Some New Information on the Formation of Substituted 4-Amino-1-Substituted Phenyl-1*H*-Pyrazoles from β-Enaminones and Diazonium Tetrafluoroborates

Petr Šimůnek,[a]* Vladimír Macháček,[a] Markéta Svobodová,[a] and Aleš Růžička[b]

[a]University of Pardubice, Faculty of Chemical Technology, Institute of Organic Chemistry and Technology, Studentská 573, CZ 532 10 Pardubice, Czech Republic
[b]University of Pardubice, Faculty of Chemical Technology, Department of General and Inorganic Chemistry, Studentská 573, CZ 532 10 Pardubice, Czech Republic
*E-mail: petr.simunek@upce.cz

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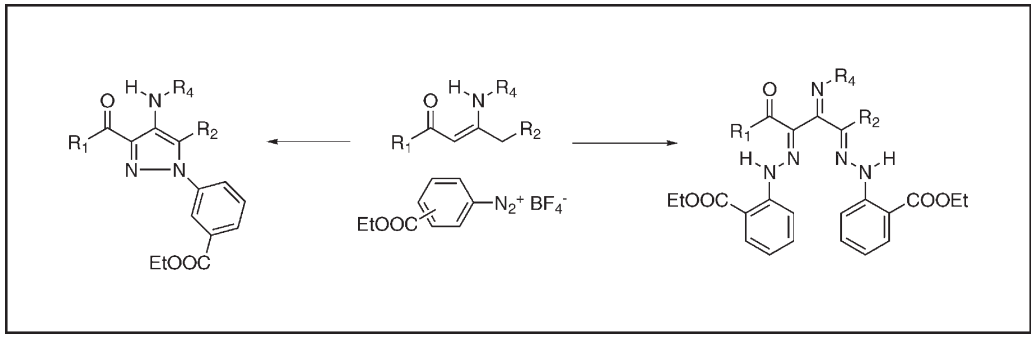

Upon reaction of 2-methyl-, 3-ethoxycarbonyl, and 4-ethoxycarbonylbenzenediazonium tetrafluoroborate with 1-cyclopropyl-3-phenylaminohex-2-en-1-one 3-cyclopropylcarbonyl-1-(substituted phenyl)-5-ethyl-4-phenylamino-1*H*-pyrazoles are formed. On the other hand, the reaction of 1-cyclopropyl-3-phenylaminohex-2-en-1-one and 5-methylaminohept-4-en-3-one with sterically more demanding 2-ethoxycarbonylbenzenediazonium tetrafluoroborate does not give the corresponding pyrazoles but the probable intermediates on the route to the pyrazoles: 1-cyclopropyl-3-phenyliminohexane-1,2,4-trione 2,4-bis(2-ethoxycarbonylphenylhydrazone) and 3-methyliminoheptane-2,4,5-trione 2,4-bis(2-ethoxycarbonylphenylhydrazone), respectively. All the compounds were identified on the basis of ^{1}H- and ^{13}C-NMR spectra. The structure of 1-cyclopropyl-3-phenyliminohexane-1,2,4-trione 2,4-bis(2-ethoxycarbonylphenylhydrazone) was confirmed by means of ^{15}N-NMR spectra and X-ray. The bis(2-ethoxycarbonylphenylhydrazones) were found to show atropoisomerism due to a hindered rotation around the bond between the carbons of imino group and the hydrazono group next to carbonyl. In the case of the crystalline cyclopropyl derivative, the unit cell was found out to contain two molecules of opposite chirality.

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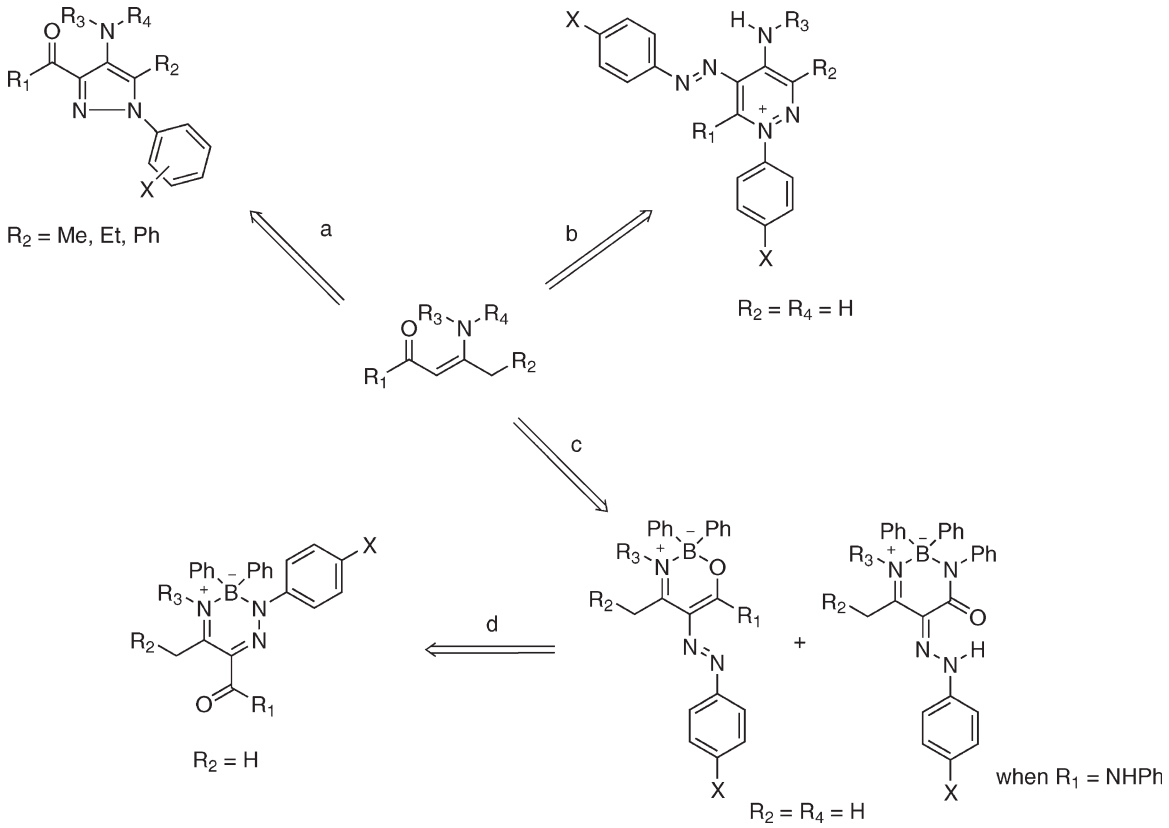
INTRODUCTION

