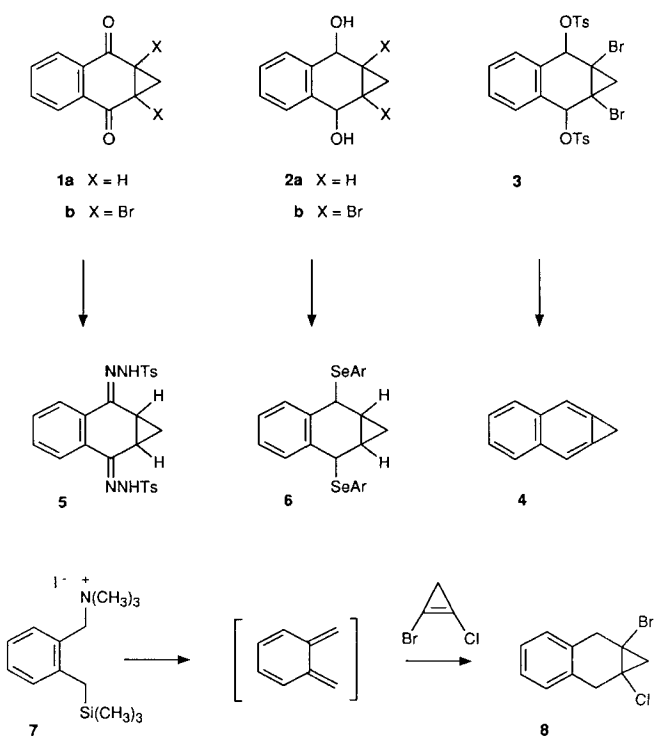
1*H*-Cyclopropa[*g*]quinoline (3-aza-1*H*-cyclopropa[*b*]naphthalene; **17**) was synthesized *via* interception of the heterocyclic *ortho*-quinodimethane **15** with 1-bromo-2-chlorocyclopropene, followed by aromatization of the adduct **16** with *t*-BuOK.

Recently, we reported the preparation of cycloproparenes by a route involving aromatization of adducts of furans or isobenzofurans to 1-bromo-2-chlorocyclopropenes with low-valent Ti [1]. This new cycloproparene synthesis was exploited subsequently to

*Scheme 1*



prepare 2,7-dimethyl-1*H*-cyclopropa[*g*]isoquinoline, the first, and so far, the only representative of this class of cycloproparenes. However, the yield of the aromatization step, which was usually satisfactory in the isocyclic series, dropped to a mere 15% for the heterocyclic compound and worse, the approach failed when applied towards the synthesis of the parent unsubstituted compound [2]. This communication deals with two new approaches to 1*H*-cyclopropa[*b*]naphthalene (**4**; *Scheme 1*) which were elaborated with the objective of application to heterocyclic analogs. One of these approaches opened a simple route for 1*H*-cyclopropa[*g*]quinoline (**17**).

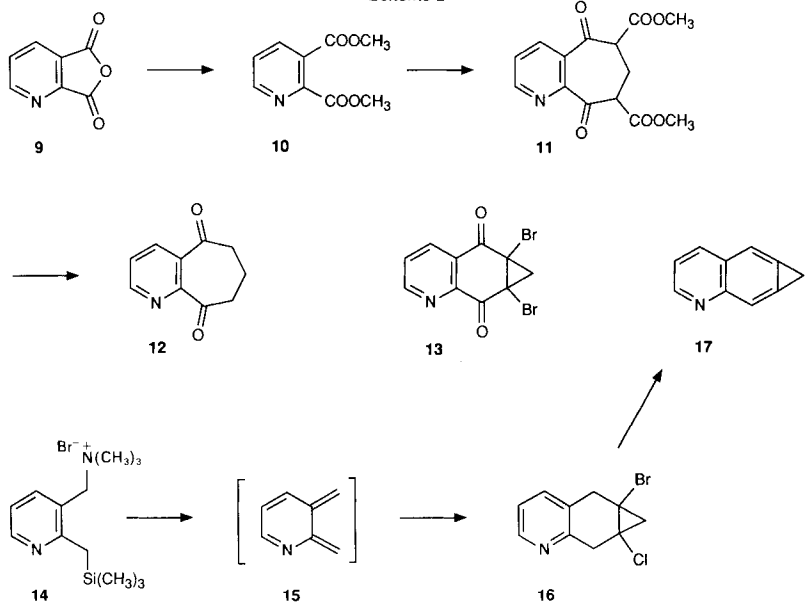
**Approaches to 1*H*-Cyclopropa[*b*]naphthalene (4).** – The C skeleton of **4** is traditionally synthesized by a carbene addition to 1,4-dihydronaphthalene [3] or by a [4 + 2] cycloaddition of an appropriate diene to a substituted cyclopropene [4]. As an alternative, we investigated a synthesis of **4**, in which the ring system is constructed from benzocycloheptene-1,4-dione. The ring-contracted compounds **1a** and **1b** were synthesized according to known procedures [5]. The dibromide **1b** was reduced to bromohydrin **2b** with $LiAlH_4$. Since reaction of **2b** with low-valent Ti [6] resulted only in decomposition and a low (*ca.* 10%) yield of 2-methylnaphthalene, **2b** was converted to the unstable ditosylate **3**. Treatment of crude **3** with 2 equiv. of BuLi afforded the desired cycloproparene **4** in 28% yield (not optimized). This sequence is longer and more complicated than the traditional synthesis of **4**, and it is not meant to be competitive, but it could be of some interest for special applications. It is noteworthy that BuLi is efficient in the aromatization of **3**, while it fails with the adducts of 1-bromo-2-chlorocyclopropene to furans [1] [2].

