

ACIDIC ALUMINA- AND  $\text{BF}_3 \cdot \text{OEt}_2$ -INDUCED REACTIONS OF  
1,2-DIPHENYL-1-AZASPIRO[2.2]PENTANE<sup>1</sup>

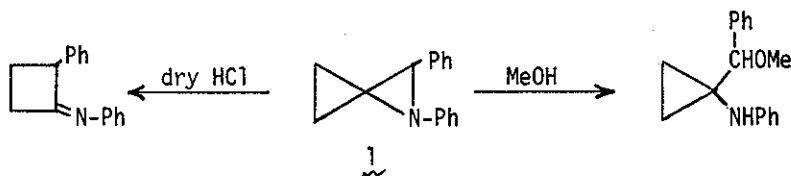
Otohiko Tsuge\* and Hirovuki Watanabe

Research Institute of Industrial Science, Kyushu University,

Hakozaki, Higashi-ku, Fukuoka 812, Japan

The acidic alumina-induced reaction of 1,2-diphenyl-1-azaspiro[2.2]pentane (**1**) afforded 3-phenylindoline-2-spirocyclopropane (**2**) and 1-anilino-1-hydroxybenzylcyclopropane (**3**). On treatment with diethyl azodicarboxylate **3** was converted to 2-benzoylquinoline (**4**). Under the influence of  $\text{BF}_3 \cdot \text{OEt}_2$  **1** gave **2** and a dimer of **1**, 1,3,4,6-tetraphenylpiperidine-2,5-bispirocyclopropane (**5**).

Crandall and Conover<sup>2</sup> have recently reported on the preparation and some chemical properties of the highly strained 1-phenyl-1-azaspiro[2.2]pentanes. 1,2-Diphenylazaspiropentane **1** undergoes two types of reactions under protonic conditions; ring expansion to cyclobutanone anil and the peripheral C-N bond fission of aziridine ring with methanol to anilincyclopropane derivative.



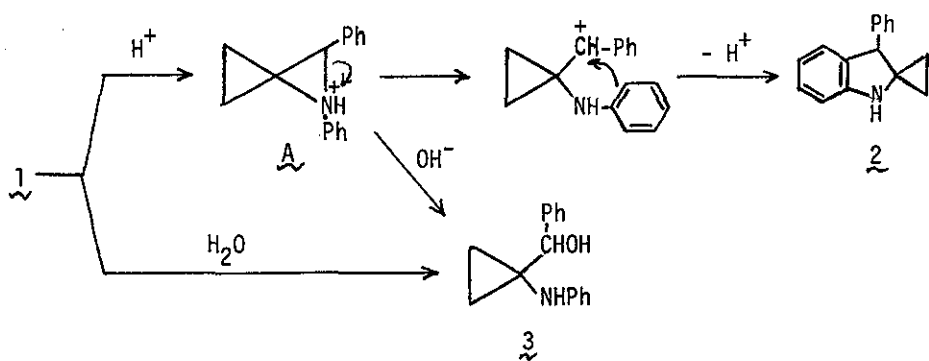
In this communication we wish to report on the acidic alumina- and  $\text{BF}_3 \cdot \text{OEt}_2$

-induced reactions of azaspiropentane 1 which revealed a new type of isomerization of 1.

A solution of azaspiropentane 1 in benzene was allowed to remain over a column of acidic alumina (grade III) ( $1/\text{alumina}=1/80$  (wt/wt)) for 2 hr. The eluate of benzene gave 3-phenylindoline-2-spirocyclopropane (2) in 24% yield, and the eluate of benzene-chloroform (3:1) gave 1-anilino-1-hydroxybenzylcyclopropane (3) in 35% yield. Structural elucidation of 2 and 3 was accomplished on the basis of spectral data.<sup>3</sup>

2: reddish yellow oil; ir (neat)  $3400\text{ cm}^{-1}$  (NH); nmr ( $\text{CCl}_4$ )  $\delta$  0.5-1.0 (4H, m, cyclopropyl  $\text{CH}_2$ ), 3.55 (1H, br, NH, exchanged with  $\text{D}_2\text{O}$ ), 4.75 (1H, s,  $\text{>CH}$ ), 6.6-7.3 (9H, m, aromatic protons); mass spectrum  $m/e$  221 ( $\text{M}^+$ ).

3: yellow oil; ir (neat) 3580 (OH),  $3400\text{ cm}^{-1}$  (NH); nmr ( $\text{CCl}_4$ )  $\delta$  0.5-1.0 (4H, m, cyclopropyl  $\text{CH}_2$ ), 3.75 (2H, br, NH and OH, exchanged with  $\text{D}_2\text{O}$ ), 4.85 (1H, s,  $\text{>CH}$ ), 6.6-7.3 (10H, m, aromatic protons); mass spectrum  $m/e$  239 ( $\text{M}^+$ ).