A number of possibilities of synthetic utility of the reaction between β-enaminones and substituted diazonium salts is published [1]. Considering that the hydrolysis of the enamino group into corresponding carbonyl compounds during the azo coupling reaction is relatively easy, we have started to deal with the reaction of benzenediazonium salts with β-enaminones in nonaqueous media, where the enamino group remains intact during the course of the reaction. During the last several years, we have described a number of products of the reactions from the structural aspects (tautomerism, *E/Z* isomerism, dynamic behavior, hydrogen bonding …) both in a solution and in a crystalline state [2]. Besides, we have also established methods for synthesis of several types of heterocyclic systems such as pyridazinium salts [3], pyrazoles [4], and boron-containing heterocycles with O—B—N and N—B—N arrangement [5] (Scheme 1). The reaction procedures are simple, the reactions proceed under mild conditions and give products often not easily available by other methods. Drawback of our methods can be relatively low yields and a necessity of chromatographic separation of the products. The heterocyclic compounds obtained are, however, polysubstituted and then give a possibility of further synthetic transformations.

The mechanism of the pyrazole formation (reaction **a** in Scheme 1) is so far not quite clear. In the previous work [4(b)], the hypothesis was pronounced that the primarily formed product of the attack of diazonium salt at α-carbon of the enaminone undergoes an oxidative cyclization to form the corresponding pyrazole. The intermediate primary product **Int** was, in the case shown in Scheme 2, isolated and characterized [4(b)]. After the

Scheme 1



reaction was over, anisole was detected in the reaction mixture. This indicates the possibility that the second molecule of the diazonium salt could act as the oxidation agent. An excess of the diazonium salt is important for achieving the maximal yield of the pyrazole. Upon using the equimolar ratio of the reactants, the yield of the pyrazole was lower (63 *vs*. 26% for molar ratios 2:1 resp. 1:1 in the case of the reaction from Scheme 2) and unreacted starting enaminone was also isolated from the reaction mixture.

A clarification of the way how the pyrazoles are formed by the above-mentioned reaction can extend the use of the synthetic method, which is significant, owing to the importance of the pyrazoles. The work brings some new facts on this reaction.

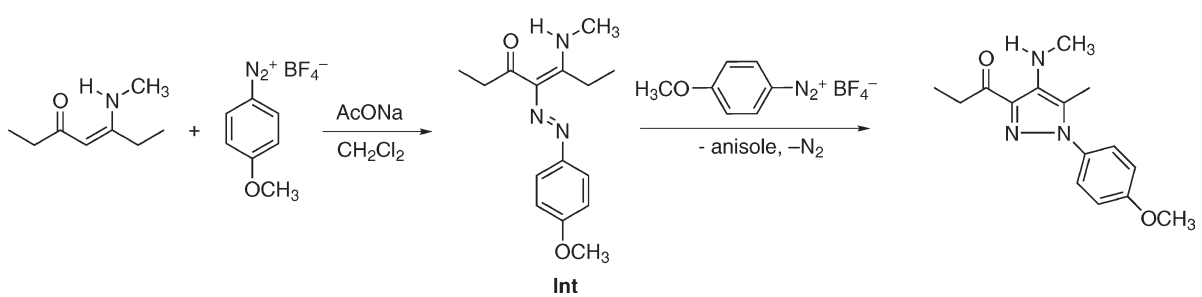
RESULTS AND DISCUSSION

To obtain additional information about the mechanism of the pyrazole formation, we have explored a steric effect of the substituents at diazonium salt on the reaction path.

