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PREPARATION OF SOME 2,4,6-CYCLOHEPTATRIENE-1-YL KETONES. STRONG PREFERENCE FOR THE NORCARADIENE ISOMER IN THE CASE OF THE 2,4,6-CYCLOHEPTATRIENE-1-YL t-BUTYL KETONE

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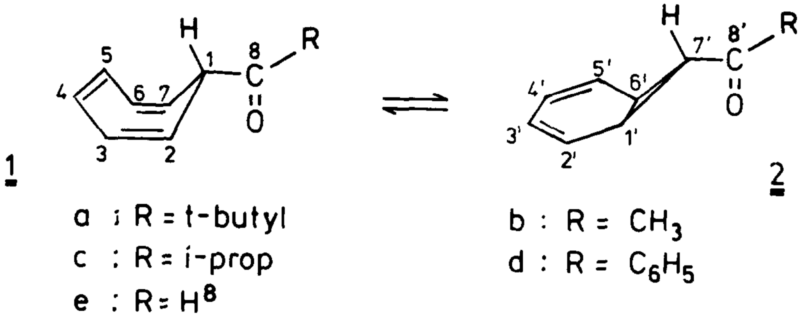
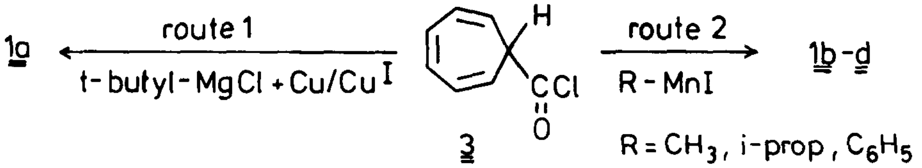
Abstract: t-Butyl, i-propyl and phenyl 2,4,6-cycloheptatriene-1-yl ketone (1a, c,d, respectively) have been synthesized. At -139°C, rather unexpectedly, the t-butyl ketone 1a exists in a 1:1 equilibrium with its norcaradiene isomer 2a.

In the course of our investigations of cyclopentadienyl and cycloheptatrienyl enolates[1,2] we were interested in some 2,4,6-cycloheptatriene-1-yl ketones which had not been described before[3]. Since M. Hanack has informed us about the independant preparation of such species in his laboratory[4], we would like to disclose our results in preliminary form.



The t-butyl ketone 1a was synthesized from the 2,4,6-cycloheptatriene-1-yl carbonyl chloride 3 via route 1[5]. The methyl, isopropyl and phenyl ketones 1b, c and d, respectively, were prepared from 3 and the corresponding manganese iodides RMnI via route 2 [6,7].



While the ^{1}H-nmr spectra of 1b-d are in agreement with the predominance of the cycloheptatrienyl valence isomer 1 in the equilibrium with the norcaradiene derivative **2** (the carbaldehyde **1e** shows a similar behaviour[8]), this is especially not so in case of **1a**, s. Tab. 1.

Tab. 1. ^{1}H-nmr spectra (400 MHz) of **1a**-**d** in THF[D_8] at 16°C, and **1e** [8] in methylene chloride[D_2] at 20°C

	$H^{4/5}$; $H^{3'/4'}$	$H^{3/6}$; $H^{2'/5'}$	$H^{2/7}$; $H^{1'/6'}$	H^1; $H^{7'}$
1a $\rightleftharpoons$ **2a**	6.58	6.32	4.46	2.39
1b $\rightleftharpoons$ **2b**	6.61	6.25	5.28	2.47
1c $\rightleftharpoons$ **2c**	6.57	6.25	4.98	2.44
1d $\rightleftharpoons$ **2d**	6.70	6.30	5.30	3.15
1e $\rightleftharpoons$ **2e**[8]	6.17 - 6.74		5.28	2.79

As one can see from Tab. 1, it is the hydrogens $H^{2/7}$ and $H^{1'/6'}$ of **1a** $\rightleftharpoons$ **2a** which are strongly shifted towards high field, indicating a pronounced proportion of the bicyclic isomer **2a** in the dynamic equilibrium.

