Hydrochloride (XIV). Mp 220-222°C (decomposed). IR spectrum (Nujol): 3361 (O–H), 3096 (N–H), 3062, 2976, 2923, 2501 br., 1698 (isoindolinone C=O), 1668 (C=O + amide-I), 1657 sh., 1634, 1595, 1551 cm^{-1} (amide-II). Found: C 63.8; H 6.2; Cl 11.3; N 8.7%. $C_{17}H_{19}ClN_2O_2$. Calculated: C 64.0; H 6.0; Cl 11.1; N 8.8%.

LITERATURE CITED

1. R. É. Valter, Ring-Chain Isomerism in Organic Chemistry [in Rusdian], Zinatne, Riga (1978).
2. B. Paul and B. Korytnyk, J. Heterocyc. Chem., 13, 701 (1976).
3. G. A. Karlivan, R. É. Valter, and S. P. Valter, Zh. Org. Khim., 13, 805 (1977).
4. R. B. Kampare, R. É. Valter, É. É. Liepin'sh, and G. A. Karlivan, Izv. Akad. Nauk. Latv. SSR, Ser. Khim., No. 2, 244 (1981).
5. A. A. Artamonov, T. Shneider, and N. V. Baranova, Khim. Geterotsikl. Soedin., No. 4, 514 (1980).

ACETALS OF LACTAMS AND ACID AMIDES.

46.* UNUSUAL REACTIONS OF α-CYANO-β-DIMETHYLAMINOCROTONAMIDE WITH ANTHRANILIC ACID DERIVATIVES

N. Z. Yalysheva, V. V. Chistyakov, and V. G. Granik

UDC 547.391.3'398.1'583.5'856.1'831:543.51'422

It has been shown that the reaction of the enaminoamide α-cyano-β-dimethylaminocrotonamide with anthranilic acid and its ethyl ester unexpectedly gives quinazoline-2,4-dione and 2-methyl-3-cyano-4-quinolone, respectively. The structures of the products were confirmed by their spectra and by direct synthesis.

It has been shown [2] that tertiary enaminoamides react with aromatic amines, the transamination being best effected in acetic acid. For this reason, it was attempted to carry out this reaction with α-cyano-β-dimethylaminocrotonamide (I) and ethyl anthranilate (II) in order to obtain the secondary N-arylenemonoamide (III), which has a functional substituent (the ethoxycarbonyl group) in the ortho-position in the benzene ring. The product obtained was the compound (IV), the mass spectrum of which contained three main peaks†, viz., the molecular peak (162), 119 $(M - CONH)^+$, and 92. The IR spectrum of the compound showed absorption at 1670 and 1700 cm^{-1} (CO), 3160 and 3250 cm^{-1} (NH). These findings, together with the elemental analysis, lead to the conclusion that the reaction of (I) and (II) follows an unexpected route to give quinazoline-2,4-dione (IV). The structure of (IV) was confirmed by comparison with an authentic sample synthesized by a literature method [3].

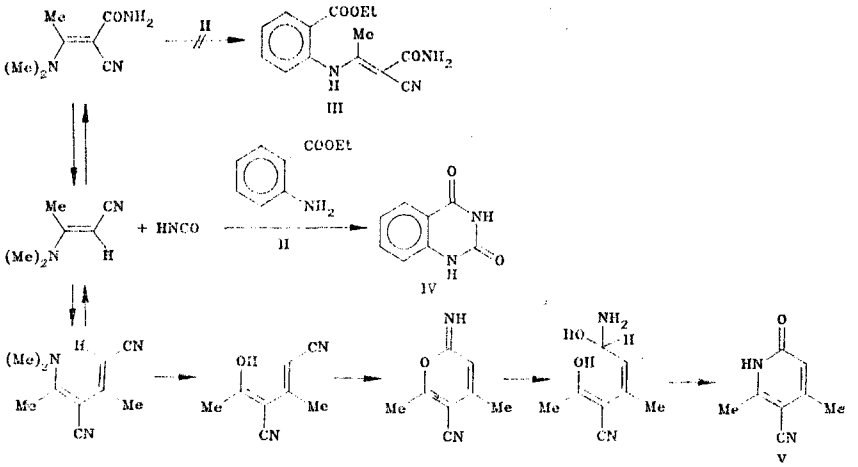
*For communication 45, see [1].

†Here and subsequently, the m/z values for the peaks are given (with the intensity relative to the maximum ion peak, %, in parentheses.