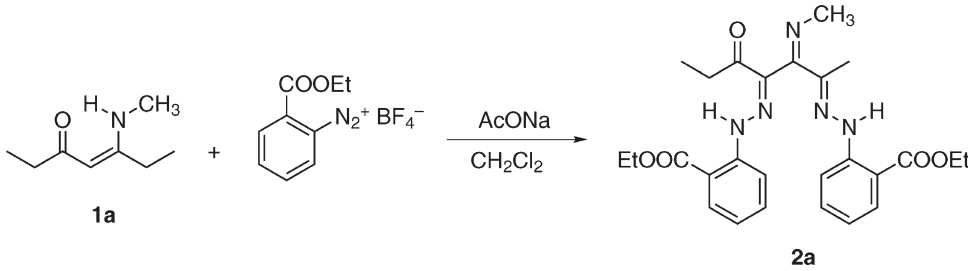
Upon reaction of the enaminone **1a** with 2-ethoxycarbonylbenzenediazonium tetrafluoroborate at molar ratio 1:2 under the same conditions as described for the pyrazole formation [4] the compound **2a**, identified on the basis of ^{1}H- and ^{13}C-NMR spectra, was formed (Scheme 3).

From the shape of the multiplets, belong to the methylene groups, the compound **2a** is obvious not to have a plane of symmetry (diastereotopic methylene groups). On account of the absence of any stereogenic centre in

Scheme 2



Scheme 3



1a **2a**

the molecule of **2a** the chirality must be the expression of steric factors (probably atropoisomerism) [6(a)]. Due to an oily consistence of the compound **2a**, it was not possible to confirm the structure by means of X-ray.

An analogous reaction of the enaminone **1b** with 2-ethoxycarbonylbenzenediazonium tetrafluoroborate gave the compound **2b**. ^{1}H- and ^{13}C-NMR data were consistent with the structure depicted in Scheme 4, which is similar to the compound **2a**. Chirality of the compound **2b**, as well as in the case of **2a**, was manifested by the presence of diastereotopic methylene groups. ^{15}N-NMR parameters (Scheme 4) confirmed the tautomeric form bis(hydrazono)imino [6(b)].

The structure of the compound **2b** was confirmed by means of X-ray diffraction (Fig. 1). In accordance with the character of ^{1}H-NMR spectrum, witnessing to an axial chirality of the compound **2b** and with the fact that the compound crystallizes in centric space group P-1 the compound **2b** forms racemic crystals having two molecules of opposite chirality in an unit cell (Fig. 2). The chirality is apparently caused by a hindered rotation along C7—C8 single bond (atropoisomerism), similarly as in the cases of binaphthyls. In every molecule, two intramolecular hydrogen bonds N—H···O having distances O4···H 1.964 a O1···H 2.023 Å, (see Fig. 1) are present. The molecule consists of two fragments connected with C7—C8 single bond, each of these fragments can be described by a plane defined by the part C=N—N (C7N3N1/C9N4N2) where the interplanar angle is 71.6(2)°. The double bond character was found for N3—C7 1.285(3), O1—C16 1.210(3), C8—N5 1.276(3), O3—C19 1.221(3), O4—C31 1.217(4), and N4—C9 1.288(3) Å connections where there is a significant shortening of C—N separation, when compared with standard double bond data (C—N 1.32 Å) found in the literature [7]. The supramolecular structure of **2b** is layered with π-π systems of phenyl rings connectivity (the distance of the planes of two coplanar benzene rings C10—C15 is 3.473 Å, their centroids have distance 3.983 Å) the neighboring entities are interconnected by a non-classical hydrogen bonding (C—H···O).

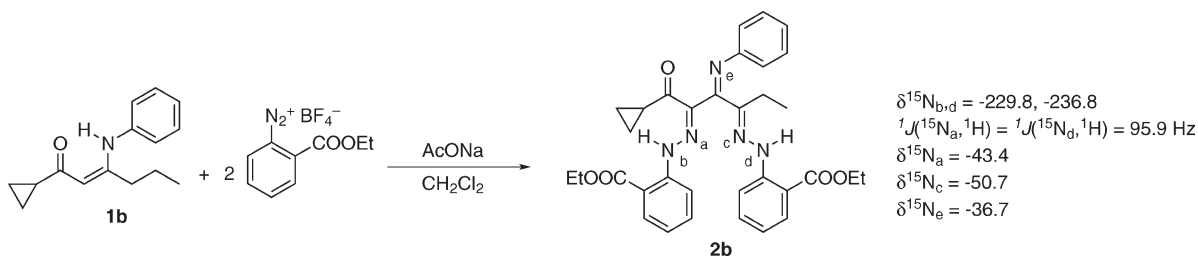
A series of proton NMR spectra of the compound **2b** in toluene-d_8 at various temperatures was measured (Fig. 3). The barrier to rotation is relatively high, even at 100°C the coalescence point was not achieved. That means that the energy barrier for mutual interconversion of the atropoisomers is higher than 150 kJ/mol [8].

The products **2a** and **2b** can be prepared also when using an equimolar ratios of the reactants but in this case the reaction mixture is contaminated with unreacted starting enaminone.

When 3- or 4-ethoxycarbonyl derivative was used instead of 2-ethoxycarbonyl derivative, the result of the reaction was different. Upon reaction of the enaminone **1b** with 3- or 4-ethoxycarbonylbenzenediazonium tetrafluoroborate, the corresponding 1-aryl-4-phenylamino-1*H*-pyrazoles **3a** or **3b** were isolated as the reaction products with yields around 60% (Scheme 5).

