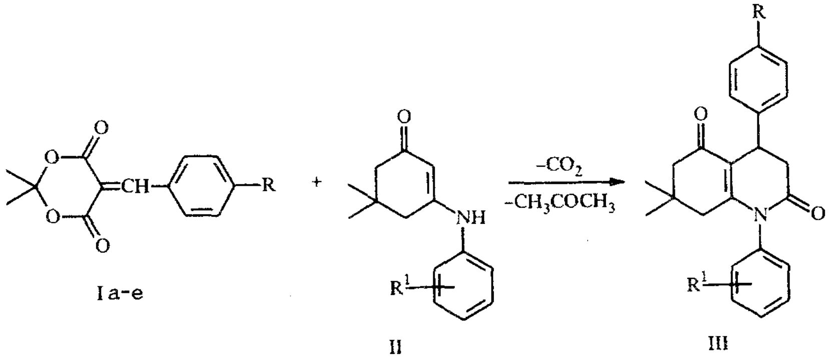
SYNTHESIS AND STRUCTURE OF 1,4-DIARYL-7,7-DIMETHYL-1,2,3,4,5,6,7,8-OCTAHYDROQUINOLINE-2,5-DIONES

M. F. Strozhev and I. É. Lielbriedis

Condensation of 5-arylidene-2,2-dimethyl-1,3-dioxane-4,6-diones with 5,5-dimethyl-3-arylamino-2-cyclohexanones yields 1,4-diaryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones. The compounds have been characterized from their IR, UV, and PMR spectra. It has been established that the N-phenyl ring, which projects from the plane of the octahydroquinolinedione ring, has a shielding effect on the magnetic field of the protons at the 7- and 8-positions of the ring in the molecules of the compounds synthesized.

As a continuation of our studies on the reactivity of 5-arylidene-2,2-dimethyl-1,3-dioxane-4,6-diones (I) and the investigation of the structure of octahydroquinolinedione rings [1-3], we have synthesized 1,4-diaryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones (IIIa-*l*). Compounds IIIa-*l* are obtained by condensation of Ia-e with 5,5-dimethyl-3-arylamino-2-cyclohexenones (IIa-e) in boiling ethanol. The reaction is accompanied by the elimination of acetone and carbon dioxide.

Compounds IIIa-*l*, which were obtained in 48-84% yield, are light-colored products, soluble in ethanol, isopropanol, DMF, dioxane, acetic acid, chloroform, and acetone, and insoluble in hydrocarbons and water. Compounds IIIb-i, which contain a hydroxyl group, are soluble in alkaline solution.



$$\text{IIIb,e,g} \xrightarrow{CH_3I} \text{IIIj,k,}\ell$$

Ia, IIIa-d, j R = H; Ib, IIIe, f, k R = NO_2; Ic, IIIg, m R = OCH_3; Id, IIIh R = Cl; Ie, IIIi R = OH;
IIa, IIIa R^1 = H; IIb, IIIb, e, g, h R^1 = *p*-OH; IIc, IIIc, f R^1 = *m*-OH; IId, IIId R^1 = *o*-OH;
IIe, IIIj, k, ℓ R^1 = *p*-OCH_3

The profile of the electronic absorption spectra is unchanged for the series of compounds IIIa-*l*. They have characteristic absorption maxima in the region of 203-206, 216-237 (maximum or shoulder), and 287-303 nm. The IR spectra of compounds IIIb-i, which contain a hydroxyl group in the phenyl substituent, are characterized by a reduction in intensity of the absorption maximum (or appearing as shoulders) at 1622-1660 cm^{-1} from the carbonyl group at the 2-position compared to the distinct peak from this group in IIIa, j, k, *l*. The broad peak due to stretching vibrations of the hydroxyl group in the region of 3115-3350

Riga Technical University, Riga LV-1048. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 9, pp. 1227-1232, September, 1993. Original article submitted March 28, 1993.