S. Ordzhonikidze All-Union Scientific-Research Institute for Pharmaceutical Chemistry, Moscow 119021.

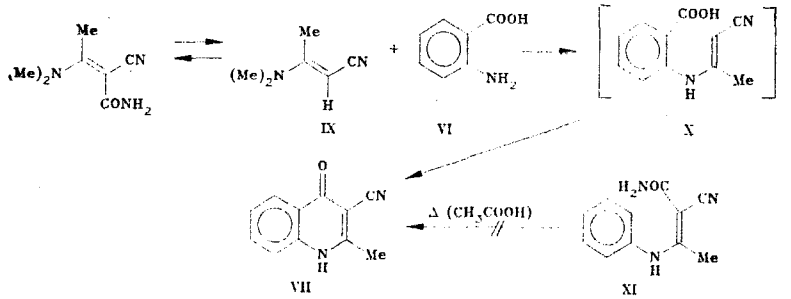
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 1, pp. 84-87, January, 1986. Original article submitted November 27, 1984.

0009-3122/86/2201-0070$12.50



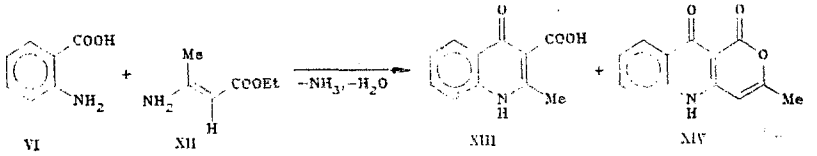
The formation of the quinazolinedione (IV) may be rationalized as follows. On heating in acetic acid the enaminoamide (I) undergoes reversible cleavage of HNCO, followed by cyclization. A similar cleavage of HNCO has been postulated previously in the case of N-carbamoylamidines [4]. Heating the enaminoamide (I) in acetic acid in the absence of ethyl anthranilate (II) affords a complex mixture, from which 4,6-dimentyl-5-cyano-2-pyridone (V) was isolated [5]. The PMR spectrum of this compound (DMF-D_6) showed signals for the 4- and 6-methyl groups at 2.25 and 2.48, respectively, and signals at 6.12 (3-H) and 7.95 ppm (NH). The mass spectrum of (V) contained a strong molecular ion peak at 148 (78). The principal mode of mass spectral fragmentation was elimination of CO (as in unsubstituted α-pyridone) to give a fragment of mass 120 (51), from which a hydrogen atom is eliminated to give a stable fragment 119 (100). The formation of the quinazolinedione (IV) and the pyridone (V) is shown by the scheme above.

It is noteworthy that (V) was previously synthesized from β-aminocrotononitrile [5]. The IR spectrum of (V) shows absorption at 720, 870, 1370, 1410, 1615, 1660, 2210, and 3400 cm^{-1}, in full agreement with the data reported in [5]. The next step in this investigation was to attempt to carry out the transamination reaction with anthranilic acid (VI) rather than with ethyl anthranilate (II). Heating (I) and (VI) in acetic acid gave a complex mixture (which contained no starting materials), from which it was possible to isolate 2-methyl-3-cyano-4-quinolone (VII) [6] in low yield. The structure of the quinolone (VII) was conformed by its mass spectrum, in which the strongest peak was for the molecular ion, 184 (100). One of the main routes of mass spectrometric fragmentation, as in the case of unsubstituted γ-pyridone [7], is elimination of carbon monoxide from $M^{+\cdot}$ to give the indole ion-radical 156 (15), which in turn decomposes in the well-known way with loss of a hydrogen atom and HCN to give the ion 128 (5). The spectrum also contains ion peaks at 130 (4), 129 (6), and 92 (11). The quinolone (VII) was also obtained by direct synthesis from α-ethoxycarbonyl-β-anilinocrotononitrile (VIII) by the literature method [6]. The formation of the quinolone (VII) appears to be also due to the conversion of the enaminoamide (I) into β-dimethylaminocrotononitrile (IX), which then undergoes deamination to (X) and cyclization, since under these conditions (heating in acetic acid) α-cyano-β-anilinocrotonamide (XI) does not cyclize to (VII). A likely scheme for the formation of the latter is shown below.

