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MONONUCLEAR HETEROCYCLIC REARRANGEMENTS—VI
CONVERSION OF 1,2,4-OXADIAZOLES INTO IMIDAZOLES

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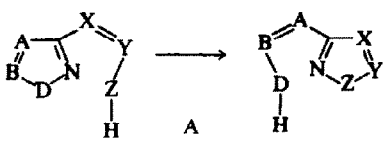
Abstract—The rearrangement of N - (1,2,4 - oxadiazol - 3 - yl)β - enamino ketones **3 a-d** and N-(1,2,4 - oxadiazol - 3 - yl) β - enaminoesters **3 e-h** into 2 - acylamino - imidazolyl derivatives **9 a-h** by the action of sodium ethoxide in N,N-dimethylformamide is the first example of a mononuclear heterocyclic rearrangement involving a nucleophilic carbon. Compounds prepared by condensation of 3 - amino - 1,2,4 - oxadiazoles **1 a-b** with β - dicarbonyl compounds **2 a-d**, show spectroscopic properties in agreement with cis-chelated structures **4**. By condensation between **1 a-b** and benzoylacetic ester **2 d**, N - (1,2,4 - oxadiazol - 3 - yl)β - ketoamides **6 a-b** have been obtained as secondary products. In solution, these compounds are in equilibrium with the corresponding tautomers **7 a-b** .

In the mononuclear heterocyclic rearrangements so far studied,[1-3] and generally represented by Schema A proposed by Katritzky and coworkers,[1] D is always an oxygen atom while Z is either an oxygen or a nitrogen, provided that Z must be electron-rich.



A

In order to investigate the influence of the ABD and XYZ structures on the rearrangements, we synthesized some N - (1,2,4 - oxadiazol - 3 - yl)β - enaminoketones **3 a-d**† and some N - (1,2,4 - oxadiazol - 3 - yl)β - enaminoesters **3 e-h**. Such compounds, having a carbon atom with high electronic density (and therefore potentially with nucleophilic properties‡), might give rise to rearrangements analogous to those so far studied, where the Z atom is carbon.

The synthesis of the starting materials for this investigation has been realized (see experimental) by condensation of 3-amino-1,2,4-oxadiazoles **1 a-b** with β-dicarbonyl compounds **2 a-d**.

β-Enaminoketones **3 a-d** and β-enaminoesters **3 e** and **3 g** are the only products of the reaction between **1 a-b** and **2 a-c**. From condensation of **1 a-b** with **2 d**, β-ketoamides **6 a-b** have been obtained as by-products, together with enaminoesters **3 f** and **3 h**. Structures **3 b** and **3 d** instead of the isomeric ones **3**, (where R_1=C_6H_5 and R_2=CH_3), have been assigned on the basis of the NMR spectra. In fact, while the aromatic protons of enaminoester **3 f** appear as a singlet at 7·34 δ, the protons ortho in the phenyl group of the condensation products between **1 a-b** and benzoylacetone **2 d** appear as a complex signal centered at ca 7·80 δ (in **3d** the signals of such protons are superimposed to those of the protons *ortho* in the phenyl group bound to the 1,2,4-oxadiazolyl heterocycle). This observation indicates that in these compounds carbonyl magnetic anisotropy occurs in agreement with the proposed structures. The examination of the obtained results shows that the extranuclear nitrogen of **1 a-b** always attacks (exclusively or preferably) the carbonyl group foreseen as the more electrophilic one in the β-dicarbonyl compounds.

As to enaminoketones **3 a-d** and enaminoesters **3 e-h**, the existence of geometric chelated and isomeric forms can be expected a priori. Spectroscopic data (UV, IR,§ and NMR) are reported in Tables 1 and 2. The NMR signals assignment offers no difficulty.