Attempts to aromatize **1a** failed, however. When **1a** was transformed into the ditosylhydrazone **5** and the latter subjected to the *Shapiro* reaction [7] under a variety of conditions, only decomposition products could be isolated. Similarly, no identifiable products resulted, when the diol **2a** was converted to the bis-selenide **6** [8] and the latter oxidized under mild conditions [9].

*o*-Quinodimethanes, accessible from oct-4-ene-1,7-diynes [10] can be intercepted with 1-bromo-2-chlorocyclopropene and the adducts aromatized to cyclopropa[*b*]naphthalenes [11]. A more recent generation of *o*-quinodimethanes uses fluoride induced 1,4-conjugative elimination of [2-(trimethylsilyl)benzyl]trimethylammonium halides **7** [12]. This method is applicable to pyridine analogs of *o*-quinodimethanes [13]. The reaction conditions are, in principle, compatible with the presence of 1-bromo-2-chlorocyclopropene. Indeed, we succeeded in trapping the *o*-quinodimethane generated from **7** with $Bu_4NF$, with 1-bromo-2-chlorocyclopropene. The yield of cycloadduct **8** was 38%, *i.e. ca.* half of what is obtained with the conventional dienophiles which are not only stable at room temperature, but at the same time more reactive in cycloaddition reactions. No trapping products could be isolated, however, when the *o*-quinodimethane was generated in the presence of tetrahalogenocyclopropene [14]. Aromatization of **8** to **4** proceeds almost quantitatively [11].

**Synthesis of 3-Aza-*H*-cyclopropa[*b*]naphthalene.** – The approach using ring contraction for building the skeleton of **4** could not be applied to the heterocyclic analog **17** (*Scheme 2*). The diketone **12** was accessible from the anhydride **9** in analogy to the isocyclic compound [15], but it decomposed upon attempted bromination with $Br_2$ or NBS to **13**.

*Scheme 2*




The *o*-quinodimethane approach proved to be the method of choice, however. The required pyridine derivative **14** [13] was reacted with CsF in MeCN in presence of an excess of 1-bromo-2-chlorocyclopropene for 4 h with ultrasound agitation [16]. After workup, the adduct **16** was isolated in 33–37% yield. The reaction could also be effected with $Bu_4NF$, but CsF gave better results. The cyclopropparene **17** was obtained upon reaction of **16** with *t*-BuOK and purified by repeated sublimation at low temperature.

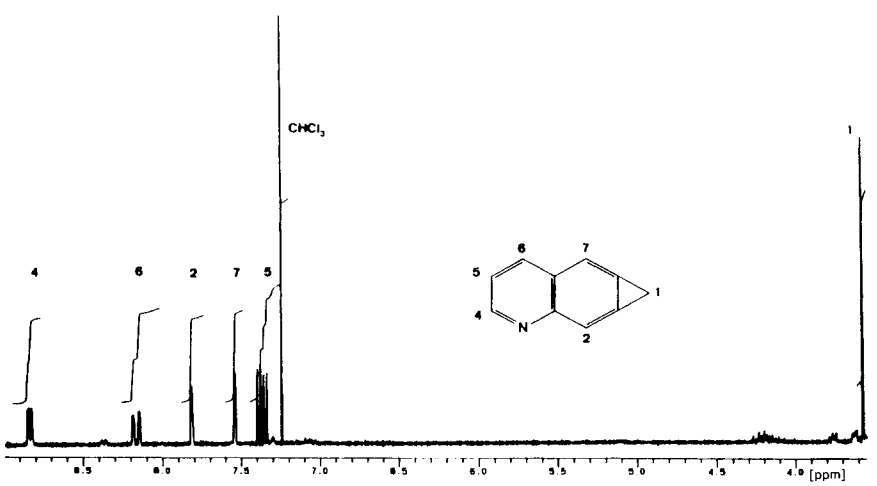



Figure. *$^1$H-NMR of 3-aza-1*H*-cyclopropa[*b*]naphthalene* (**17**)