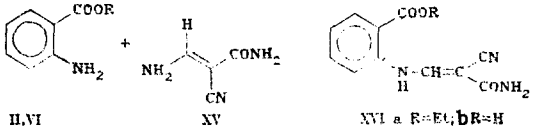


According to this scheme, the β-monosubstituted enamine (IX) reacts with anthranilic acid (VI). It was of interest to examine this reaction in another case, namely the reaction of the acid (VI) with β-aminocrotonic ester (XII). On heating these compounds in acetic acid,

a mixture of two compounds was obtained, which was separated by treatment with caustic alkali. Using this method, it was possible to isolate the previously-described 2-methyl-4-quinolone-3-carboxylic acid (XIII) [8] and the pyranoquinolone (XIV), into which it is subsequently converted under these conditions. The mass spectrum of (XIII) contained a strong peak for the molecular ion at 203 (75), and peaks for $[M - CH_3]^+$ at 188 (100), 120 (35), attributed to the fragment $H_2NC_6H_4C{\equiv}O^+$, 92 ($C_6H_4NH_2^+$, 25) and 77 (Ph^+, 11). The (XIV) molecule is stable to electron impact. The spectrum shows a strong molecular ion peak, $M^{+\cdot}$ 227 (81), $[M - CO]^+$ 199 (100), and probably $[M - CH_2COCH_3]^+$ 170 (59). The IR spectrum of (XIV) shows absorption at 3160 (NH), 1750 (lactone CO), and 1670 cm^{-1} (quinolone CO), confirming the presence of the pyran ring. The PMR spectrum in DMSO-D_6 also corresponds to the proposed structure, signals being present for CH_3 at 2.61, CH at 6.26, and Ph at 7.21-8.10 ppm.



To conclude this investigation, it was found that when the enaminoamide (XV) (which does not contain a CH_3 group in the α-position of the enamine) reacts with ethyl anthranilate or anthranilic acid, the normal transamination products (XVIa, b) are formed.



II, VI
II R=Et; VI R=H

XV

XVI a R=Et; b R=H

EXPERIMENTAL

Mass spectra were obtained on a Varian MAT-112 spectrometer with direct introduction of the sample into the ion source. The ionization chamber temperature was 180°C, and the energy of the ionizing electrons 70 eV. IR spectra were obtained on a Perkin-Elmer 457 in vaseline oil.

Quinazoline-2,4-dione (IV). A mixture of 1.53 g (10 mmole) of the enamine (I) and 4.95 g (30 mmole) of the ester (II) in 15 ml of glacial acetic acid was boiled for 5 h, then cooled, the solid filtered off, and washed with water and alcohol to give 0.9 g (50%) of (IV) mp 350°C (from DMF). Found: C 59.0; H 4.1; N 17.4%. $C_8H_6N_2O_2$. Calculated: C 59.3; H 3.7; N 17.3%.

4,6-Dimethyl-5-cyano-2-pyridone (V). A solution of 0.5 g (3.3 mmole) of the enamine (I) in 10 ml of glacial acetic acid was boiled for 2.5 h, evaporated, filtered, and washed with alcohol to give 0.05 g (10%) of (V), mp 294-296°C (from methanol) [5]. Found: C 64.8; H 5.6; N 19.2%. $C_8H_8N_2O$. Calculated: C 64.9; H 5.4; N 18.9%.

2-Methyl-3-cyano-4-quinolone (VII). A mixture of 1 g (6.5 mmole) of the enamine (I) and 2.74 g (20 mmole) of the acid (VI) in 10 ml of glacial acetic acid was boiled for 7 h. The solid which separated was filtered off and washed with water and alcohol to give 0.1 g (8%) of (VII), mp 360-368°C (from DMF) [6]. Found: C 71.7; H 4.4; N 15.2%. $C_{11}H_8N_2O$. Calculated: C 71.9; H 4.3; N 15.5%.

2-Methyl-4-quinolone-3-carboxylic Acid (XVIII and 3-Methyl-1,2,5,10-tetrahydropyrano [4,3-b]quinoline-1,10-dione (XIV). A mixture of 1.26 g (10 mmole) of the ester (XII) and 4.11 g (30 mmole) of the acid (VI) in 10 ml of glacial acetic acid was boiled for 10 h, evaporated, filtered, and washed with alcohol to give 0.32 g of a mixture of (XIII) and XIV). The mixture was dissolved in 0.02 N NaOH, and the insoluble solid filtered off and washed with water and alcohol to give 0.08 g (4%) of (XIV), mp 300°C (from DMF). Found: C 68.4; H 3.8; N 5.9%. $C_{13}H_9NO_3$. Calculated: C 68.7; H 4.0; N. 6.2%.

The mother liquors were acidified with HCl to pH 3-4, and the solid which separated was filtered off, and washed with water and alcohol to give 0.09 g (4%) of (XIII), mp 239-243°C (from DMF)[8].

