ISSN 1070-4280, Russian Journal of Organic Chemistry, 2012, Vol. 48, No. 9, pp. 1257–1258. © Pleiades Publishing, Ltd., 2012.
Original Russian Text © V.V. Konovalova, Yu.V. Shklyaev, A.N. Maslivets, 2012, published in Zhurnal Organicheskoi Khimii, 2012, Vol. 48, No. 9, pp. 1257–1258.

SHORT COMMUNICATIONS

Synthesis of Dispiro Hetero Analogs of Pyrrolizidine Alkaloids

V. V. Konovalova[a], Yu. V. Shklyaev[a], and A. N. Maslivets[b]

[a] *Institute of Technical Chemistry, Ural Division, Russian Academy of Sciences, Perm, Russia*
[b] *Perm State University, ul. Bukireva 15, Perm, 614990 Russia*
e-mail: koh2@psu.ru

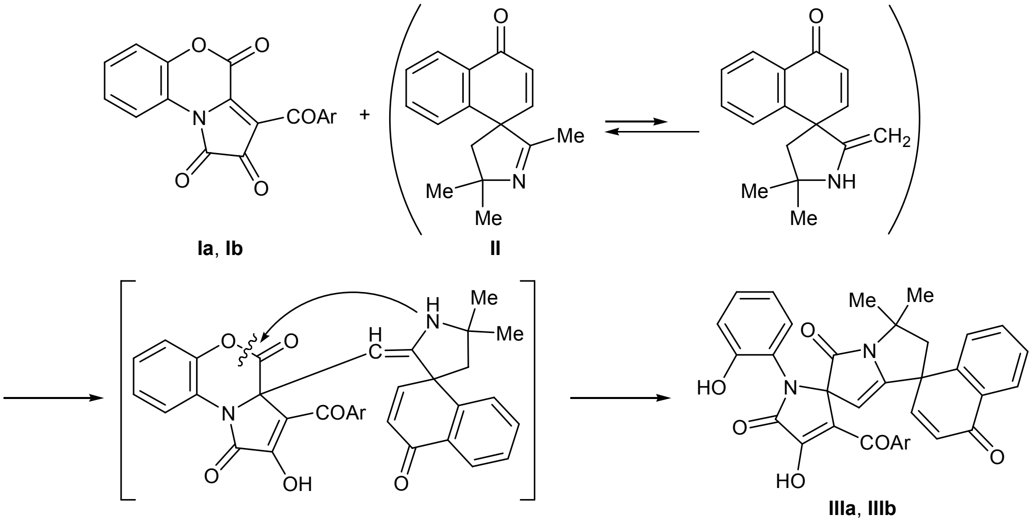
Received September 27, 2011

DOI: 10.1134/S1070428012090205

Reactions of spiro heterocyclic enamines with 1*H*-pyrrole-2,3-diones, including those fused at the $N^1–C^5$ bond to nitrogen-containing heterocycles, were not studied. We have found that 3-aroyl-1*H*-pyrrolo[2,1-*c*][1,4]benzoxazine-1,2,4-triones **Ia** and **Ib** react with an equimolar amount of 2′,5′,5′-trimethyl-4′,5′-dihydro-4*H*-spiro[naphthalene-1,3′-pyrrol]-4-one (**II**) (which may be regarded as potential 1,3-C,N-binucleophile) in boiling anhydrous benzene (reaction time 2–5 min, until bright violet color typical of the initial pyrrolobenzoxazinetriones disappeared) to give 3″-aroyl-4″-hydroxy-1″-(2-hydroxyphenyl)-3′,3′-dimethyl-2′,3′-dihydrodispiro[naphthalene-1,1′-pyrrolizine-6′,2″-pyrrole]-4,5′,5″(1″*H*)-triones **IIIa** and **IIIb** in almost quantitative yield. The spectral parameters of compounds **IIIa** and **IIIb** are very similar to those found for model ethyl 4-benzoyl-3-hydroxy-1-(2-hydroxyphenyl)-8-methyl-2,6-dioxo-1,7-diazaspiro[4.4]nona-3,8-diene-9-carboxylate whose structure was proved by X-ray analysis [1].

Presumably, the first step is addition of the activated β-CH group in the enamino tautomer of **II** at the C^{3a} atom in **Ia** or **Ib**, followed by closure of pyrrole ring via intramolecular attack by the amino group of the enamine fragment on the lactone carbonyl carbon atom in the oxazine ring and opening of the latter at the $C^4–O^5$ bond, as was reported by us previously for the reaction of pyrrolobenzoxazinetriones with 1-methyl-3,4-dihydroisoquinolines [2]. The described reaction is an example of regioselective synthesis of previously inaccessible dispiro heterocyclic system with various substituents in several positions of both heterocyclic fragments. The products may be regarded as dispiro heterocyclic analogs of pyrrolizidine alkaloids [3].