The $^1$H-NMR of **17** (*Fig.*) shows the expected pattern for a 6,7-disubstituted quinoline [17] and the signal of the $CH_2$ group at 3.56 ppm, typical for cycloproparenes [18]. Other characteristic spectral features of **17** are the resonance lines corresponding to C(2) and C(7) at 112.9 and 114.1 ppm in the $^{13}$C-NMR and the C=C vibration at 1678 cm$^{-1}$ in the IR.

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## Experimental Part

*General.* See [2].

*Synthesis of 1H-Cyclopropa[b]naphthalene* (**4**) *from* **1a**. *1a,7a-Dibromo-1a,2,7,7a-tetrahydrocyclopropa[b]naphthalene-2,7-diol* (**2b**). To a soln. of $NaBH_4$ (18 mg, 0.45 mmol) in NaOH (10 ml, 0.01M) was added, at 4°, **1b** [5] (300 mg, 0.9 mmol) in THF (10 ml). The mixture was stirred during 18 h at r.t., then extracted with $Et_2O$ (6 × 20 ml), the $Et_2O$ dried ($K_2CO_3$), and evaporated. Recrystallization with $CHCl_3$ yielded **2b** (270 mg, 89%). M.p. 162° IR ($CHCl_3$): 3580*m*, 2980*m*, 2960*m*, 2870*m*, 1460*w*, 1390*m*, 1230*m*, 1175*s*, 1045*s*, 1000*m*, 800*w*, 720*m*. $^1$H-NMR (200 MHz, $CDCl_3$): 7.75–7.60 (*m*, 2H); 7.45–7.20 (*m*, 2H); 5.22 (*d*, $^3J$ = 4.5, 2H); 2.76 (*d*, $^3J$ = 4.5, 2H); 1.58 (*d*, $^2J$ = 8.5, 1H); 1.34 (*d*, $^2J$ = 8.5, 1H). MS: 336, 334, 332 (0.5, 1, 1, $M^+$), 237 (9), 235 (9), 209 (18), 174 (18), 173 (17), 156 (11), 145 (32), 144 (11), 129 (20), 128 (100), 127 (30), 117 (27), 91 (13), 77 (40), 63 (22), 51 (39).

*1H-Cyclopropa[b]naphthalene* (**4**). NaH (36 mg, 60% in mineral oil, 0.9 mmol) was washed with hexane and suspended in THF (5.0 ml) at −20°. Bromohydrine **2b** (100 mg, 0.3 mmol) in THF (2.0 ml) was added, and the temp. was allowed to rise to −10° in 30 min. TsCl (120 mg, 0.60 mmol) was added in one portion, and the mixture was stirred 48 h at 0°. It was decomposed with ice-water (5 ml) and immediately extracted with $Et_2O$ (3 × 20 ml). The combined org. layers were washed with cold sat. NaCl, dried ($K_2CO_3$), and evaporated at low temp. After addition of dry $Et_2O$ (5 ml), the soln. was cooled to −78°, and BuLi (0.63 ml, 0.9 mmol) was added under $N_2$. The temp. of the flask was allowed to rise to r.t. $H_2O$ (5.0 ml) was added, the layers were separated, and the org. phase was extracted with $Et_2O$ (2 × 20 ml). Purification of the crude product by prep. TLC (silica gel, hexane) afforded 12 mg (28%) of **4** [11].

*1a-Bromo-7a-chloro-1a,2,7,7,a-tetrahydrocyclopropa[b]naphthalene* (**8**). To $Bu_4NF$ (1.65 ml, 1M in THF) was added, at −30° and under $N_2$, 1-bromo-2,2-dichloro-1-(trimethylsilyl)cyclopropane [19] (216 mg, 0.82 mmol) in THF (5 ml). The mixture was stirred for 1 h at −20°, whereupon *trimethyl{2-[(trimethylsilyl)methyl]-benzyl}ammonium iodide* (**7**) [12] (300 mg, 0.82 mmol) in MeCN (10 ml) was added. After 20 h at −20°, the temp. was allowed to reach 25°. $Et_2O$ (20 ml) was added, and the mixture was washed with $H_2O$ (20 ml). The aq. phase was extracted with $Et_2O$ (2 × 20 ml), and the combined org. layers were dried ($MgSO_4$). Purification of the crude product by flash chromatography (silica gel, hexane/$CH_2Cl_2$ 2:1) afforded 81 mg (38%) of **8**. The spectral properties of **8** have been described in [11] [14].