0009-3122/93/2909-1048$12.50

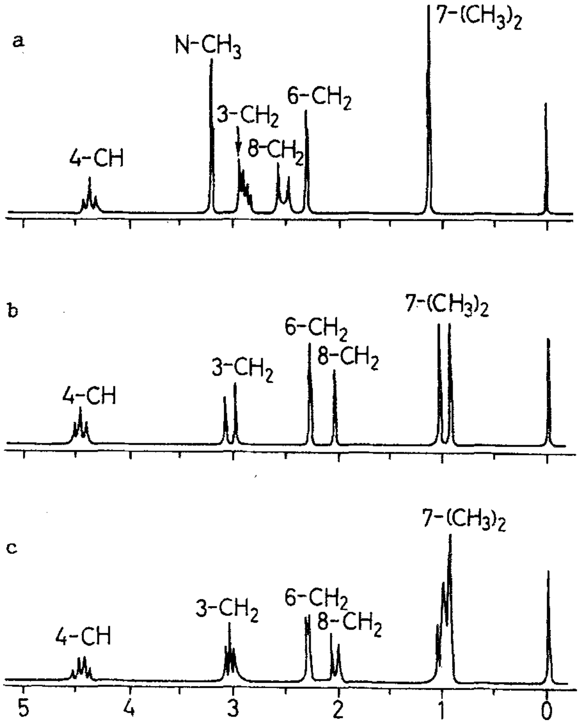
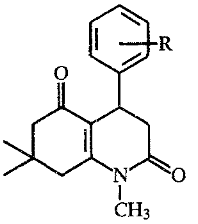


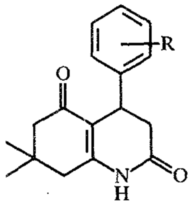
Fig. 1. PMR spectra: a) 1,7,7-trimethyl-4-phenyl-1,2,3,4,5,6,7,8-octahydro quinoline-2,5-dione; b) compound IIIb; c) compound IIId.

cm^{-1} indicates that it participates in intermolecular hydrogen bonding with the carbonyl group at the 2-position. The stretching vibrations of the carbonyl group at the 5-position provide a distinct signal in the region of 1647-1702 cm^{-1}.

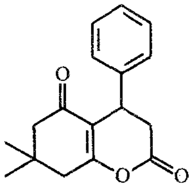
In the PMR spectra of compounds IIIa-*l* the signals from the protons of the phenyl substituents have been identified, and the protons at the 3- and 4-positions of the octahydroquinolinedione ring give signals that are typical of an ABX system approximation. The hydroxyl proton appears as a singlet or a broad singlet in the region of 5.17-9.62 ppm. With the exception of IIId (Fig. 1c), the methyl protons at the 7-position give rise to two symmetrical singlets that are equal in intensity.



IV



V



VI

The signals from the protons at the 6- and 8-positions were identified by analysis of the PMR spectra of compounds IIIa-*l*, 4-aryl-1,7,7-trimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-dione (IV) [1], 4-aryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-dione (V) [3], and 4-phenyl-7,7-dimethyl-3,4,5,6,7,8-hexahydrocoumarin-5-one (VI) [4].

The signals that occur in a fixed position for all four series being compared (2.16-2.35 ppm) can be assigned to the protons of the CH_2 group at the 6-position. There are no differences in the shielding of either proton (one singlet) and the chemical shifts are hardly affected by the presence or nature of the substituents at the 1- and/or 4-positions of the octahydroquinolinedione ring. On the other hand, the protons at the 8-position, as a result of their greater proximity to the substituents on the nitrogen atom at the 1-position or to the unshared electron pair of the oxygen atom at the 1-position of compound VI, experience an increased effect from this substituent or the unshared electron pair. This is reflected in a change in position and shape of the resonance absorption signal of the protons. For IIIa-*l* the signals occur in the region of 2.02-2.12 ppm, for IV they occur at 2.51-2.60 ppm, for V at 2.22-2.57 ppm, and for VI at 2.48-2.55 ppm. The displacement of the proton signals from the CH_2 group at the 8-position of compounds IIIa-*l* upfield compared to compounds IV-VI may be due to the shielding effect of the phenyl substituent at the 1-position that occurs when there is a parallel or near-parallel configuration of the plane of the phenyl

TABLE 1. 1,4-Diaryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones (IIIa-*l*)

