# Synthesis of 4-Hydroxy-2-pyridones attached to the Bornane Ring System

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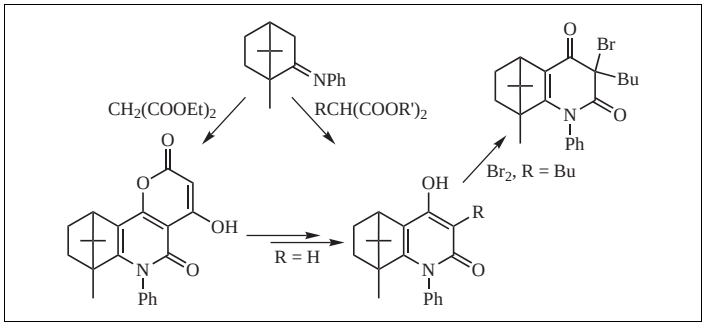
***Dedicated to Professor Václav Dědek, Prague Institute of Chemical Technology, on the occasion of his 80th birthday***




The reaction of camphoraniles **3a,b** with "magic malonates" (bis-2,4,6-trichlorophenylmalonates) **4a,b** leads to 4-hydroxy-2(1*H*)-pyridones attached to bornane ring system **6a-c** in good yields. Less satisfactory yields were obtained with the diethyl malonate **5b**. The reaction of an excess of diethyl malonate **5** itself with **3b** yields the pyrono derivative **7**, which can readily be degraded *via* the acetyl derivative **8** to the basic structure **9**.

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## Introduction.

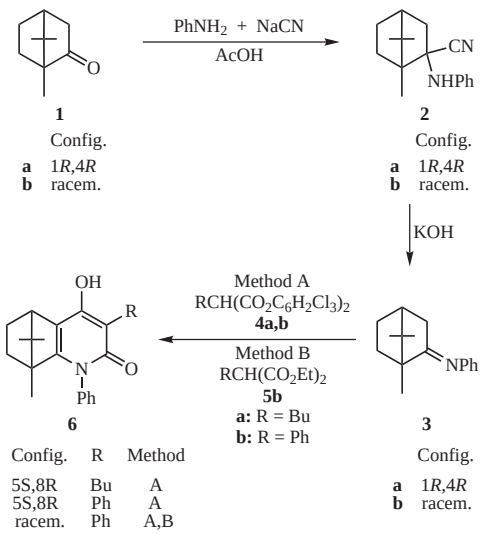
The 4-hydroxy-2-pyridone moiety is part of a number of natural products such (as for instance) the highly toxic ricinine (plant *Ricinus communis* L.), bassianin (fungi of *Beauveria species*), tenellin (fungi *Beauveria tenella* and *Beauveria bassiana*), ilicicolin H (fungus *Cylindrocladium ilicicola*), sambutoxin (fungi of various *Fusarium* sp.), harzianopyridon (fungus *Trichoderma harzianum*), mocimycin (*Streptomyces* sp.), funiculosin (fungus *Penicillium funiculosum*) and aurodox (*Streptomyces* sp.). Many of these type of compounds show interesting antibiotic activity [1]. 4-Hydroxy-2-pyridones (as "deazauracils") has been used as base in the synthesis of nucleosides [4], and 3-acyl-4-hydroxy-2-pyridones belong to the group of "cyclic tricarbonyl methane compounds" which play an important role in agricultural chemistry [5,6]. In view of this background we have studied the synthesis of 4-hydroxy-2-pyridones condensed with the bornane moiety (**6**, **7**, **9**) and the 3-acetyl derivative (**8**).

The synthesis of 4-hydroxy-2(1*H*)-pyridones from enamines or azomethines by cyclocondensation with reactive malonic acid derivatives, such as carbon suboxide, chlorocarbonyl ketenes, and bis-2,4,6-trichlorophenyl malonates (**4**) is well known, and literature surveys on the use of these reagents have been published [7-10]. It has been assumed earlier that only activated enamines – derived from ß-ketoesters or 1,3-diketones with ammonia or primary amines – can thermally be condensed with simple dialkyl malonates, and that non activated azomethines (*Schiff* bases) require "magic malonates, (AMEs") [7c], chlorocarbonyl ketenes ("CCKs") [7b] or malonyl dichlorides [11,12] for a successful condensation to yield 4-hydroxy-2-pyridones. It was only more recently that the reaction of simple azomethines has been described with commercially available dialkyl malonates [2,3,9,10,14-17].