*1-Bromo-7a-chloro-1a,2,7,7a-tetrahydrocyclopropa[g]quinoline* (**16**). To CsF (580 mg, 3.8 mmol) was added, at −30° and under $N_2$, 1-bromo-2,2-dichloro-1-(trimethylsilyl)cyclopropane (165 mg, 0.60 mmol) in MeCN (10 ml). After 1 h at −20°, *trimethyl{{2-[(trimethylsilyl)methyl]pyridin-3-yl}methyl}ammonium bromide* (**14**) [13] (180 mg, 0.57 mmol) in MeCN (5.0 ml) was added. In parallel, 1-bromo-2-chlorocyclopropene was prepared by addition of 1-bromo-2,2-dichloro-1-(trimethylsilyl)cyclopropane [19] (330 mg, 1.2 mmol) in MeCN (10 ml) to CsF (580 mg, 3.8 mmol) at −30° and reacting it during 1 h at −20°. The soln. containing **14** was warmed up to r.t. during 2 h and placed in an ultrasound bath. The 1-bromo-2-chlorocyclopropene, prepared independently was added over 2 h. The mixture was heated to 40° during 30 min, and then decomposed with $H_2O$ (40 ml). It was extracted with $CH_2Cl_2$ (4 × 40 ml), the org. layers were washed with sat. NaCl (50 ml) and dried ($MgSO_4$). After evaporation and flash chromatography (silica gel, $Et_2O$/pentane 2:1), 50 mg (34%) of **16** were isolated as a 1:1 mixture of isomers. An anal. sample was obtained by sublimation at 65°/0.1 mm Hg. M.p. 41–42°. IR ($CHCl_3$): 3005*m*, 2960*m*, 2840*w*, 2830*w*, 1580*m*, 1450*m*, 1430*m*, 1230*m*, 1080*s*, 1010*m*, 800*m*, 760*s*. $^1$H-NMR (400 MHz, $CDCl_3$): 8.41 (*dd*, $^3J$ = 4.8, $^4J$ = 1, 1H); 7.36 (*m*, 1H); 7.12 (*dd*, $^3J$ = 4.8, $^3J$ = 7.3, 1H); 3.85–3.42 (*m*, 4H); 1.41 (*AB*, $^2J$ = 8, $\delta_a$ = 1.42, $\delta_b$ = 1.4, 2H). MS: 261, 259, 257 (2, 6, 4, $M^+$), 224 (10), 222 (10), 205 (53), 180 (28), 178 (82), 143 (64), 142 (100), 115 (20), 89 (11), 57 (16).

*1H-Cyclopropa[g]quinoline* (**17**). To **16** (100 mg, 0.39 mmol) in THF (15 ml) was added, at −78°, *t*-BuOK (280 mg, 2.6 mmol) in THF (10 ml) during 25 min. After stirring for 3 h at −78°, 20 ml of $Et_2O$ and 30 ml of $H_2O$/MeOH 3:8 were added. The layers were separated, and the aq. phase was extracted with $Et_2O$ (3 × 20 ml).

After drying ($K_2CO_3$), the solvent was evaporated under reduced pressure. After sublimation (r.t., 0.01 mm Hg), 45 mg of **17** (82%) was isolated as an oil. UV (heptane): 220 (3.94), 267 (3.10), 306 (3.03), 312 (3.06), 319 (3.21). IR ($CHCl_3$): 3010*m*, 3000*m*, 2975*s*, 2965*s*, 2845*w*, 1678*m*, 1605*w*, 1593*m*, 1522*s*, 1350*w*, 1320*w*, 1260*w*, 1050*w*, 910*m*, 850*s*. $^1$H-NMR (200 MHz, $CDCl_3$): 8.78 (*dd*, $^3J$ = 4, $^4J$ = 1.5, 1H); 8.18 (*dd*, $^3J$ = 8, $^4J$ = 1.5, 1H); 7.75 (*d*, $^5J$ = 1, 1H); 7.56 (*d*, $^5J$ = 1, 1H); 7.35 (*dd*, $^3J$ = 4, $^3J$ = 8, 1H); 3.56 (*s*, 2H). $^{13}$C-NMR (50 MHz, $CDCl_3$): 151.7 (C); 149.2 (CH); 136.4 (CH); 131.5 (C); 127.6 (C); 123.7 (C); 120.5 (CH); 114.1 (CH); 112.9 (CH); 19.3 ($CH_2$). MS ($C_{10}H_7N$; calc: 141.057849; found: 141.0570984): 141 (100, $M^+$), 140 (46), 114 (35), 113 (14), 88 (10), 71 (9), 63 (14), 51 (9).

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