Compound III	mp, °C (ethanol)	IR spectrum, ν, cm^{-1}			UV spectrum, λ_{max}, nm (log ε) (ethanol)	PMR spectrum, δ, ppm (CDCl$_3$)								Yield, %
		5-CO	2-CO	OH		C(CH$_3$)$_2$ (6H, 2S)	8-CH$_2$ (2H, S)	6-CH$_2$ (2H, S)	3-CH$_2$ (2H)	4-CH (1H, t)	OCH$_3$ (3H, S)	1,4-Ar^{1}Ar^2 (8H, m)	OH (1H, s)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	146...148	1705	1654		206(22,8), 237 shl (6,6), 299 (17,8)	0,92 1,01	2,03	2,28	2,99...3,05, m	4,48		7,22...7,40, 10H		56
b	229...231	1690	1654	3155...3195	205 (21,8), 230 (12,6), 302 (17,0)	0,93 1,01	2,04	2,28	3,00...3,06, m	4,47		6,76...7,27, 9H	9,60**	70
c*	258...260	1691	1636 shl	3200...3285	206 (21,2), 219 shl (15,6), 299 (16,8)	0,94 1,01	2,08	2,24	3,01...3,07, m	4,50		6,31...7,49, 9H	9,62**	63
d	123...124	1712shl 1697	1660 shl 1649	3180...3200	204 (21,3), 219 shl (14,2), 303 (16,4)	0,94 0,99 1,02, 3 s	2,06, m	2,27, 2,29, 2c	3,03, t	4,47, q		6,77...7,39, 9H	7,83,** br.s	58
e*	268...270	1695	1632 shl	3180	203 (23,2), 230 shl (14,0), 287 (20,4)	0,92 1,02	2,06	2,29	3,03...3,09, m	4,59		6,56...8,20	9,58**	59
f	157...159	1710	1657 shl	3320...3350	204 (20,4), 216 shl (16,6), 287 (19,4)	0,93 1,02	2,10	2,30	3,03...3,11, m	4,56, q		6,33...8,16	5,67, br.s	65
g	289...291	1647	1622	3115...3145	206 (21,4), 227 (18,4), 301 (14,0)	0,96 1,02	2,07	2,29	3,00...3,04, m	4,42	3,76	6,73...7,18	6,44	54

TABLE 1. (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
h	254...256	1697	1655	3220...3250	204 (27,2), 222 (22,0), 303 (17,4)	0,92 1,00	2,03	2,27	2,98...3,02, m	4,43		6,63...6,90	6,08	60
i	263...265	1706	1632 shl	3160	205 (23,8), 227 (15,4), 299 (16,2)	0,92 1,00	2,02	2,29	2,96...3,01, m	4,38		6,59...7,44, 9H	5,17	48
j	140...142	1702	1645		207 (20,4), 231 (13,2), 303 (17,8)	0,97 1,04	2,07	2,29	3,00...3,04, m	4,49	3,84	6,91...7,31, 9H		70
k	143...145	1703	1639		206 (21,4), 230 shl (14,8), 290 (20,6)	0,93 1,04	2,09	2,31	3,04...3,11, m	4,58	3,84	6,93...8,22		57
ℓ	177...179	1694	1654		205 (19,8), 228 (21,2), 286 shl (13,6), 303 (16,0)	0,93 1,02	2,04	2,28	2,96...3,02, m	4,42	3,73 3,82 2s	6,73...7,27		86

---

*Compound IIIc was recrystallized from acetic acid, compound IIIe from dioxane.

**The signals were obtained by recording the spectra in DMSO-d_6 (proton signal could not be identified in $CDCl_3$).

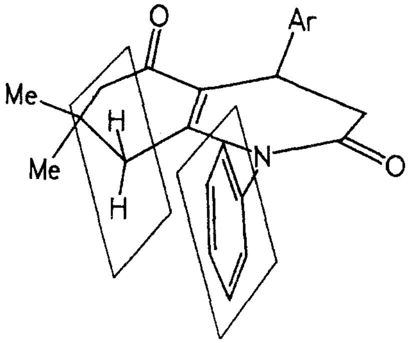


Fig. 2. Relative configuration of the N-phenyl substituent and the protons of the methylene group at the 8-position in 1,4-diaryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones (IIIa-*l*).