E. Ziegler and co-workers have shown already in 1967 that cyclanone-aniles [18] (including camphoranile [19]) react with substituted "malonyldichlorides" (which means chlorocarbonyl ketenes [11,12]) to yield condensed 4-hydroxy-2-pyridones. More recently we have found that

cyclanone-aniles react in acceptable yields (around 60%) with diethylmalonate [20]. This induced us to do some reactions of camphoranile with the active malonates (AMEs **4a,b**) as well as with diethyl phenylmalonate **5b**, which is known to give the best results in cyclocondensation reactions because of its high boiling point (Scheme I).

Scheme I

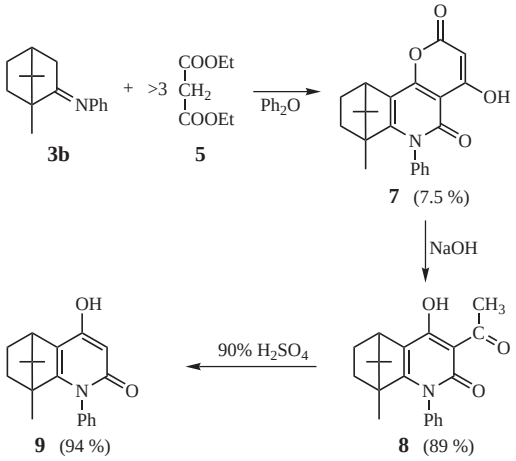



Results and Discussion.

For the preparation of camphoranil (**3**) we have used the natural (+)-camphor (**1a**) as well as the synthetic racemic camphor (**1b**) since both are commercially available. However, for the synthesis of the azomethines **3a,b** we have used our reliable two step procedure *via* the *Strecker* intermediates **2a,b**, which was accomplished by the addition of sodium or potassium cyanide to a cooled mixture of **1a,b** and aniline in acetic acid [2,3]. The aniles **3a,b** were then obtained from the cyanides **2a,b** with potassium hydroxide in refluxing methanol and can be used after dilution with water, extraction with petroleum ether, and evaporation without further purification. This procedure is more convenient than the known ones which require distillation leading to selfcondensation and other side reactions [21,22]. The reaction of **3a,b** with AMEs **4a,b** without solvent at 240-250 °C (Method A) yields the tetrahydro-4-hydroxy-methanoquinoline-2(1*H*)-ones **6a,b** in about 60% yield and **6c** with 80%. Disappointingly, the synthesis of **6c** with diethyl phenylmalonate at 250-265 °C yielded this compound in 1.5% yield only.

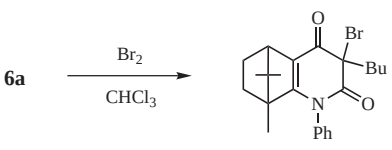
Nevertheless we tried also the reaction of camphoranile **3b** with an excess of diethyl malonate **5** itself in diphenyl ether at 230-250 °C. According to the literature [14,17,23] this reaction should lead to the hydroxyl-2-pyrono derivative **7** of the basic ring system **6**. Indeed the 4-hydroxy-pyrano[3,2-*c*]quinoline-2,5-(6*H*)-dione **7** was obtained in a yield of 7.5%. This compound was previously synthesized from **3b** and carbon suboxide in ether at 100 °C in a sealed vessel with a comparable yield of 9.4 % [24]. Considering the costly, tedious and time consuming preparation of carbon suboxide [7a,8] we believe that the method for the preparation of **7** with diethyl malonate is much more convenient. The unusual low yield might be due mainly to steric hindrance. Degradation of **7** to the basic structure of this series of 4-hydroxy-2-pyridones attached to the bornane system (compound **9**) with no substituent in position **3** follows a well established pathway [23,25]: the alkaline ring opening with sodium hydroxide in glycol/water at 140 °C yields after acidification with hydrochloric acid the decarboxylated acetyl derivative **8** in about 90 %. The acetyl group of this enolized "tricarbonyl methane" compound is removed *via* an *ipso* substitution with a proton using 90% sulfuric acid at 140 °C [23,25] leading to a nearly quantitative yield of **9** [26] (Scheme II).