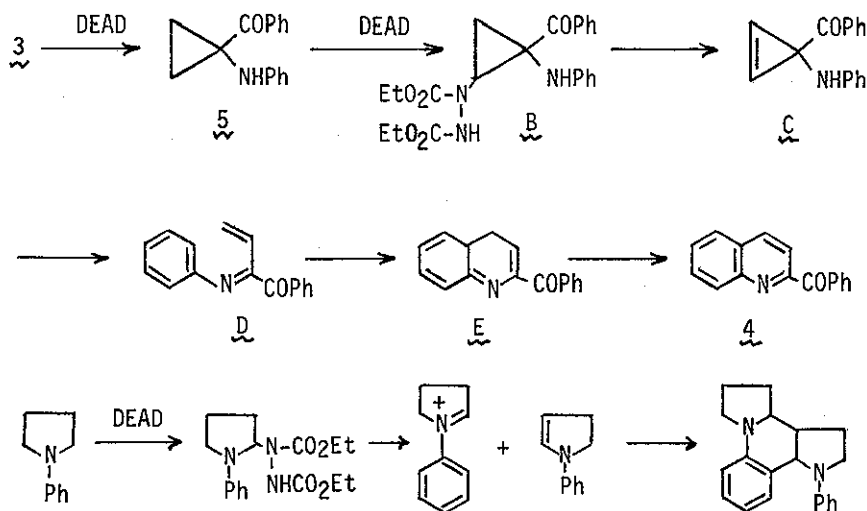


Compound 2 might form via a protonated intermediate A, followed by ring opening and subsequent cyclization with concurrent deprotonation as shown in Scheme 1. The formation of 3 can be interpreted by the peripheral C-N bond fission of aziridine ring with water or by the attack of hydroxide ion on A.

with concurrent ring opening.

Treatment of 3 with diethyl azodicarboxylate (DEAD) in boiling benzene for 10 hr afforded 2-benzoylquinoline (4) in 54% yield [4: mp 110-111°C (lit.<sup>4</sup> mp 111°C); ir (KBr) 1660 cm<sup>-1</sup> (CO); mass spectrum m/e 233 (M<sup>+</sup>)]. A plausible pathway for the formation of 4 is illustrated in Scheme 2. 1-Anilino-1-benzoyl-cyclopropane (5) and then cyclopropene intermediate C are formed by dehydrogenation with DEAD. Subsequent ring opening of C yields a diene intermediate D which undergoes an electrocyclic reaction to give E. Dehydrogenation of E gives the final product 4. This pathway is supported by the following evidence.

Treatment of 3 with pyridine 1-oxide in boiling benzene for 8 hr gave 5, mp 142-143°C, in 10% yield [5: ir (KBr) 3400 (NH), 1660 cm<sup>-1</sup> (CO); nmr (CDCl<sub>3</sub>) δ 1.22, 1.73 (each 2H, m, cyclopropyl CH<sub>2</sub>), 4.52 (1H, br, NH, exchanged with D<sub>2</sub>O), 6.5-7.9 (10H, m, aromatic protons); mass spectrum m/e 237 (M<sup>+</sup>), 236, 132 (M<sup>+</sup> - PhCO)]. When 5 was heated with DEAD in boiling benzene for 6 hr, 4 was obtained in 60%.

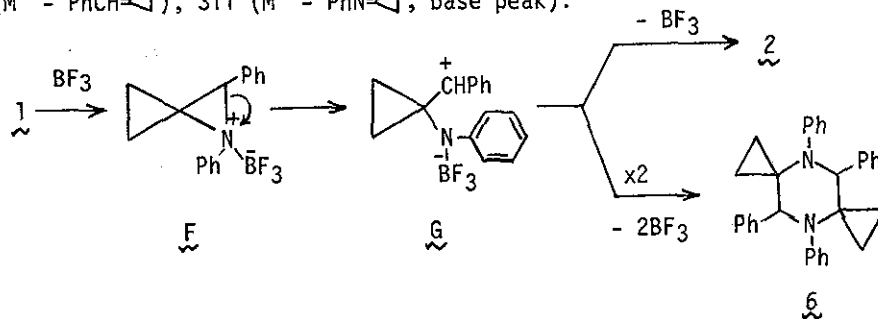


DEAD: diethyl azodicarboxylate

Scheme 2

yield. A good analogy exists for this type of reaction in the interaction of 1-phenylpyrrolidine and DEAD to form the adduct which on thermolysis forms a mixture of isomeric dimers of 1-phenylpyrroline (Scheme 2).<sup>5</sup>

When azaspiropentane **1** was treated with 0.5 molar  $\text{BF}_3 \cdot \text{OEt}_2$  in ethyl ether at  $0^\circ\text{C}$ , under nitrogen for 1 hr, **2** and a dimer **6** were obtained in 45 and 5% yields respectively. The same reaction at room temperature for 18 hr resulted only in the formation of **2** in 63% yield. On the basis of spectral data, the dimer was assigned to be 1,3,4,6-tetraphenylpiperidine-2,5-bispirocyclopropane (**6**). **6**: mp  $293\text{--}295^\circ\text{C}$ ; nmr ( $\text{CDCl}_3$ )  $\delta$  0.57-1.58 (8H, m, cyclopropyl  $\text{CH}_2$ ), 5.28 (2H, s,  $\text{>CH}$ ), 6.5-7.4 (20H, m, aromatic protons); mass spectrum  $m/e$  442 ( $\text{M}^+$ ), 312 ( $\text{M}^+ - \text{PhCH}=\triangle$ ), 311 ( $\text{M}^+ - \text{PhN}=\triangle$ , base peak).



Scheme 3

The potential pathway for the formation of **2** and **6** is depicted in Scheme 3. In analogy with the above alumina-induced reaction, **2** would be formed via **G**, which was generated by ring opening of complex **F**. Dimerization of **G** with concurrent elimination of  $\text{BF}_3$  would give dimer **6**.

#### REFERENCES

1. Studies of Highly Strained Heterocycles. Part I.
2. J. Crandall and W. W. Conover, *J. Org. Chem.*, 1974, **39**, 63.
3. All compounds gave satisfactory analytical values.
4. A. Kaufmann, P. Dandliker, and H. Burkhard, *Ber.*, 1913, **46**, 2929.
5. G. H. Kerr, O. Meth-Cohn, E. B. Mullock, and H. Suschitzky, *J. Chem. Soc. Parkin I*, 1974, 1614.

Received, 2nd October, 1976