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SYNTHESIS AND SOME PROPERTIES OF 1*H*-1-BENZAZEPINES

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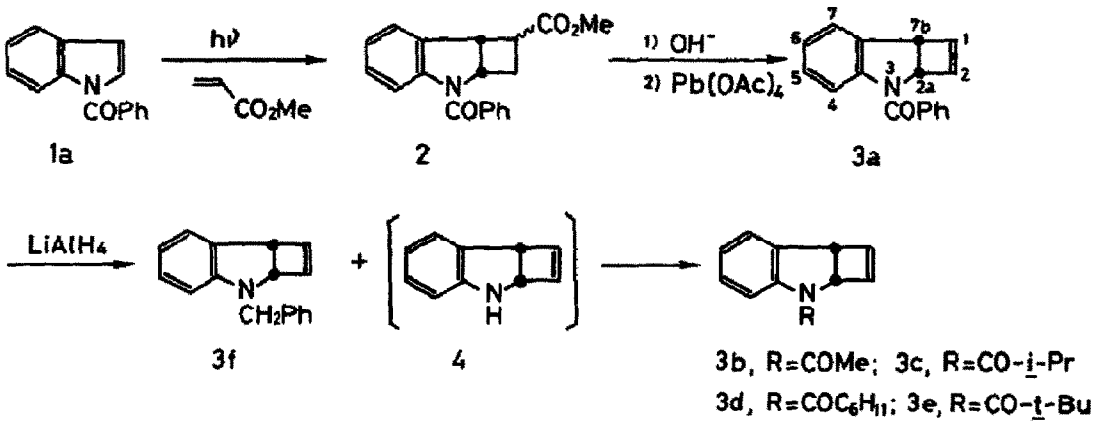
Summary: 1*H*-1-Benzazepines were synthesized by thermal ring opening of 2a,7b-dihydrocyclobut[*b*]indoles. The thermal and photochemical behavior of the 1*H*-1-benzazepines is also described.

Whereas the chemistry of azepines[1] and dibenz[*b*,*f*]azepines[2] has been studied to a considerable extent, that of 1*H*-1-benzazepines,[3] particularly derivatives lacking ring substituents,[4] remains relatively unexplored. We now wish to report a novel route to 1-substituted 1*H*-1-benzazepines which involves a thermal ring opening of 2a,7b-dihydrocyclobut[*b*]indoles. The thermal and photochemical behavior of the 1*H*-1-benzazepines is also described.

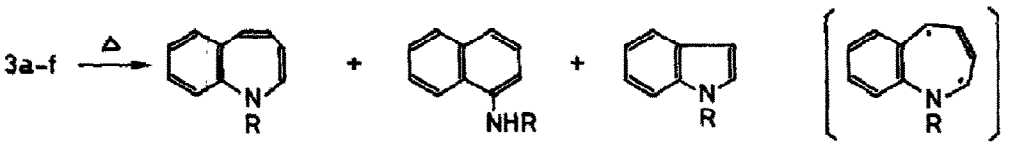
The dihydrocyclobut[*b*]indoles 3a-f were prepared as illustrated in Scheme 1. By applying the method of Jurian and coworkers,[5] photoadduct 2[6] was obtained in 67% yield as a mixture of the stereoisomers from 1-benzoylindole (1a) and methyl acrylate. Alkaline hydrolysis of 2 followed by oxidative decarboxylation with lead tetraacetate gave 3-benzoyl-2a,7b-dihydrocyclobut[*b*]indole (3a)[7] in 27% yield. Lithium aluminum hydride reduction of 3a in ether at room temperature afforded a mixture of 4 and the 3-benzyl derivative 3f[7] in *ca.* 2:1 ratio.

Scheme 1



Because of instability of 4, the crude mixture was directly treated with aceti anhydride, isobutyryl chloride, cyclohexylcarbonyl chloride, and pivaloyl chlo to give the corresponding 3-acyl derivatives 3b-e[7] in 50-60% yields, together with 3f (30%).

We were particularly interested in the possibility of rearranging the dihy cyclobut[*b*]indoles 3 to their valence isomer, 1*H*-1-benzazepines 5. When heate at 270-280° for 10 min without solvent, 3a gave 1-benzoyl-1*H*-1-benzazepine (5a (major)[9] and *N*-benzoyl-1-naphthylamine (6a) (minor) as an inseparable mixture (73%) along with 1a (4%) and unreacted 3a (23%). At higher temperature (300-3 3a gave 6a as the major product. Similar conversion of 3b-e into the corresp ing 1*H*-1-benzazepines 5b-e and other products was accomplished in yields liste in Table 1. Although the detailed mechanistic studies have not been carried o the intervention of biradicals 7 seems most plausible in view of the elevated temperatures required for this reaction and the general acceptance of biradica in related thermal ring opening of fused cyclobutenes.[10] An interesting aspec of the ring opening reaction is that the reaction is subject to steric acceler ation by the bulky 3-acyl group. On the other hand, 3f underwent smooth ring opening at the much lower temperature. A thermally allowed disrotatory openin process of the five-membered heterocyclic ring may be operative in this case.