Scheme II




The halogenation of 4-hydroxy-2-pyridones [2,3,16, 17,27] and their condensed derivatives [28] has been studied before. It has been shown that the first electrophilic substitution occurs at position 3 between the two oxygen functions leading to a 2,4-dioxopyridine system. Thus the reaction of **6** with bromine in chloroform solution leads to the formation of the 3-bromo-2,4(1*H*,3*H*)-dione derivative **10** (Scheme III). This

Scheme III



structure is supported by the infrared spectrum, which exhibits two strong carbonyl frequencies at 1648 $cm^{-1}$ (amide carbonyl at C-2) and 1704 $cm^{-1}$ (CO at C-4).

## EXPERIMENTAL

Melting points were determined on a Gallencamp melting point apparatus, Mod MFB-595 in open capillary tubes. IR spectra were recorded on a Perkin Elmer 298 spectrometer in potassium bromide pellets. $^1$H nmr spectra were recorded on a Varian Gemini 200 instrument. Chemical shifts are given on the δ scale (ppm). Microanalyses were performed on a C,H,N-automate Carlo Erba 1106. The purity of substances was checked by thin-layer chromatography on tlc aluminum sheets silica gel 60 F254, No. 5554 (E. Merck, Darmstadt) using uv light (254 and 366 nm) for detection.

(1*R*,4*R*)-1,7,7-Trimethyl-2-(phenylamino)bicyclo[2.2.1]heptane-2-carbonitrile (**2a**).

A stirred solution of (+)-camphor **1a** (7.61 g, 50 mmol) and aniline (7.45 g, 80 mmol) in glacial acetic acid was cooled in an ice bath. Solid sodium cyanide (7.35 g, 150 mmol) was added during 2 minutes. The obtained thick suspension was cooled in ice bath for 0.5 h and then left for 7 days at room temperature. After dilution with water (40 ml), colorless crystals of **2a** were collected by filtration, washed consequently with water (2 × 30 ml) and petroleum ether (2 × 30 ml) and were used in the further reaction without purification (mp 117-130 °C, yield 9.07 g, *i.e.* 71 %). A sample (1.00 g) of this substance furnished 0.91 g (65 % on reactant **1a**) of analytical pure **2a** (mixture of two diastereoisomers), colorless crystals, mp 122-130 °C (cyclohexane); ir: 3473 m, 3120 w, 3053 w, 3007 m, 2980 w, 2935 w, 2285 w, 1624 s, 1520 s, 1624 s, 1520 s, 1502 m, 1476 m, 1454 m, 1423 m, 1412 m, 1340 m, 1328 m, 1280 m, 1242 m, 908 m, 775 s, 740 m, 718 s; $^1$H nmr in $CDCl_3$: δ 0.98, 1.10 and 1.16 (3 × s, 3 × 3H, 3 × $CH_3$), 1.30-2.50 (m, 7H, H-3, -4, -5, -6), 3.94 (s, 1H, NH), 6.75 (d, 2H, H-2 + H-6 of phenyl, *J* = 7.5 Hz), 6.85 (t, 1H, H-4 of phenyl, *J* = 7.5 Hz), 7.25 (dd, 2H, H-3 + H-5 of phenyl, *J* = 7.5 Hz, 7.5 Hz).

*Anal.* Calcd. for $C_{17}H_{22}N_2$: C, 80.27; H, 8.72; N, 11.01. Found: C, 80.36; H, 8.78; N, 10.92.

Racemic 1,7,7-trimethyl-2-(phenylamino)bicyclo[2.2.1]heptane-2-carbonitrile (**2b**).