From this dependence of the structure of the product on the position of ethoxycarbonyl group, one can assume on the steric effect on the reaction course. For proving the hypothesis, a reaction of the enaminone **1b** with sterically less demanding 2-methylbenzenediazonium tetrafluoroborate was performed. This reaction gave the pyrazole **3c** with yield 54% (Scheme 6).

Scheme 4



1b **2b**

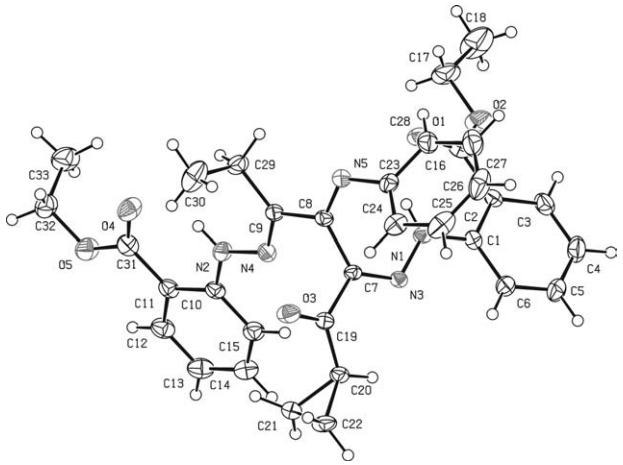


Figure 1. ORTEP view of the compound **2b**. Thermal ellipsoids are drawn at 50% probability level.

CONCLUSIONS

Additional information about the scope and limitations of the formation of pyrazoles by reaction of diazonium salts with enaminones has been obtained. From the observed dependence of the structure of the reaction products on the position of the substituent at the diazonium salt (group COOEt in the positions ortho, meta, or para) and volume of the group at ortho position (COOEt *vs*. CH_3), it can be stated that the steric effect of the substituent at the diazonium salt plays a certain role in the formation of pyrazole by reaction of diazonium tetrafluoroborate with β-enaminone. Upon increasing the steric demands of the ortho substituent, the products of double azo coupling **2a**,**b** were isolated and the pyrazole, in contrast to the reaction of sterically less demanding isomeric diazonium tetrafluoroborates, was not formed [9]. The mechanism of the formation of pyrazoles by means of the above-discussed reaction is still under examination.

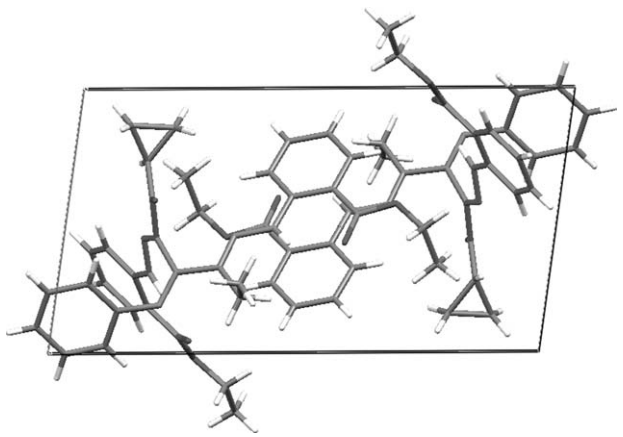


Figure 2. Packing diagram of the compound **2b** as viewed down the crystallographic *c* axis.

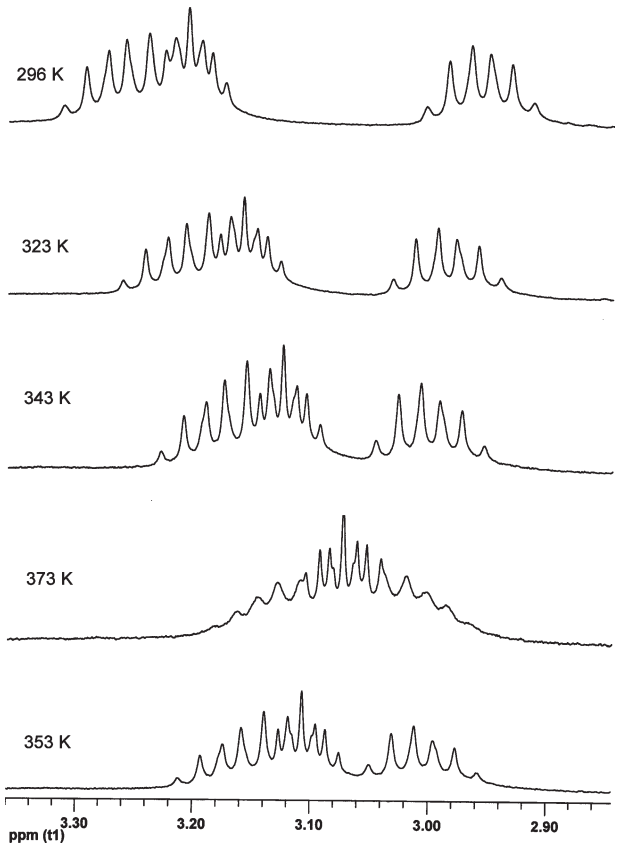


Figure 3. Temperature-dependent ^{1}H-NMR spectra of the diastereotopic CH_3—C$\mathbf{H_aH_b}$ arrangement in the compound **2b** in toluene-d_8.