From the temperature dependant ^{1}H-nmr spectra down to -139°C (s. Tab. 2), it has been possible to assign the signals of H^{1-7} and $H^{1'-7'}$ and thus (i) to calculate the amount of **1a** and **2a**, respectively, at different temperatures and (ii) to determine the configuration at $C^{7'}$ of **2a**.

Tab. 2. Temperature dependant ^{1}H-nmr spectra (400 MHz) of **1a** and **2a** in a 5:1 mixture of hexadeuterodimethylether and THF[D_8]. At temperatures between -50 and -90°C line broadening of the otherwise sharp signals is observed.

T [°C]	$H^{4/5}$; $H^{3'/4'}$	$H^{3/6}$; $H^{2'/5'}$	$H^{2/7}$; $H^{1'/6'}$	H^1; $H^{7'}$
-35	6.58	6.32	4.46	2.39
-139	6.86 6.40	6.40 6.16	5.32 2.51	3.0 1.32

(i) From the integral of the signals of $H^{2/7}$ and $H^{1'/6'}$ at -139°C (5.32 and 2.51 ppm, respectively) 52±4% of the norcaradiene **2a** are determined at this temperature. The chemical shift of these signals at -35°C (4.46 ppm) leads to 33±6% of **2a** ($\Delta\Delta G^\circ_{-35^\circ C}$ = 210±120 cal/mol). In the case of the carbaldehyde system **1e** $\rightleftharpoons$ **2e** 7% of the bicyclic **2e** are found at -145°C [8].

It has of course long been known that the norcaradiene structure **2** is strongly favored if <u>two</u> acceptor substituents are present at C^7 [9-12]. We are, however, not aware of any other cycloheptatrienyl system besides **1a** with only <u>one</u> substituent at C^7 - the substituent bearing <u>no charge</u>[13] - with a comparable preference of the norcaradiene isomer.

At present we have no convincing explanation for the enhanced stability of 2a, especially since the acceptor qualities of the -C(O)H group in 1e should be more pronounced than those of the -C(O)t-butyl group in 1a. It is, therefore, tempting to speculate that a widening of the angle $H^{7'}-C^{7'}-C^{8'}$ in 2a caused by the bulky t-butyl group leads to a smaller $C^{1'}-C^{7'}-C^{6'}$ angle in the cyclopropane ring of 2a and thus to a shorter $C^{1'}C^{6'}$ bond[14,15].

(ii) The trans coupling constants $^3J_{H^{1'}H^{7'}}$ in norcaradienes are in the range of 3-4 Hz [13,16] while the corresponding cis coupling constants should be in the order of 9±2 Hz [13,16]. In the -139°C spectrum of 2a, $^3J_{H^{1'}H^{7'}}$ amounts to 3.3 Hz[17], thus clearly revealing the anti configuration of the -C(O)t-butyl substituent. There is no experimental evidence for the diastereoisomer of 2a. Similarly, there is only one cycloheptatriene conformer detectable, probably the exo conformer 1a. It is not likely that the corresponding endo conformer is very stable because of strong steric interactions[18].

Finally, we would like to mention that in our hands the standard methods to prepare a cycloheptatrienyl ketone enolate from 1a-d in THF have failed. There has been, however, no problem to prepare cycloheptatrienyl ester and amide enolates in this solvent[2], as reported for the amide in the literature[19].

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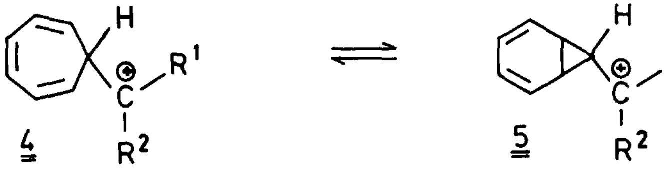
Literature and References