This substance was prepared by the same manner as substance **2a** starting from (±)-camphor (7.61 g, 50.0 mmol), aniline (5.12 g, 55 mmol), glacial acetic acid (20 ml) and potassium cyanide (4.88 g, 75 mmol). Obtained substance **2b** was analytically pure without being crystallized (colorless crystals, mp 149-151 °C, yield 9.14 g, *i.e.* 72 %.); ir: 3418 s, 3055 w, 3015 w, 2990 w, 2970 m, 2945 w, 2930 w, 2890 w, 2226 w, 1608 s, 1511 s, 1395 m, 1324 m, 1315 m, 745 s, 694 m; 1H nmr in $CDCl_3$: δ 0.96, 1.08 and 1.15 (3 × s, 3 × 3H, 3 × $CH_3$), 1.30-2.50 (m, 7H, H-3, -4, -5, -6), 3.91 (s, 1H, NH), 6.74 (d, 2H, H-2 + H-6 of phenyl, *J* = 7.5 Hz), 6.84 (t, 1H, H-4 of phenyl, *J* = 7.5 Hz), 7.24 (dd, 2H, H-3 + H-5 of phenyl, *J* = 7.5 Hz, 7.5 Hz). Melting point 152 °C is given in the literature [29].

*Anal.* Calcd. for $C_{17}H_{22}N_2$: C, 80.27; H, 8.72; N, 11.01. Found: C, 80.22; H, 8.62; N, 11.03.

*N*-((1*R*,4*R*)-1,7,7-Trimethylbicyclo[2.2.1]heptan-2-ylidene)benzenamine (**3a**) (double bond geometry unknown).

The mixture of aminonitrile **2a** (11.20 g, 44,0 mmol) and methanol (60 ml) was homogenized by heating, potassium hydroxide (3.7 g, 66 mmol) dissolved in methanol (33 ml) was added, and the solution was refluxed for 75 minutes. The cooled mixture was diluted with water (100 ml) and extracted with petroleum ether (4 × 25 ml). The extract was dried ($Na_2SO_4$) and evaporation of volatile components *in vacuo* at 55 °C to constant weight yielded 9.50 g (95 %) of **3a**, colorless liquid solidifying being kept in freezing box as colorless crystals, mp 10-18 °C; ir: 3060 w, 3025 w, 2960 s, 2878 m, 1685 s, 1600 s, 1488 m, 1449 m, 1390 m, 1220 m, 1065 m, 786 m, 748 m, 711 m, 699 m; $^1$H nmr in $CDCl_3$: δ 0.87, 0.98 and 1.11 (3 × s, 3 × 3H, 3 × $CH_3$), 1.20-2.27 (m, 7H, $CH_2CHCH_2CH_2$), 6.75 (d, 2H, H-2 + H-6, *J* = 7.5 Hz), 7.03 (t, 1H, H-4, *J* = 7.5 Hz), 7.28 (dd, 2H, H-3 + H-5, *J* = 7.5 Hz, 7.5 Hz). Literature melting point 13.5 °C [21] or 13 °C [22], respectively.

*Anal.* Calcd. for $C_{16}H_{21}N$: C, 84.53; H, 9.31; N, 6.16. Found: C, 84.20; H, 9.43; N, 6.17.

Racemic *N*-(1,7,7-trimethylbicyclo[2.2.1]heptan-2-ylidene)benzenamine (**3b**) (double bond geometry unknown).

This compound was prepared in the same manner as substance **3a** starting from **2b** (12.72 g, 50.0 mmol). Potassium hydroxide (5.6 g, 100 mmol) as reagent and methanol (total 107 ml) as solvent were used. There was obtained 11.07 g (97 %) of **3b**, colorless liquid solidifying being kept in freezing box as colorless crystals, mp 16 °C; ir: 3080 w, 3055 w, 3020 w, 2957 s, 2870 m, 1682 s, 1598 s, 1487 m, 1447 m, 1389 m, 1220 m, 1063 m, 784 m, 746 m, 710 m, 696 m; $^1$H nmr in $CDCl_3$: δ 0.88, 0.98 and 1.09 (3 × s, 3 × 3H, 3 × $CH_3$), 1.18-2.27 (m, 7H, $CH_2CHCH_2CH_2$), 6.74 (d, 2H, H-2 + H-6, *J* = 7.5 Hz), 7.03 (t, 1H, H-4, *J* = 7.5 Hz), 7.28 (dd, 2H, H-3 + H-5, *J* = 7.5 Hz, 7.5 Hz). Melting point 15-16 °C was published [30]. Both ir and nmr spectra are in agreement with published [31] data.

*Anal.* Calcd. for $C_{16}H_{21}N$: C, 84.53; H, 9.31; N, 6.16. Found: C, 84.54; H, 8.99; N, 6.54.