α-Cyano-β-(o-ethoxycarbonylphenyl)aminoacrylamide (XVIa). A mixture of 0.6 g (4.3 mmole) of the enamine (XV) and 2.5 g (15 mmole) of the ester (II) in 10 ml of glacial acetic acid was boiled for 6 h, cooled, and the solid filtered off and washed with water and alcohol to give 0.24 g (19%) of (XVIa), mp 227-229°C (from DMF). $M^{+\cdot}$ 259. Found: C 60.3; H 5.2; N 16.5%. $C_{13}H_{13}N_3O_3$. Calculated: C 60.2; H 5.0; N 16.2%.

α-Cyano-β-(o-carboxyphenyl)aminoacrylamide (XVIb). A mixture of 0.6 g (4.3 mmole) of the enamine (XV) and 2 g (15 mmole) of the ester (II) in 10 ml of glacial acetic acid was boiled for 6 h, cooled, and the solid filtered off and washed with water and alcohol to give 0.24 g (19%) of (XVIa), mp 227-229°C (from DMF). $M^{+\cdot}$ 259. Found: C 57.0; H 3.9; N 18.1%. Calculated: C 57.1; H 3.9; N 18.2%.

LITERATURE CITED

1. L. V. Ershov and V. G. Granik, Khim. Geterotsikl. Soedin., No. 7, 929 (1985).
2. L. V. Ershov, S. S. Kiselev, and V. G. Granik, Khim. Geterotsikl. Soedin., No. 4, 538 (1984).
3. Organic Synthesis, A. H. Blatt (ed.), Wiley, New York; Chapman and Hall, London (1946), Coll. Vol. 2, p. 79.
4. S. I. Kaimanakova, E. A. Kuleshova, N. P. Solov'eva, and V. G. Granik, Khim. Geterotsikl. Soedin., No. 11, 1553 (1982).
5. K. Sato, M. Ohashi, T. Amakasu, and K. Takeda, Bull. Chem. Soc. Japan, 42, 2319 (1969).
6. R. J. Grout, B. M. Hynam, and M. W. Partridge, J. Chem. Soc., C, 1590 (1969).
7. G. Budzikevich, K. Djerassi, and D. Williams, Interpretation of the Mass Spectra of Organic Compounds [Russian translation], Mir, Moscow (1966).
8. R. T. Coutts and D. G. Wiberley, J. Chem. Soc., No. 6, 2518 (1962).

SYNTHESIS OF 5-OXOINDENO[1,2-b]PYRIDINIUM SALTS

A. Z. Zandersons, V. K. Lusis, D. Kh. Mutsenietse, and G. Ya. Dubur

UDC 547.821.3'665.07

When N-methylated 4-aryl-5-oxo-4,5-dihydroindeno[1,2-b]pyridines are oxidized with hydrogen peroxide in the presence of perchloric acid, in addition to the formation of the indenopyridinium perchlorates, cleavage of the dihydropyridine ring occurs, giving the 2-arylideneindan-1,3-dione.

We have previously converted the 1,4-dihydro-isomers of cyclic pyridine derivatives into the corresponding 1,2-isomers by reducing pyridinium salts [1, 2]. Similar conversions of polycyclic dihydropyridines such as dihydroindeno[1,2-b]pyridines have not been described. The aim of this investigation was to develop methods for the synthesis of N-methyl-5-oxoindeno[1,2-b]pyridinium salts. The starting materials were 5-oxoindeno[1,2-b]pyridines (I) or the N-methylated 5-oxo-4,5-dihydroindeno[1,2-b]pyridines (II) [3, 4]. In the case of pyridines (I), these were heated with methyl toluene-p-sulfonate or dimethyl sulfate. The use of this classical method for the synthesis of the salts was restricted by preparative difficulties, namely, resinification and the hygroscopicity of the products. When the salts (III) were obtained as the monosulfates or tosylates, therefore, they were converted into the perchlorates by ion exchange by treatment with $NaClO_4$, since pyridinium perchlorates are readily crystallizable compounds. A method used by us previously [1, 2] for the preparation of pyridinium salts by the oxidation of N-methylated 1,4-dihydropyridines with hydrogen peroxide in the presence of perchloric acid was complicated in the indenopyridine series by the occurrence of side reactions, i.e., in addition to salt formation, cleavage of the dihydro-

Institute of Organic Synthesis, Academy of Sciences of the Latvian SSR, Riga 226006.

Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 1, pp. 88-90. January, 1986. Original article submitted December 3, 1984.

0009-3122/86/2201-0073$12.50