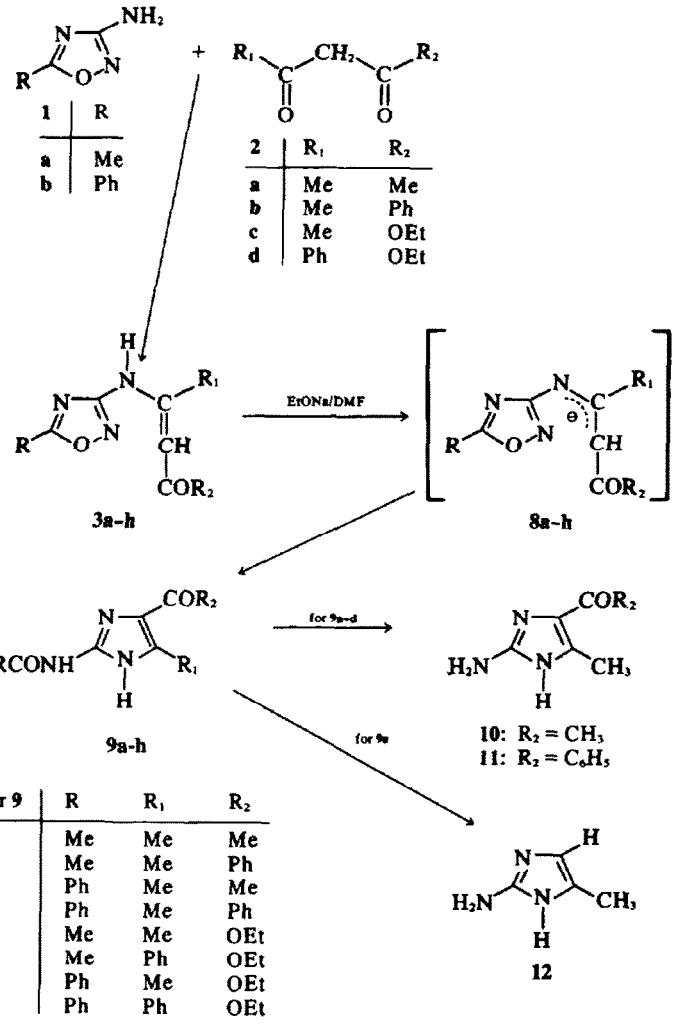
The NH protons resonance occurs far downfield in $CDCl_3$ and only a slight solvent effect is observed in DMSO, thus indicating that these protons are involved in a strong chelation which is not destroyed by association with DMSO. Moreover, the existence of an allyl coupling between R_1 (CH_3) and the vinyl proton reveals a high order of the bond CH_3—C=CH—[5] and therefore the tautomeric forms **4** prevail over the **5** ones.

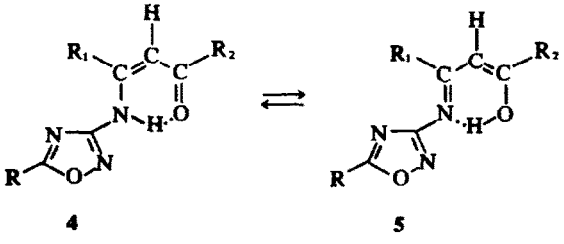
As indicated by spectral data (IR and NMR, see Experimental) the pure β-ketoamides **6 a-b** exist

†A preliminary account on this work has appeared in *Tetrahedron Letters*, 4959 (1972).

‡MO Calculation on enaminoketones from aliphatic amines showed that an appreciable negative charge is localized on the central carbon of the enamine chain.[4]

§The absorptions of 1,2,4-oxadiazolyl nucleus and β-enaminoketone and β-enaminoester system are superimposed, and IR spectra of **3 a-b** are not easily interpreted in the range 1500–1700 cm^{-1}. Therefore, in Table 1 the absorptions pertinent to this zone are reported without assignment.

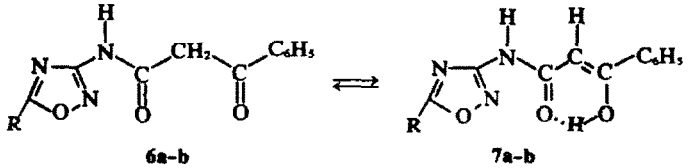




4 5

only in the solid state, while in solution they are in equilibrium with their cis-chelated enol tautomers **7 a-b**.