(5*S*,8*R*)-3-Butyl-5,6,7,8-tetrahydro-4-hydroxy-8,9,9-trimethyl-1-phenyl-5,8-methanoquinolin-2(1*H*)-one (**6a**).

Method A (with AME).

A mixture of anil **3a** (5.68 g, 25 mmol) and bis(2,4,6-trichlorophenyl) butylmalonate **4a** (11.96 g, 23.0 mmol) was heated to 240-250 °C for 1.5 h. Cooled reaction mixture was triturated with petroleum ether (50 ml) and solid was collected by filtration affording 5.13 g (63 %) of pure (tlc) **6a**, mp 278-286 °C. A part (4.07 g) of this substance afforded 4.07 g (52 % on reactants) of analytical pure **6a**, colorless crystals, mp 289-291 °C (butan-1-ol); ir: 3340-2400 b, 2980 w, 2954 s, 2920 w, 2873 w, 1619 s, 1570 s, 1529 s, 1490 m, 1475 m, 1433 s, 1386 s, 1321 m, 1290 m, 1245 s, 1230 m, 1212 s, 1202 s, 1174 m, 1164 m, 1115 m, 1105 m, 1084 m, 754 m; $^1$H nmr in DMSO-$d_6$: δ 0.24 (s, 3H, $CH_3$-8), 0.76 (s, 6H, $CH_3$-9), 0.90 (t, 3H, $CH_3$ of butyl, *J* = 7 Hz), 1.00-1.18 (m, 1H, H-6 or H-7), 1.22-1.44 (m, 5H, H-2 + H-3 of butyl and one of H-6 or H-7), 1.49-1.64 (m, 1H, H-6 or H-7), 1.88-2.06 (m, 1H, H-6 or H-7) , 2.40 (t, 2H, H-1 of butyl, *J* = 9 Hz), 3.09 (d, 1H, H-5, *J* = 3.5 Hz), 7.20 (dd, 2H, H-3 + H-5 of phenyl, *J* = 4 Hz), 7.47 (d, 3H, H-2 + H-4 + H-6 of phenyl, *J* = 4 Hz), 9.52 (s, 1H, OH).

*Anal.* Calcd. for $C_{23}H_{29}NO_2$: C, 78.59; H, 8.32; N, 3.99. Found: C, 78.76; H, 8.41; N, 3.94.

(5*S*,8*R*)-5,6,7,8-Tetrahydro-4-hydroxy-8,9,9-trimethyl-1,3-diphenyl-5,8-methanoquinolin-2(1*H*)-one (**6b**).

Method A (with AME).

The reaction was performed by the same manner as described for the preparation of compound **6a** starting from anil **3a** (3.41 g, 15.0 mmol) and bis(2,4,6-trichlorophenyl) phenylmalonate **4b** (8.09 g, 15.0 mmol). Cooled reaction mixture was triturated in petroleum ether (20 ml), solid phase was collected by filtration, washed gradually with petroleum ether (2 × 20 ml) and diethyl ether (2 × 10 ml) and crystallized affording 3.42 g (61 %) of **6b**, colorless crystals, mp 352 °C dec (dimethylformamide), lit. mp 350 °C (nitrobenzene) [19]; ir: 3600-2300 b, 3040 w, 2960 w, 2877 w, 1615 s, 1569 m, 1532 s, 1451 m, 1431 m, 1388 s, 1296 s, 1270 s, 1204 s, 1187 m, 800 m, 775 m, 762 m, 745 s, 732 m, 715 m; $^1$H nmr in DMSO-$d_6$: δ 0.26 (s, 3H, $CH_3$-8), 0.79 and 0.83 (2 × s, 2 × 3H, $CH_3$-9), 1.10-1.25, 1.35-1.50, 1.50-1.70 and 1.90-2.10 (4 × m, 4 × 1H, H-6 + H-7), 3.17 (d, 1H, H-5, *J* = 4 Hz), 7.15-7.50 (m, 10H, $H_{Ar}$).

*Anal.* Calcd. for $C_{25}H_{25}NO_2$: C, 80.83; H, 6.78; N, 3.77. Found: C, 80.84; H, 6.36; N, 4.03.

