ONE-POT SYNTHESIS OF PROPELLANE HETERO ANALOGUE FROM *N*-PHENYL-SUBSTITUTED 3-ACYL-1,2-DIHYDROCINNOLINE-1,2-DICARBOXIMIDES UNDER PHASE-TRANSFER-CATALYZED CONDITIONS

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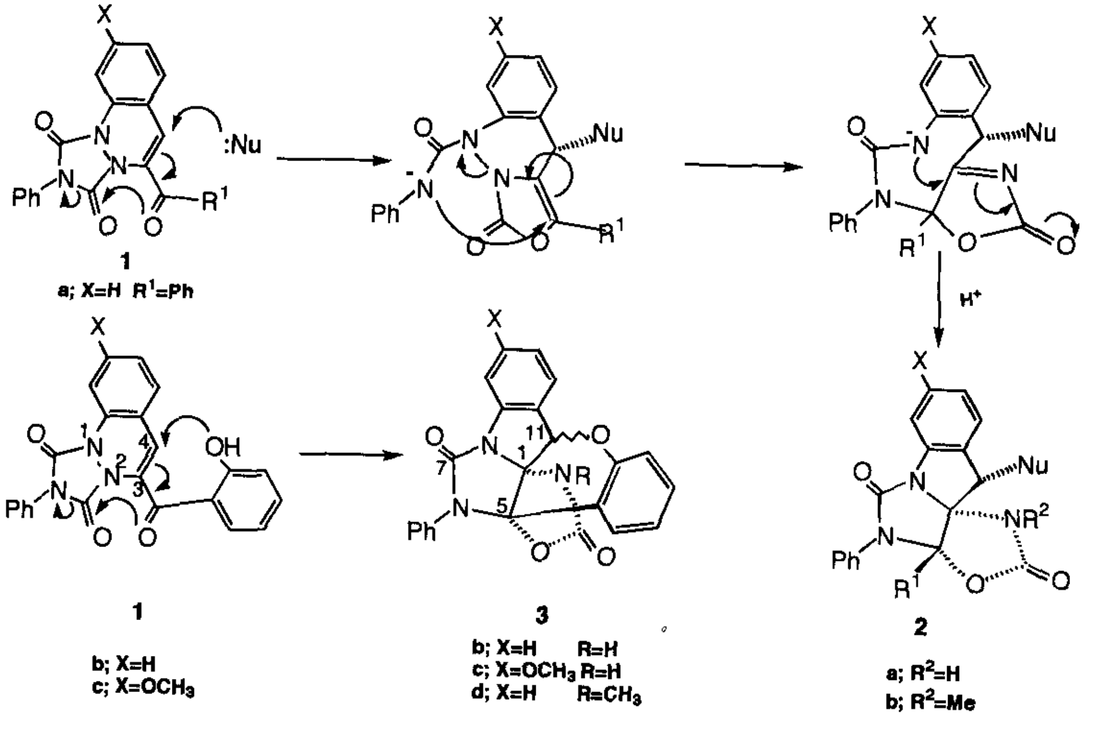
Abstract-Novel propellane hetero analogues were prepared in one-pot from *N*-phenyl-substituted 3-acyl-1,2-dihydrocinnoline-1,2-dicarboximides under phase-transfer catalyzed conditions.

We have recently reported that *N*-phenyl-substituted 3-acyl-1,2-dihydrocinnoline-1,2-dicarboximides (1) and related compounds serve as elaborate precursors for syntheses of heterocyclic compounds,as exemplified by photo-rearrangements to indole derivatives[1] and by nucleophile-assisted stereoselective rearrangements to tricyclic compounds.[2] In particular,the mechanism of the nucleophile-assisted rearrangement to give **2** comprises a combination of many consecutive reactions starting from a Michael addition of a nucleophile (:Nu) to a polar enone substructure as shown in Scheme 1.[2] A successful one-pot synthesis of a series of hetero analogues (**2**) of an angular triquinane (tricyclic [6.3.0.$0^{1,5}$]undec-9-ene skeleton),which exhibits biological activities,[3] encouraged us to attempt the construction of more intricate heterocycles.