EXPERIMENTAL

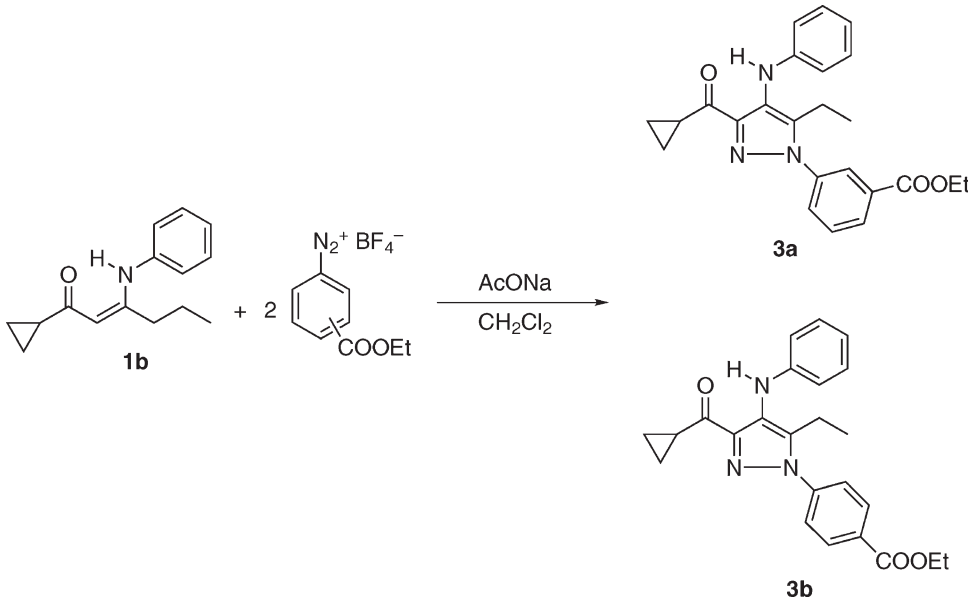
General procedures. The melting points were measured on a hot-stage microscope and were not corrected. The elemental analyses were carried out on an automatic analyzer FISONS EA 1108.

NMR measurements. NMR spectra were measured in $CDCl_3$ using the Bruker AVANCE 500 spectrometer operating at 500.13 MHz (^{1}H), 125.77 MHz (^{13}C) and 50.69 (^{15}N) and Bruker AVANCE III 400 operating at 400.13 MHz (^{1}H) and 100.62 MHz (^{13}C). TMS was used as an internal standard for ^{1}H ($\delta = 0.00$). The ^{13}C-NMR spectra were measured in a standard way and by means of the APT pulse sequence. The direction of the individual signals as well as those of the solvent is depicted by arrows ↓ or ↑. The ^{13}C-NMR spectra were calibrated on the middle signal of the solvent multiplet ($\delta =$ 77.0). The ^{15}N-NMR spectra were calibrated on an external neat nitromethane placed in a coaxial capillary (δ 0.0).

The proton signals were assigned with the help of H,H COSY pulse sequence.

The assignment of the individual carbon signals was carried out by means of 2D pulse sequences *gs* ^{1}H—^{13}C HMQC and

Scheme 5



multiplicity-edited $^1H—^{13}C$ HSQC allowing to distinguish between CH_2 and CH/CH_3 carbons (experiments performed with the CH coupling 145 Hz) and *gs* $^1H—^{13}C$ HMBC (experiment performed with the long-range CH coupling 10 Hz).

The ^{15}N chemical shifts were measured by indirect detection using 2D *gs* $^1H—^{15}N$ HMBC. The gradient ratios were 70:30:50.1. Experiments were performed with the NH one-bond coupling 90 Hz, and NH long-range coupling 5 Hz. All the pulse sequences were taken from Bruker software library.

Temperature-dependent NMR spectra of the compound **2b** were measured in toluene-d_8.

The concentration was 20 mg **2b**/0.6 mL of the solvent. The field homogeneity was maintained by checking the shimming quality after every temperature change.

X-ray crystallography. The X-ray data were collected on a Nonius Kappa CCD diffractometer fitted with MoK_α radiation (λ = 0.71073 Å) at 150(1) K. The absorption correction was performed using a Gaussian procedure [10], the structure was solved by direct methods (SIR92) [11] and full-matrix least-squares refinements on F^2 were carried out using the program SHELXL97 [12]. (For crystallographic data, see Table 1).

The compound has been assigned the CCDC reference number 705671. See http://www.rsc.org.suppdata/*** for crystallographic data in cif or another electronic format.

Material. Dichloromethane was used commercial (Fluka) stored over molecular sieves in the bottle equipped with Sure/Seal. Diazonium tetrafluoroborates were prepared by the literature method [2(c)] and dried *in vacuo*. Anhydrous sodium acetate was purchased commercially and was used without change.

1-Cyclopropylhexane-1,3-dione and enaminone **1a** were prepared according to the described procedures [4(a)].