Racemic 4-Hydroxy-8,9,9-trimethyl-1,3-diphenyl-5,6,7,8-tetrahydro-5,8-methanoquinolin-2(1*H*)-one (**6c**).

Method B (with diethyl phenylmalonate **5b**).

A mixture of anil **3b** (11.37 g, 50.0 mmol), **5b** (15.36 g, 65.0 mmol) and *N*,*N*-dimethylpyridin-4-amine (0.02 g, 0.16 mmol) was heated in a flask equipped with a short tube to 250-265 °C (oil bath) until the boiling ceased (13 hours). Cooled reaction mixture was triturated with petroleum ether (100 ml), solid phase was collected by filtration and washed with fresh petroleum ether (20 ml). The gray crude product was suspended in ethanol. The suspension was boiled for three minutes and cooled down. Solid phase was collected by filtration affording 0.28 g (1.5 %) of **6c**, colorless crystals, mp 358-361 °C dec; ir: 3640-3300 b, 2960 w, 1615 s, 1535 s, 1388 s, 1296 m, 1270 m, 1204 m, 696m; 1H nmr in DMSO-$d_6$: δ 0,27 (s, 3H, $CH_3$-8), 0.80 and 0.85 (2 × s, 2 × 3H, $CH_3$-9), 1.10-1.25, 1.36-1.53, 1.53-1.70 and 1.95-2.08 (4 × m, 4 × 1H, H-6 + H-7), 3.15-3.23 (m, 1H, H-5), 7.15-7.55 (m, 10H, $H_{Ar}$), 9.75 (s, 1H, OH).

*Anal.* Calcd. for $C_{25}H_{25}NO_2$: C, 80.83; H, 6.78; N, 3.77. Found: C, 80.78; H, 6.68; N, 3.75.

Method A (with AME).

A mixture of anil **3b** (2.54 g, 11.2 mmol) and bis(2,4,6-trichlorophenyl) phenylmalonate **4b** (5.39 g, 10.0 mmol) was heated to 240-258 °C for 10 minutes. Cooled reaction mixture was triturated with petroleum ether (20 ml), solid phase was collected by filtration and washed gradually with petroleum ether (2 × 15 ml) and diethyl ether (3 × 15 ml) affording 2.98 g (80 %) of pure (tlc, ir, 1H nmr) compound **6c**, yellowish crystals, mp 360-361 °C dec.

4-Hydroxy-7,11,11-trimethyl-6-phenyl-7,8,9,10-tetrahydro-7,10-methano-2*H*-pyrano[3,2-*c*]quinoline-2,5(6*H*)-dione (**7**).

A mixture of anil **3b** (5.00 g, 22.0 mmol), diethyl malonate **5** (10.8 ml, 11.4 g, 71 mmol) and diphenyl ether (40 ml) was heated to 230 – 270 °C (oil bath) until the arisen alcohol had distilled off. Cooled reaction mixture was diluted with diethyl ether. The precipitated solid was collected by filtration and crystallized affording 0.60 g (7.5 %) of **7**, yellow prisms, mp 280-281 °C (ethanol); ir: 2960 m, 1730 s, 1660 s, 1570 s, 1535 m, 1495 s; 1H nmr in DMSO-$d_6$: δ 0.30 (s, 3H, $CH_3$-7), 0.80 (s, 6H, $CH_3$-11), 1.25-2.45 (m, 4H, H-8 + H-9), 3.06-3.16 (m, 1H, H-10), 5.35 (s, 1H, H-3), 7.30-7.60 (m, 5H, $H_{Ar}$), 13.55 (s, 1H, OH). Melting point of 265-267 °C (ethanol) was published [24] for a compound obtained with $C_3O_2$.

*Anal.* Calcd. for $C_{22}H_{21}NO_4$: C, 72.71; H, 5.82; N, 3.85. Found: C, 72.61; H, 5.83; N, 3.85.

3-Acetyl-4-hydroxy-8,9,9-trimethyl-1-phenyl-5,6,7,8-tetrahydro-5,8-methanoquinolin-2(1*H*)-one (**8**).

A solution of compound **7** (0.60 g, 1.7 mmol) and sodium hydroxide (1.0 g, 25 mmol) in ethylene glycol (20 ml) and water (1.0 ml) was heated under reflux for 30 minutes. Cooled solution was acidified with 2 *M* hydrochloric acid. Precipitated solid was collected by filtration and crystallized affording 0.51 g (92 %) of **8**, light brown prisms, mp 187-188 °C (ethanol); ir: 2960 m, 1665 s, 1610 s, 1575 s, 1550 w.