We expected that compounds (**1b,c**) possessing a phenolic hydroxyl group would be transformed to a propellane hetero analogue (**3**) by intramolecular nucleophile-assisted rearrangements in one-pot (Scheme 1). We describe here the first successful synthesis of benzo[4.3.3]propellane hetero analogues (3).

N-Phenyl-substituted 3-(2'-hydroxybenzoyl)-1,2-dihydrocinnoline-1,2-dicarboximides (1b,c) were prepared by base-induced addition-elimination reactions of substituted benzylidene-2'-hydroxyacetophenones with 4-phenyl-4,5-dihydro-*3H*-1,2,4-triazole-3,5-dione (PTAD)[4] in overall yields of 12 % for 1b and 15 % for 1c. Their spectral data and elemental analyses satisfied the structures.[5] Particularly,thier ^{1}H-nmr spectra showed the presence of intramolecular hydrogen bond between benzoylcarbonyl and hydroxyl groups. Attempted intramolecular Michael addition of 1b by potassium hydroxide in ethanol was unsuccessful,presumably because of the presence of the strong hydrogen-bond. Thus,in order to cleave the hydrogen bond and also to prevent non-participated hydrolysis of the dicarboximide group,phase-transfer-catalyzed conditions were employed.[6] A dichloromethane solution of 1b was stirred vigorously with an aqueous 10% sodium hydroxide solution at 25℃ for 24 h in the presence of tetrabutylammonium bromide. Conventional work-up and purifications by a centrifugal chromatography (dichloromethane



Scheme 1

as an eluent) gave **3b** as colorless solid in a 58 % yield.[7] The structure was confirmed from its spectral data, elemental analyses, and chemical transformation. In a mass spectrum a molecular ion (*m/z* 397) was observed. A characteristic absorption of an amide group appeared at 3160 cm^{-1} in its ir spectrum. The ^{13}C-nmr spectrum showed two quaternary carbons (δ 84.4 and 89.8) corresponding to central carbons (C-1 and C-5) of the propellane and a methine carbon (C-11, δ 81.8), while the carbonyl carbon signal of the benzoyl group disappeared. The ^{1}H-nmr spectrum showed a singlet signal (11-H, δ 5.08) and the absence of an intramolecular hydrogen-bonded hydroxyl group. Furthermore, these and other spectral data were quite similar to previously reported triquinane hetero analogue (**2a**).[2] Methylation of **3b** with methyl iodide under phase-transfer-catalyzed conditions ($CH_2Cl_2/NaOH/(C_4H_9)_4NBr$) afforded **3d**. Its spectral data[8] were also similar to **2b**.[2] These results indicate that **3b** has a hetero benzo[4.3.3]propellane structure. Similar treatment of **1c** afforded **3c** in a 30 % yield.[9] These intriguing hetero benzo[4.3.3]propellanes would be built up *via* a stream of elaborate skeletal rearrangements starting from an intramolecular Michael addition of a phenolate ion to the polar enone substructure as anticipated (Scheme 1).

In summary, we have developed a one-pot new route to intricate heterocycles from relatively simple starting materials. Further investigations on the construction of other complex compounds and their reactivities are in progress in our laboratories.

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REFERENCES AND NOTES

1. S.Tanaka, K.Seguchi, K.Itoh, and A.Sera, *Chem.Lett.*, **1994**, 771.
2. S.Tanaka, K.Seguchi, K.Itoh, and A.Sera, *J.Chem.Soc., Perkin Trans.1*, **1994**, 2335.
3. (a) L.A.Paquette, *Top.Curr.Chem.*, 1984, **119**, 1; (b) B.M.Trost, *Chem.Soc.Rev.*, 1982, **11**, 141.
4. (a) K.Seguchi and S.Tanaka, *Bull.Chem.Soc.Jpn.*, 1991, **64**, 3188; (b) K.Seguchi and S.Tanaka,

J.Chem.Soc.,Chem.Commun.,1991,89.