1. G. Boche, R. Eiben, W. Thiel, Angew. Chem. 94, 703 (1982); Angew. Chem., Int. Ed. Engl. 21, 688 (1982); Angew. Chem. Suppl. 1982, 1535.
2. G. Boche, F. Bosold, R. Eiben, Angew. Chem. 96, 788 (1984); Angew. Chem., Int. Ed. Engl. 23, 797 (1984).
3. Only two of such ketones are known in the literature. Cycloheptatriene-7-yl methyl ketone: a. C.R. Ganellin, R. Pettit, J. Chem. Soc. 1958, 576; b. G. Linstrumelle, Bull. Soc. Chim. Fr. 1970, 920; bis-cycloheptatriene-7-yl ketone: Y. Kayama, M. Oda, Y. Kitahara, Syn. Commun. 3, 53 (1973).
4. See the accompanying communication. We are grateful to Professor Hanack for informing us about his results prior to publication.
5. J.-E. Dubois, B. Leheup, F. Heenequin and P. Bauer, Bull. Soc. Chim. Fr. 1967, 1150.
6. G. Cahiez, D. Bernard, J.F. Normant, Synthesis 1977, 130.
7. Yields: 1a: 88%; 1b: 73%; 1c: 65%; 1d: 40%. 1a (m.p.: 47-48°C), 1b and 1c are analytically pure. In the ^1H-nmr spectrum even of freshly prepared 1d one detects various amounts (20-40%) of benzyl phenyl ketone ("desoxybenzoin"). On purification (distillation, chromatography) 1d rearranged almost completely into this isomer. Tetracyanoethylene adducts have been isolated from 2b (m.p.: 165-166°C, decomp.), 2c (m.p.: 176-177°C, decomp.)

and 2d (m.p.: 201-203°C, decomp.).

8. M.Balci, H. Fischer, and H. Günther, Angew. Chem. 92, 316 (1980); Angew. Chem., Int. Ed. Engl. 19, 301 (1980).
9. E. Ciganek, J. Am. Chem. Soc. 87, 652 (1965).
10. G. Maier, Angew. Chem. 79, 446 (1967); Angew. Chem., Int. Ed. Engl. 6, 402 (1967).
11. a. R. Hoffmann, Tetrahedron Lett. 1970, 2907; b. H. Günther, Tetrahedron Lett. 1970, 5173.
12. W.Bauer, J. Daub, G. Maas, M. Michna, K.M. Rapp, J. Stezowski, Chem. Ber. 115, 99 (1982).
13. Especially in the system **4γ** ⇌ **5γ** the norcaradiene structure is favored due to the enhanced acceptor qualities of the cationic substituent, as reported by W. Betz, J. Daub, Chem. Ber. 107, 2095 (1974).



	R^1	R^2	T[°C]	**5**[%]
α	$NHCH_3$	$NHCH_3$	-	0
β	$N(CH_3)_2$	OCH_3	30	42
γ	$O-CH_2-C(CH_3)_2-O$		-43.5	100

14. This would be comparable to the Thorpe-Ingold effect of gem-dimethyl groups, see E.L. Eliel, N.L. Allinger, S.J. Angyal, G.A. Morrison, Conformational Analysis, Wiley Interscience, 1965, New York, London, Sydney, p. 191.
15. In the other bisected conformation of the -C(O)t-butyl substituent in **2a** the t-butyl group would strongly interfere with the hydrogens $H^{1'}$ and $H^{6'}$, as shown by models. We thus prefer the conformation with oxygen atom close to $H^{1'}$ and $H^{6'}$.
16. K. Takeuchi, Y. Senzaki, K. Okamoto, J. Chem. Soc. Chem. Commun. 1984, 111, and further literature cited.
17. The complete ^1H-nmr spectrum of **2a** (except for the t-butyl group) at -139° has been simulated by Program LAOCN5 by L. Cassidei and O. Sciacovelli, Quantum Chemistry Program Exchange, Nr. 458, Indiana University, Bloomington. The coupling constant $^3J_{H^{1'}H^{7'}}$ = 3.3 Hz is the simulated one.
18. H. Günther et al.[8] have detected both the exo and the endo conformer of the carbaldehyde **1e**.
19. W. Bauer, J. Daub, K.M. Rapp, Chem. Ber. 116, 1777 (1983), and earlier lit. cited. A whole series of substituted cycloheptatrienyl "anions" (however no ketone enolate) have been prepared in ammonia ; A.W. Zwaard, H. Kloosterziel, Recl. Trav. Chim. Pays-Bas 100, 126 (1981).

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