In fact, in the NMR spectra all the signals due to the protons of **6 a-b** and **7 a-b** are present. By integrating the signals of the vinyl and methylene protons, it was possible to calculate the percent of the keto form, which increases going from $CDCl_3$ to DMSO. Such a result shows that the enol form is



6a-b **7a-b**

a: R = CH_3
b: R = C_6H_5

less polar than the keto one, and this is in agreement only with an intramolecular hydrogen bond in the enol form.[6] Furthermore, when the NMR spectra in DMSO are recorded after adding D_2O, the resonance of the =CH—, CH_2, OH and NH protons disappear, thus indicating that forms **6a-b** and **7a-b** are in equilibrium.[6]

The existence of tautomers **6 a-b** and **7 a-b** in solution is shown also by the IR spectra in $CHCl_3$. In fact, absorption at ca 1700 cm^{-1}, 1670 cm^{-1}, and 1600 cm^{-1} may be attributed to keto, amido, and chelated keto carbonyls respectively.[7] The stretchings of the latter carbonyl are not present in the spectra recorded in Nujol, thus indicating that only tautomers **6 a-b** exist in the solid state. The expected changes are found also in the zone of the NH and OH stretchings on passing from the spectra recorded in solution to those in the solid state. Also the UV spectra, recorded in the series of solvents, water, methanol, ethanol, and cyclohexane (see Experimental), show a typical trend for the equilibrium **6 a-b**⇌**7 a-b** as a function of solvent.[8]

Rearrangement of (1,2,4 *a oxadiazolyl)enamino-ketones and enamino-esters* **3 a-h** *into* 2-*acylaminoimidazole derivatives* **9 a-h**.

Experimental conditions (such as heating, treatment with KOH or sodium ethoxide in ethanol), which proved to be suitable when the side-chain atom involved in the new cycle closure was either an oxygen or a nitrogen, have been chosen to ascertain the above hypothesis about a rearrangement of enaminoketones and enaminoesters **3 a-h** into imidazolyl derivatives **9 a-h**. All attempts under these conditions failed and the aim has been reached by using sodium ethoxide in N,N-dimethylformamide, whose ability in increasing the reactivity of anionic reagents is well known, owing to its characteristics of dipolar and aprotic solvent. In fact, by keeping equimolar amounts of **3 a-h** and sodium ethoxide in DMF 3 h at 110°C imidazolyl derivatives **9 a-h** have been obtained in very good yields. The structures of these compounds have been determined both by analytical methods (UV, IR, and NMR, Table 1 and 2) and chemically, as for **9 a-d** and **9 e**. In fact, the latter compound has been degraded to 2-amino-4(5)-methylimidazole **12**, whose picrate was identical with an authentic sample. The acid hydrolysis of **9 a-d** yielded (together with acetic or benzoic acid) 2 - amino - imidazoles **10*** and **11**,† whose chemical and physical characteristics are equal to those reported in the literature.[10]

The results obtained in the present work indicate that the Z atom (Schema A) may also be different from oxygen or nitrogen, when it has a high electronic density. In our case (nucleophilic carbon), the use of a proper solvent, increasing the nucleophilic reactivity, was necessary in agreement with the forecast made on the basis of the electronic densities calculated by the MO method on similar systems. The reaction we studied, which seems to be of general interest, may be well applied to the synthesis of 2-acylamino-imidazole differently substituted in the position 4 and 5.

EXPERIMENTAL

M.ps points were determined by a Kofler hotplate apparatus and are uncorrected. Infrared spectra were recorded on a Perkin-Elmer Infracord 137 spectrophotometer. UV spectra were determined on a Beckman DB automatic spectrophotometer. NMR spectra (60 MHz) were obtained by a Jeol-C-60 H spectrometer, with TMS as internal standard.