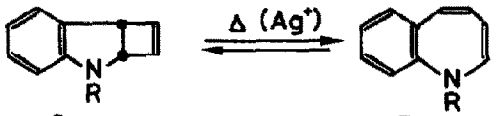
5a-f 6a-f 1a-f 7

Table 1. Thermolysis of Dihydrocyclobut[*b*]indoles

Compd	R	Conditions	Isolated Yield (%) 5	6	1	3
3a	COPh	270-280°,10 min	73[a]	a	4	23
3a	COPh	300-310°,3 min	0	90	trace	0
3b	COMe	320°,10 min	43	0	3	45
3c	CO-*i*-Pr	270-280°,10 min	62[a]	a	trace	23
3d	COC_6H_{11}	270-280°,10 min	58	trace	trace	36
3e	CO-*t*-Bu	230°,10 min	27	0	0	71
3e	CO-*t*-Bu	250°,10 min	73	trace	trace	16
3e	CO-*t*-Bu	270-280°,10 min	6	57	trace	18
3f	CH_2Ph	refluxing xylene,10 min	88	0	0	0

a Obtained as an inseparable mixture containing a small amount of 6.

The temperature of the ring opening of 3a-e was found to be lowered by 100-160° in the presence of silver ion.[11] Thus, refluxing a solution of 3a in xylene in the presence of $AgBF_4$ for 10 hr gave 5a (58%) and the starting material 3a (34%). No reaction took place in the absence of silver ion. Prolonged heating (20 hr) did not change the product ratio, suggesting the reversibility of the reaction. In fact, treatment of 5a under the same conditions gave a mixture of 3a and 5a. Similar results were obtained from 3b-e (Table 2).



3a-e 5a-e

Table 2. Silver Ion-Catalyzed Thermolysis of Dihydrobenz[*b*]indoles

Compd	Conditions	Isolated Yield (%) 5	3
3a	refluxing xylene,10 hr	58	34
3b	refluxing mesitylene,5 hr	18	72
3c	refluxing xylene,5 hr	43	49
3d	refluxing xylene,5 hr	43	39
3e	refluxing xylene,5 hr	12	63

The structural assignment of 5a-f was based on the spectroscopic data (Table 3) and catalytic hydrogenation of 5a over platinum oxide to 1-benzoyl-2,3,4,5-tetrahydro-1*H*-1-benzazepine.[12]

Table 3. Nmr Spectral Data for 1*H*-1-Benzazepines (in $CDCl_3$)

Compd	Chemical shifts (δ) 2-H	3-H	4-H	5-H	Coupling constants (Hz) $J_{2,3}$	$J_{3,4}$	$J_{4,5}$
5a	6.72(d)	5.97(dd)	6.41(dd)	7.02(d)	8.0	5.5	12.0
5b	6.49(d)	5.91(dd)	6.24(dd)	6.84(d)	7.5	6.0	11.0
5c	6.53(d)	5.97(dd)	6.33(dd)	6.93(d)	7.5	5.5	11.0
5d	6.52(d)	5.95(dd)	6.31(dd)	6.92(d)	7.5	5.5	11.5
5e	6.63(d)	5.96(dd)	6.36(dd)	7.04(d)	8.0	5.0	11.5
5f	5.46(d)	5.10(dd)	5.96(dd)	6.59(d)	7.5	5.5	11.0

Heating 5a at 300-310° for 5 min without solvent gave 6a in 86% yield. Interestingly, the pivaloyl derivative 5e rearranged at lower temperature (270°) to 6e (77%). The observed rearrangement finds analogy in the rearrangement of substituted *N*-carbomethoxyazepines[13] and is rationalized in terms of azanorcaradiene intermediates.

Irradiation of 5a in tetrahydrofuran with a 300W high-pressure mercury la in a Pyrex vessel for 4 hr under argon atmosphere gave 3a in 83% yield. Simila 5e and 5f were transformed into 3e and 3f in 87 and 83% yields, respectively. This photochemical valence tautomerism closely parallels the behavior of 1-benzoxepin[8] and 1-benzothiepin.[14]

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References and Notes

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7. 3a, mp 190-191°C; 3b, mp 94-95°C (lit.[8] 94-95°); 3c, mp 114.5-115°C; 3d, mp 95-96.5°C; 3e, mp 143-144°C; 3f, liquid.
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