4″-Hydroxy-1″-(2-hydroxyphenyl)-3′,3′-dimethyl-3″-(4-methylbenzoyl)-2′,3′-dihydrodispiro[naph-



Ar = 4-MeC$_6$H$_4$ (**a**), 4-ClC$_6$H$_4$ (**b**).

thalene-1,1′-pyrrolizine-6′,2″-pyrrole]-4,5′,5″(1″*H*)-trione (IIIa). A solution of equimolar amounts (1.0 mmol) of compounds **Ia** and **II** in 20 ml of anhydrous benzene was heated for 5 min under reflux (until it lost its color). The mixture was cooled, and the precipitate was filtered off. Yield 97%, mp 213–215°C (from ethyl acetate). IR spectrum, ν, cm^{-1}: 3225 br (OH), 1714 ($C^{5''}$=O, $C^{5'}$=O), 1664 (C^4=O), 1625 (3″-C=O). ^1H NMR spectrum, δ, ppm: 1.60 s and 1.70 s (3H each, Me), 2.03 s (3H, $\mathbf{Me}C_6H_4$), 2.54 (2H, 2′-H, *AB*), 4.54 s (1H, 7′-H), 6.14 d (1H, 3-H), 6.38 d (1H, 2-H), 6.98–7.94 m (12H, H_{arom}), 9.56 s (1H, $C_6H_4O\mathbf{H}$), 12.31 br.s (1H, 4″-OH). Found, %: C 73.26; H 5.05; N 4.70. $C_{35}H_{28}N_2O_6$. Calculated, %: C 73.41; H 4.93; N 4.89.

3″-(4-Chlorobenzoyl)-4″-hydroxy-1″-(2-hydroxyphenyl)-3′,3′-dimethyl-2′,3′-dihydrodispiro[naphthalene-1,1′-pyrrolizine-6′,2″-pyrrole]-4,5′,5″(1″*H*)-trione (IIIb) was synthesized in a similar way. Yield 96%, mp 204–205°C (from ethyl acetate). IR spectrum, ν, cm^{-1}: 3219 br (OH), 1708 ($C^{5''}$=O, $C^{5'}$=O), 1663 (C^4=O), 1620 (3″-C=O). ^1H NMR spectrum, δ, ppm: 1.60 s and 1.70 s (3H each, Me), 2.62 (2H, 2′-H, *AB*), 4.55 s (1H, 7′-H), 6.13 d (1H, 3-H), 6.39 d (1H, 2-H), 6.89–7.94 m (12H, H_{arom}), 9.57 s (1H, $C_6H_4O\mathbf{H}$), 11.93 br.s (1H, 4″-OH). Found, %: C 68.80; H 4.25; N 4.55. $C_{34}H_{25}ClN_2O_6$. Calculated, %: C 68.86; H 4.25; N 4.72.

The IR spectra were recorded on a Bruker IFS 66 spectrometer with Fourier transform from samples dispersed in mineral oil. The ^1H NMR spectra were run on a Varian Mercury-300 spectrometer at 300 MHz using DMSO-d_6 as solvent and tetramethylsilane as internal reference. The purity of the products was checked by thin-layer chromatography on Sorbfil plates using ethyl acetate as eluent; spots were developed by treatment with a 0.5% solution of chloranil in toluene.

This study was performed under financial support by the Presidium of the Russian Academy of Sciences (program nos. 18, 21), by the Russian Foundation for Basic Research (project nos. 12-03-00146, 12-03-00696), and by the Council for Grants at the President of the Russian Federation (project no. MK-2998.2011.3).

REFERENCES

1. Racheva, N.L., Aliev, Z.G, Belova, M.A., Mashevskaya, I.V., and Maslivets, A.N., *Russ. J. Org. Chem.*, 2008, vol. 44, p. 701.
2. Racheva, N.L., Shklyaev, Yu.V., Rozhkova, Yu.S., and Maslivets, A.N., *Russ. J. Org. Chem.*, 2007, vol. 43, p. 1330.
3. Semenov, A.A. and Kartsev, V.G., *Osnovy khimii prirodnykh soedinenii* (Fundamentals of the Chemistry of Natural Compounds), Moscow, ICSPF, 2009, vol. 2, p. 45.