Preparation of N - (1,2,4 - oxadiazol - 3 - yl)β - enaminoketones **3 a-d** *and N - (1,2,4 - oxadiazol - 3 - yl)β - enaminoesters* **3 e** and **3 g**, *general procedure.* Equimolar amounts of 3 - amino - 5 - methyl (phenyl) - 1,2,4 - oxadiazole **1 a-b** and acetylacetone, benzoylacetone, and ethyl acetoacetate **2 a-c** were heated (8, 14, and 50 h, respectively) in anhydrous toluene (100 ml), removing azeotropically the reaction water and using *p*-toluensolfonic acid as a catalyst. Solvent was removed at reduced pressure and the crude residue was purified first from ligroin **3 b-d** or light petroleum ether **3a**, **3e**, and **3g**, and then from the appropriate solvent (Table 1). Yield: 60–80%.

Preparation of 5 - methyl - N - (1,2,4 - oxadiazol - 3 - yl)β - enaminoester **3f** *and 5 - methyl - N - (1,2,4 - oxadiazol - 3 - yl)β - ketoamide* **6a**. 3 - Amino - 5 - methyl - 1,2,4 - oxadiazole **1a** (5 g) and ethyl benzoylacetate (11 ml) in dry toluene, with a catalytic amount of *p*-toluensulfonic acid are refluxed 100 h, removing azeotropically the reaction water. Then the solvent is evaporated at reduced pressure and the residue oil is repeatedly extracted with boiling petroleum ether. On cooling the ethereal extracts, **3 f** is obtained (5 g, physical data in Table 1 and 2). By adding benzene (50 ml) to the residue insoluble in petroleum ether, **6 a** separates slowly, (1·5 g, 12%), m.p. 176°C after recrystallization from ethanol. UV (water): 310, 280, 245, 221 nm (log ε: 3·20, 3·43, 4·16, 3·93); UV (methanol): 302, 262, 238 nm (log ε: 4·01, 3·69, 4·07); UV (ethanol): 302, 262, 238 nm (log ε: 4·06, 3·72, 4·04) UV (cyclohexane): 306, 258, 235 nm (log ε: 4·12, 3·42, 3·67). IR (nujol): 3215, 3165 cm^{-1} (NH), 1698 cm^{-1} (C=O keto), 1684 cm^{-1} (C=O amido); IR ($CHCl_3$): 3333 cm^{-1}, 3175 cm^{-1} (NH, OH), 1701 cm^{-1} (C=O keto), 1669 cm^{-1} (C=O amido), 1600 cm^{-1} (C=O chelated); NMR ($CDCl_3$, saturated solution, $7·4 \times 10^{-2}$M): 2·52δ (s, 3H,keto), 2·60 δ (s, 3H, enol), 4·26 δ(s,2H,keto), 6·36δ(s, 1H, enol), 7·30–8·05 δ (m,5H,keto and enol), 8·75 δ(s,1H,NH,enol), 9·98 δ (s broad, 1H,NH, keto), 13·88 δ (s,1H,OH chelated enol); the equilibrium con-

*A pure sample of **10** has also been obtained by coupling the 4(5) - methyl - 5(4) - acetyl - imidazole **13**[11] with phenyldiazonium chloride and by reducing with hydrogen and Pd/C the corresponding 2-phenylazo - 4(5) - methyl - 5(4) - acetyl - imidazole **14**.

†Grinsteins *et al*[10] assign the structure of 2 - amino - 4(5) - acetyl - 5(4) - phenyl - imidazole, as an alternative to structure **11**, to the product obtained from reaction of cyanamide with 1 - benzoyl - 1 - aminoacetone hydrochloride. On the basis of the results of the present work, structure **11** is the correct one.

Table 1. Characterization data of N-(1,2,4-oxadiazol-3-yl)β-enaminoketones (3 a-d)[a], N-(1,2,4-oxadiazol-3-yl)β-enaminoesters (3 e-h)[a] and 2-acylamino-imidazolyl derivatives (9 a-h)[a].