1-Cyclopropyl-3-phenylaminohex-2-en-1-one (1b). A mixture of 1-cyclopropylhexane-1,3-dione (3.08 g, 0.02 mol), aniline (1.86 g, 0.02 mol), and catalytic amount of *p*-toluenesulfonic acid in 20 mL of toluene was refluxed for 4.5 h. The reaction water was removed azeotropically and the toluene distilled off was periodically replaced with the fresh one. After the reaction was over, the solvent was distilled off *in vacuo*, and the rest was subjected to a column chromatography (silica gel/CH_2Cl_2). Yield 3.43 g (75%). Boiling point 145–150°C/6 kPa, melting point 46–50°C.

^1H-NMR (500 MHz, $CDCl_3$) δ: 0.82–0.86 (m, 2H, cycloPr), 0.93 (t, 3H, J = 7.4, CH_3), 1.05–1.08 (m, 2H, cycloPr), 1.52–1.59 (m, 2H, CH_2), 1.77–1.82 (m, 1H, cycloPr), 2.33–2.36 (m, 2H, CH_2), 5.42 (s, 1H, =CH), 7.14–7.16 (m, 2H, CH_{ortho}), 7.22–7.25 (m, 1H, CH_{para}), 7.36–7.39 (m, 2H, CH_{meta}), 12.50 (brs, 1H, NH). ^{13}C-NMR (125 MHz, $CDCl_3$) δ: 9.2, 13.8, 20.3, 21.4, 33.8, 96.1, 125.0, 125.5, 129.0, 138.7, 163.5, 198.0.

Scheme 6

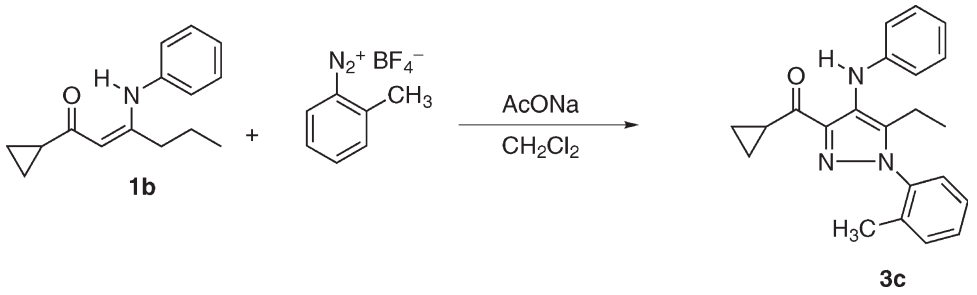


Table 1

Crystal data of the compound **2b**.

Formula	$C_{33}H_{35}N_5O_5$
Formula weight	581.66
Crystal system	Triclinic
Space group	P-1 (No. 2)
a (Å)	9.2420(6)
b (Å)	10.8120(5)
c (Å)	16.5300(9)
α (°)	99.128(5)
β (°)	95.157(6)
γ (°)	106.520(5)
U (Å^3)	1547.53(16)
Z	2
D_c (g·cm^{-3})	1.248
Temperature (K)	150
μ(MoKα) (mm^{-1})	0.086
F(000)	616
Crystal size (mm)	0.08 × 0.16 × 0.35
Radiation (Å)	MoKα 0.71073
Θ_{min}, Θ_{max} (°)	1.3, 27.5
Dataset	−12:11; −13:14; −21:21
Tot.	23,733
Uniq. data	6964
R(int)	0.094
Observed data [$I > 2.0\ \sigma(I)$]	4258
N_{ref}	6964
N_{par}	388
R	0.0757
wR^2	0.1710
S	1.19
$\Delta\rho_{min}$, $\Delta\rho_{max}$ (e/Å^3)	−0.33, 0.27

Anal. Calcd. for $C_{15}H_{19}NO$: C 78.56, H 8.35, N 6.11. Found: C 78.75, H 8.23, N 6.26.

3-Methyliminoheptane-2,4,5-trione, 2,4-bis(2-ethoxycarbonylphenylhydrazone) 2a. Anhydrous sodium acetate (1.85 g, 22.5 mmol) was added to a solution of the enaminone **1a** (0.53 g, 3.75 mmol) in CH_2Cl_2 (75 mL) under stirring followed by 2-ethoxycarbonylbenzenediazonium tetrafluoroborate (1.98 g, 7.5 mmol). The mixture was stirred under inert at laboratory temperature for 140 min (negative test for the presence of the diazonium salt by means of 4,5-dihydroxynaphthalene-2,7-disulfonic acid). The mixture was then filtered by suction, the filter cake was washed with dichloromethane and the filtrate was evaporated *in vacuo*. The residue was subjected to a column chromatography (silica gel/CH_2Cl_2 changed to CH_2Cl_2-EtOAc 4:1 v/v during the separation). Obtained 0.97 g (52%) of a red oil.