ring relative to the plane of the atoms of the methylene group at the 8-position. The magnetic equivalence of the protons may be due to the symmetric configuration of the hydrogen atoms relative to the phenyl ring (Fig. 2). The magnetic nonequivalence of the methyl group protons at the 7-position is thus related to the anisotropy of the magnetic field created by the phenyl ring at the 1-position. The shielding effect of the phenyl ring on the field of the methyl protons at the 7-position causes a displacement of the signals upfield (0.90-1.04 ppm for IIIa-*l* as compared with 0.98-1.25 ppm for IV-VI). The most significant magnetic anisotropy effect occurs with the o-hydroxyl substituent on the phenyl group (IIId). In this case the methyl groups at the 7-position appear as three characteristic signals with a total integral intensity of 6H (Fig. 1c).

Alkylation of IIIb, e, g with methyl iodide in an acetone—water mixture containing potassium carbonate for 2 h gives 1-(p-methoxyphenyl)-4-aryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones (IIIj, k, *l*), which were isolated as crystalline precipitates in 40-60% yield. The IR and UV spectra and properties of compounds IIIj, k, *l* obtained by alkylation are identical to those for the same compounds obtained directly by condensation of Ia-c and IIe.

EXPERIMENTAL

The IR spectra were recorded on a Specord IR-75 spectrophotometer, the UV spectra were recorded on a Specord UV-Vis spectrophotometer in ethanol, and the PMR spectra were recorded on a Tesla BS 487-C instrument (80 MHz) in $CDCl_3$ with TMS as internal standard.

The C, H, N, and Cl elemental analysis data of compounds III corresponded to the calculated values.

5-Arylidene-2,2-dimethyl-1,3-dioxane-4,6-diones Ia-e were obtained according to [5] and 5,5-dimethyl-3-arylamino-2-cyclohexenones IIa-e were obtained according to [6] (IIa) and [7] (IIb-e).

1,4-Diaryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-dione (IIIa-*l*). A mixture of 10 mmoles of 5-arylidene-2,2-dimethyl-1,3-dioxane-4,6-dione (Ia-e) and 10 mmoles of 5,5-dimethyl-3-arylamino-2-cyclohexenone (IIa-e) in 15 ml of ethanol was refluxed for 1-1.5 h. The solution was concentrated down and placed in a refrigerator. The precipitate that formed was filtered off and recrystallized (see Table 1).

Alkylation of 1-(p-Hydroxyphenyl)-4-aryl-7,7-dimethyl-1,2,3,4,5,6,7,8-octahydroquinoline-2,5-diones (IIIb, e, g) with Methyl Iodide. To a solution of 10 mmoles of compound IIIb, e, g in a mixture of 30 ml of acetone and 6 ml of distilled water was added 1.5 g (11 mmoles) of potassium carbonate and 0.64 ml (1.45 g, 10 mmoles) of methyl iodide. The mixture was refluxed for 2 h, cooled, and a dilute solution of hydrochloric acid was added to it until evolution of carbon dioxide had ceased. The reaction solution was filtered and placed in a refrigerator. The precipitate that formed was filtered off and recrystallized from ethanol. Yield of light-colored compounds: 41% (IIIj), 57% (IIIk), 59% (III*l*). When samples were mixed with those of IIIj, k, *l* obtained by condensation of Ia-c and IIe, there was no depression of the melting point.

REFERENCES

1. M. F. Strozhev, I. É. Lielbriedis, and O. Ya. Neiland, Khim. Geterotsikl. Soedin., No. 6, 786 (1990).
2. M. F. Strozhev and I. É. Lielbriedis, Khim. Geterotsikl. Soedin., No. 7, 947 (1990).
3. I. É. Lielbriedis, R. B. Kampare, and G. Ya. Dubar, Latv. Khim. Zh., No. 2, 212 (1990).
4. P. Margaretha, Tetrahedron Lett., No. 17, 1449 (1977).
5. P. Schuster, O. E. Polansky, and F. Wessely, Monatsh. Chem., **95**, 53 (1964).
6. P. Haas, J. Chem. Soc., **89**, 187 (1906).
7. J. V. Greenhill, J. Chem. Soc. Perkin Trans. 1, **20**, 2207 (1976).