*Anal.* Calcd. for $C_{21}H_{23}NO_3$: C, 74.75; H, 6.87; N, 4.15. Found: C, 74.83; H, 6.70; N, 4.02.

4-Hydroxy-8,9,9-trimethyl-1-phenyl-5,6,7,8-tetrahydro-5,8-methanoquinolin-2(1*H*)-one (**9**).

A solution of acetyl derivative **8** (1.00 g, 2.96 mmol) in 90% sulfuric acid was gradually heated to 140 °C for 15 minutes, cooled, poured onto ice, and the obtained suspension was filtered. The filter cake was purified by dissolution in 2 *M* aqueous sodium hydroxide and reprecipitation with 2 *M* hydrochloric acid. Subsequent crystallization of refined product afforded 0.83 g (95 %) of **9**, colorless prisms, mp 319-320 °C (dimethylformamide), lit. mp 318 °C (water – ethanol) [19].; ir: 2960 m, 1660 s, 1570 s, 1550 m; $^1$H nmr in DMSO-$d_6$: δ 0.2 (s, 3H, $CH_3$-8), 0.9 (s, 6H, $CH_3$-9), 1.0-1.2, 1.2-1.5, 1.5-1.7 and 1.9-2.1 (4 × m, 4 × 1H, H-6 + H-7), 2.87-2.93 (m, 1H, H-5), 5.7 (s, 1H, H-3), 7.20-7.30 (m, 2H, H-2 + H-6 of phenyl), 7.40-7.50 (m, 3H, H-3 + H-4 + H-5 of phenyl), 10.95 (s, 1H, OH).

*Anal.* Calcd. for $C_{19}H_{21}NO_2$: C, 77.26; H, 7.17; N, 4.74. Found: C, 76.99; H, 6.97; N, 4.82.

(5*S*,8*R*)-3-Bromo-3-butyl-8,9,9-trimethyl-1-phenyl-5,6,7,8-tetrahydro-5,8-methanoquinoline-2,4(1*H*,3*H*)-dione (**10**).

Bromine solution (5.0 ml) in chloroform containing 0.1 g of $Br_2$ per mililiter was added to the suspension of compound **6a** (1.05 g, 3.00 mmol) in chloroform (20 ml). A clear orange solution was formed immediately. Additional bromine solution was added to the solution, until the presence of bromine was detectable by means of starch iodide paper dipped in 0.5 *M*-HCl (total 7 ml of bromine solution). The reaction mixture was taken down *in vacuo*, remaining viscous liquid was triturated with methanol (2 ml) and left under methanol overnight in refrigerator. The formed orange-yellow crystals were collected by filtration and crystallized affording 0.88 g (68 %) of **10**, yellow crystals, mp 105-108 °C (methanol); ir: 2962 m, 2937 m, 2876 m, 1704 s, 1648 s, 1583 s, 1491 m, 1468 m, 1454 m, 1431 s, 1331 s, 1279 m, 1238 m, 1183 m, 1169 m, 1146 m, 766 m, 705 m; $^1$H nmr in DMSO-$d_6$: δ 0.20 (s, 3H, $CH_3$-8), 0.75 (s, 3H, $CH_3$-9), 0.79-0.91 (m, 6H, $CH_3$-9 and $CH_3$ of butyl), 1.00-1.35 (m, 5H, H-2 + H-3 of butyl and one of H-6 or H-7), 1.63 (t, 2H,

*J* = 6 Hz), 1.87-2.04 (m, 1H), 2.21-2.46 (m, 2H, H-1 of butyl), 2.77 (dd, 1H, H-5, *J* = 9 Hz, 4 Hz), 7.24-7.60 (m, 5H, $H_{Ar}$).

*Anal.* Calcd. for $C_{23}H_{28}BrNO_2$: C, 64.19; H, 6.56; N, 3.25. Found: C, 63.90; H, 6.37; N, 2.92.

Acknowledgement.

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REFERENCES AND NOTES

[1] For literature see ref. [2,3] and [23].

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