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 1.24 (t, 3H, J = 7.4, $CH_2\mathbf{CH_3}$), 1.30 (t, 3H, J = 7.1, $OCH_2\mathbf{CH_3}$), 1.36 (t, 3H, J = 7.1, $OCH_2\mathbf{CH_3}$), 2.31 (s, 3H, CH_3), 3.10 (dq, 2H, J = 12.5, 7.4, $\mathbf{CH_2}CH_3$), 3.28 (s, 3H, NCH_3), 4.27 (dq, 2H, J = 7.1, 1.4, $O\mathbf{CH_2}CH_3$), 4.32 (dq, 2H, J = 7.1, 1.0, $O\mathbf{CH_2}CH_3$), 6.75 (ddd, 1H, J = 8.2, 7.0, 1.4 Ar1), 6.92 (ddd, 1H, J = 8.2, 7.3, 1.1 Ar2), 7.28–7.33 (m, 1H, Ar1), 7.35–7.37 (m, 1H, Ar1), 7.49–7.53 (m, 1H, Ar2), 7.85–7.88 (m, 2H, Ar1+Ar2), 7.91 (dd, 1H, J = 8.0, 1.4, Ar2), 11.14 (s, 1H, NH), 11.26 (s, 1H, NH). ^{13}C-NMR (100 MHz, $CDCl_3$) δ: 8.7 ($\mathbf{CH_3}CH_2$), 10.0 (CH_3),14.15, 14.25 (2 × $\mathbf{CH_3}CH_2O$), 30.2 ($CH_3\mathbf{CH_2}$), 41.4 (NCH_3), 60.9, 61.1 (2 × $\mathbf{CH_2}CH_3$), 110.8 (**C**—COOEt), 112.5 (**C**—COOEt), 113.6 (CH Ar2), 114.1 (CH Ar1), 118.7 (CH Ar1), 120.4 (CH Ar2), 130.7, 131.0 (2 × CH Ar1 + Ar2), 134.3, 134.4 (2 × CH Ar1 + Ar2), 142.3 (C=N—NH), 144.3 (C=N—NH), 145.6 (C—NH—N=), 146.7 (C—NH—N=), 163.2 (**C**=N—CH_3), 167.6 (**C**OOEt), 168.3 (**C**OOEt), 198.5 (C=O).

Due to the oily consistency of the compound and to its lability, it was not possible to prepare the sample in purity sufficient to elemental analysis.

1-Cyclopropyl-3-phenyliminohexane-1,2,4-trione 2,4-bis(2-ethoxycarbonylphenylhydrazone) 2b. Anhydrous sodium acetate (1.81 g, 22.05 mmol) was added to a solution of the enaminone **1b** (0.84 g, 3.67 mmol) in CH_2Cl_2 (20 mL) under stirring followed by 2-ethoxycarbonylbenzenediazonium tetrafluoroborate (1.94 g, 7.35 mmol). The mixture was stirred at laboratory temperature 24 h, then filtered by suction, the filter cake was washed with dichloromethane, and the filtrate was evaporated *in vacuo*. The residue was subjected to a column chromatography (silica gel/CH_2Cl_2 changed to EtOAc during the separation).

A yellow crystalline compound was obtained. Yield (1.29 g) 60%. Recrystallization from ethanol, mp 158–161°C.

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.87–0.92 (m, 1H, cycloPr), 0.97–1.06 (m, 2H, cycloPr), 1.12–1.17 (m, 1H, cycloPr), 1.35–1.41 (m, 9H, 3 × CH_3), 2.88 (dq, J = 15.0, 7.5, 1H, $C\mathbf{H_a}H_b$—CH_3), 3.05–3.14 (m, 2H, $CH_a\mathbf{H_b}$—CH_3 + CH cycloPr), 4.31–4.39 (m, 4H, 2 × OCH_2), 6.80 (t, J = 7.5, 1H, Ar1), 6.89 (t, J = 7.6, 1H, Ar2), 6.91–6.93 (m, 2H, *N*Ph, ortho), 6.99–7.02 (m, 1H, *N*Ph, para), 7.15–7.18 (m, 2H, *N*Ph, meta), 7.33 (t, J = 7.8, 1H, Ar1), 7.43 (t, J = 7.8, 1H, Ar2), 7.52 (d, J = 8.3, 1H, Ar1), 7.72 (d, J = 8.4, 1H, Ar2), 7.90–7.92 (m, 2H, Ar1 + Ar2), 11.52 (br s, 2H, NH). ^{13}C-NMR (APT, 125 MHz, $CDCl_3$ ↓) δ: 9.1↑ ($\mathbf{CH_3}CH_2$), 10.7↓, 10.8↓ (2 × CH_2, cyclopropyl), 14.20↑, 14.23↑ (2 × $\mathbf{CH_3}CH_2O$), 15.3↑ (CH, cyclopropyl), 17.4↓ ($CH_3\mathbf{CH_2}$), 60.9↓, 61.1↓ (2 × $CH_3\mathbf{CH_2}O$), 111.1↓, 112.3↓ (2 × **C**—COOEt), 114.1↑ (CH, Ar1), 114.3↑ (CH, Ar2),119.0↑ (CH, ortho), 119.04↑ (CH, Ar1), 120.1↑ (CH, Ar2), 124.6↑ (CH, para), 128.3↑ (CH, meta), 130.65↑, 130.72↑ (2 × CH, Ar1 + Ar2), 134.2↑ (CH Ar2), 134.3↑ (CH, Ar1), 143.8↓ (C=N—NH), 145.6↓, 146.5↓ (2 × C—NH—N=), 148.6↓ (C=N—NH), 150.0↓ (C_q—N=), 161.1↓ (**C**=N—Ph), 167.5↓, 168.3↓ (2 × **C**OOEt), 197.8↓ (C=O).

Anal. Calcd. for $C_{33}H_{35}N_5O_5$: C 68.14, H 6.06, N 12.04. Found: C 68.29, H 6.31, N 12.00.