5. **1b**: Yellow powder from EtOH; mp 178-179°C; selected spectral data,^{1}H-nmr(CDCl$_3$)δ: 6.06(1H,s,4-H),11.26(1H,s,OH); ^{13}C-nmr(CDCl$_3$)δ: 113.8(d,C-4),190.0(s,C=O);ir(KBr) 3020,1717,1620 cm^{-1}; ms *m/z*(%) 397(M$^+$,100). Anal. Calcd for $C_{23}H_{15}N_3O_4$: C,69.50; H,3.81; N,10.58.Found: C,69.33; H,3.73; N,10.59. **1c**: Yellow powder from EtOH; mp 191-192°C; selected spectral data,^{1}H-nmr(CDCl$_3$)δ: 3.87(3H,s,OMe),6.13(1H,s,4-H), 11.27(1H,s,OH); ^{13}C-nmr(CDCl$_3$)δ: 55.8(q),112.2(d,C-4),189.8(s,C=O); ir(KBr) 3080, 1767,1722 cm^{-1}; ms *m/z*(%) 427(M$^+$,100). Anal. Calcd for $C_{24}H_{17}N_3O_5$: C,67.42; H,4.01; N,9.84.Found: C,67.24; H,3.87; N,9.85.
6. W.P.Weber and G.W.Gokel,"Phase Transfer Catalysis in Organic Synthesis",Springer-Verlag,New York,1977.
7. **3b**: Colorless needles from EtOH; mp 300°C; ^{1}H-nmr(CDCl$_3$)δ: 5.08(1H,s,11-H),6.77-7.77 (14H,m,Ph,NH); ^{13}C-nmr(CDCl$_3$)δ: 81.8(d),84.4(s),89.8(s),118.4(d),118.5(d),120.5(s), 123.1(d),126.2(d),126.7(d),127.4(d),128.8(d),128.9(d),129.0(s),129.1(d),131.8(d), 132.3(d),133.2(s),144.1(s),151.8(s),155.1(s),155.7(s); ir(KBr) 3160,1797,1692,1489, 1309,1140 cm^{-1}; ms *m/z*(%) 397(M$^+$,100),277(49),235(75),179(13),158(69),121(16). Anal. Calcd for $C_{23}H_{15}N_3O_4$: C,69.50; H,3.81; N,10.58.Found: C,69.62; H,3.61; N, 10.58.
8. **3d**: Colorless needles from EtOH; mp 250°C; ^{1}H-nmr(CDCl$_3$)δ: 2.76(3H,s,Me),5.12(1H, s,11-H),6.77-7.73(13H,m,Ph); ^{13}C-nmr(DMSO-d$_6$)δ: 27.3(q),79.3(d),86.7(s),87.0(s), 116.7(d),118.0(d),118.7(d),120.3(s),122.7(d),126.0(d),126.4(d),126.8(d),128.3(d), 129.3(s),129.7(d),129.8(d),132.0(d),133.0(s),143.7(s),151.3(s),154.0(s),157.7(s); ir (KBr) 1780,1727 cm^{-1}; ms *m/z*(%) 411(M$^+$,80),291(55),248(33),235(100),142(35); HR-ms *m/z* Calcd for $C_{24}H_{17}N_3O_4$ 411.1220.Found: 411.1234.
9. **3c**: Colorless needles from EtOH; mp 280-281°C; ^{1}H-nmr(DMSO-d$_6$)δ: 3.80(3H,s,OMe),5.10 (1H,s,11-H),6.73-7.80(13H,m,Ph,NH); ^{13}C-nmr(DMSO-d$_6$)δ: 55.9(q),80.7(d),85.4(s),88.3 (s),103.3(d),111.6(d),118.5(d),120.7(s),121.5(d),122.7(d),126.7(d),127.8(d),128.1(d), 128.4(d),128.9(d),131.7(s),133.2(s),145.1(s),151.6(s),154.5(s),155.1(s),162.1(s); ir (KBr) 3255,1794,1698,1106 cm^{-1}; ms *m/z*(%) 427(M$^+$,100),307(31),265(35),250(44),188 (45); HR-ms *m/z* Calcd for $C_{24}H_{17}N_3O_5$ 427.1168.Found: 427.1168.

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