3-Cyclopropylcarbonyl-1-(3-ethoxycarbonylphenyl)-5-ethyl-4-phenylamino-1*H*-pyrazole (3a). The compound was prepared from 3-ethoxycarbonylbenzenediazonium tetrafluoroborate and enaminone **1b** adopting the same procedure as in the case of **2b**. Reaction time 22 h. Chromatography silica gel/*n*-hexane-EtOAc 3:1 (v/v) Yield 68%, oil.

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.87 (t, 3H, J = 7.0, CH_3), 0.97–1.00 (m, 2H, cycloPr), 1.17–1.20 (m, 2H, cycloPr), 1.42 (t, 3H, J = 7.0, CH_3), 2.65 (q, 2H, J = 7.5, CH_2), 3.03–3.08 (m, 1H, cycloPr), 4.43 (q, 2H, J = 7.5, CH_2O), 6.82–6.86 (m, 3H), 6.88 (brs, 1H), 7.21–7.24 (m, 2H), 7.62 (t, 1H, J = 8.0), 7.76 (ddd, 1H, J = 1.2, 2.5, 8.0), 8.16 (dt, 1H, J = 1.2, 8.0), 8.26 (t, 1H, J = 1.7). ^{13}C-NMR (APT, 125 MHz, $CDCl_3$ ↓) δ: 11.6 ↓, 11.7 ↑, 14.3 ↑, 17.3 ↑, 18.9 ↓, 61.5 ↓, 115.7 ↑, 119.9 ↑, 125.7 ↓, 126.3 ↑, 129.1 ↑, 129.5 ↑, 129.6 ↑, 131.9 ↓, 137.5 ↓, 140.0 ↓, 143.0 ↓, 144.8 ↓, 165.4 ↓, 198.1 ↓.

Anal. Calcd. for $C_{24}H_{25}N_3O_3$: C 71.44, H 6.25, N 10.41. Found: C 71.61, H 6.30, N 10.32.

3-Cyclopropylcarbonyl-1-(4-ethoxycarbonylphenyl)-5-ethyl-4-phenylamino-1*H*-pyrazole (3b). The compound was prepared from 4-ethoxycarbonylbenzenediazonium tetrafluoroborate and enaminone **1b** adopting the same procedure as in the case of **2b**. Reaction time 22 h. Chromatography silica gel/*n*-hexane-EtOAc 3:1 (v/v) Yield 60%, oil.

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.88 (t, 3H, J = 7.5, CH_3), 0.98–1.03 (m, 2H, cycloPr), 1.17–1.22 (m, 2H, cycloPr), 1.44 (t, 3H, J = 7.0, CH_3), 2.68 (q, 2H, J = 7.5, CH_2), 3.03–3.10 (m, 1H, cycloPr), 4.43 (q, 2H, J = 7.5, OCH_2), 6.80–6.88 (m, 4H), 7.21–7.25 (m, 2H), 7.64–7.66 (m, 2H), 8.20–8.22 (m, 2H). ^{13}C-NMR (APT, 125 MHz, $CDCl_3$ ↓) δ: 11.6 ↓, 11.7↑, 14.3 ↑, 17.3 ↑, 19.1 ↓, 61.4 ↓, 115.7 ↑, 120.0 ↑, 124.7 ↑, 126.1 ↓, 129.1 ↑, 130.3 ↓, 130.7 ↑, 137.3 ↓, 143.1 ↓, 143.3 ↓, 144.7 ↓, 165.6 ↓, 198.1 ↓.

Anal. Calcd. for $C_{24}H_{25}N_3O_3$: C 71.44, H 6.25, N 10.41. Found: C 71.61, H 6.54, N 10.33.

3-Cyclopropylcarbonyl-5-ethyl-1-(2-methylphenyl)-4-phenylamino-1*H*-pyrazole (3c). The compound was prepared from 2-methylbenzenediazonium tetrafluoroborate and enaminone **1b** adopting the same procedure as in the case of **2b**. Reaction time 135 min. Chromatography silica gel/*n*-hexane-EtOAc 3:1 (v/v) Yield 54%, oil.

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.81 (t, 3H, J = 7.5, CH_3), 0.94–0.98 (m, 2H, cycloPr), 1.16–1.19 (m, 2H, cycloPr), 2.16 (s, 3H, CH_3), 2.41 (q 2H, J = 7.5, CH_2), 2.98–3.04 (m, 1H, cycloPr), 6.78–6.86 (m, 4H, Ar + NH), 7.19–7.23 (m, 2H, Ar), 7.34–7.43 (m, 4H, Ar). ^{13}C-NMR (APT, 100 MHz, $CDCl_3$) δ: 11.5 ↓, 11.6 ↑, 17.27 ↑, 17.29 ↑, 18.6 ↓, 115.7 ↑, 119.8 ↑, 124.7 ↓, 126.8 ↑, 127.6 ↑, 129.0 ↑, 129.7 ↑, 131.2 ↑, 135.9 ↓, 138.3 ↓, 138.5 ↓, 142.7 ↓, 145.1 ↓, 198.2 ↓.

Anal. Calcd. for $C_{22}H_{23}N_3O$: C 76.49, H 6.71, N 12.16. Found: C 76.32, H 6.97, N 11.92.

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