	Recryst from[b]	M.p. (°C)	Formula	Analysis C	Found H	(Required) N	Ultraviolet[c] λ_{max}, nm (log ε)	Infrared[d]
3a	B	50	$C_8H_{11}N_3O_2$	53·32 (53·03)	5·74 (6·12)	23·28 (23·19)	305 (4·28)	1656, 1639, 1590, 1587
3b	A	125	$C_{13}H_{13}N_3O_2$	64·11 (64·18)	5·41 (5·39)	17·23 (17·28)	336,250 (4·38, 3·88)	1625, 1613, 1587, 1553
3c	A	112	$C_{13}H_{13}N_3O_2$	64·39 (64·18)	5·13 (5·39)	17·14 (17·28)	307, 253*, 246 (4·84, 4·16, 4·20)	1631, 1605, 1587, 1560
3d	A	154	$C_{18}H_{15}N_3O_2$	70·67 (70·80)	4·79 (4·95)	13·83 (13·76)	338, 251 (4·44, 4·38)	1634, 1621, 1608, 1582, 1546
3e	B	63	$C_9H_{13}N_3O_3$	51·28 (51·17)	6·37 (6·20)	19·96 (19·90)	281 (4·37)	1661, 1639, 1592, 1562
3f	B	69	$C_{14}H_{15}N_3O_3$	61·65 (61·53)	5·66 (5·53)	15·40 (15·38)	289 (4·38)	1664, 1637, 1595, 1562
3g	A	110	$C_{14}H_{15}N_3O_3$	61·78 (61·53)	5·68 (5·53)	15·44 (15·38)	276, 252 (4·50, 4·30)	1661, 1639, 1613, 1592, 1562, 1550
3h	A	135	$C_{19}H_{17}N_3O_3$	68·37 (68·05)	5·17 (5·11)	12·36 (12·53)	278–282, 248 (4·36, 4·41)	1664, 1621, 1587, 1565, 1550
9a	A	233	$C_8H_{11}N_3O_2$	52·90 (53·03)	6·22 (6·12)	23·23 (23·19)	284, 241 (4·12, 3·94)	3247, 3125 (N–H) 1686, 1645 (C=O)
9b	C	170	$C_{13}H_{13}N_3O_2$	64·34 (64·18)	5·46 (5·39)	17·45 (17·28)	308, 244 (4·08, 4·19)	3226 (N–H) 1681, 1639 (C=O)
9c	D	221	$C_{13}H_{13}N_3O_2$	64·20 (64·18)	5·54 (5·39)	17·49 (17·28)	292, 223 (4·19, 4·08)	3333, 3185 (N–H) 1656, 1613 (C=O)
9d	D	173	$C_{18}H_{15}N_3O_2$	71·01 (70·80)	5·17 (4·95)	13·77 (13·76)	311, 280*, 245*, 226 (4·20, 4·09, 4·13, 4·23)	3205, 3106 (N–H) 1653, 1637 (C=O)
9e	A	265	$C_9H_{13}N_3O_3$	51·27 (51·17)	6·40 (6·20)	19·83 (19·90)	260, 245 (4·14, 4·06)	3226, 3077 (N–H) 1712, 1667 (C=O)
9f	A	155	$C_{14}H_{15}N_3O_3$	61·79 (61·53)	5·78 (5·53)	15·32 (15·38)	280, 238 (4·08, 4·33)	3333, 3247 (N–H) 1692, 1681 (C=O)
9g	D	170	$C_{14}H_{15}N_3O_3$	61·72 (61·53)	5·47 (5·53)	15·33 (15·38)	276, 260*, 227 (4·18, 4·13, 4·07)	3333, 3145 (N–H) 1701, 1661 (C=O)
9h	A	145	$C_{19}H_{17}N_3O_3$	68·55 (68·05)	5·13 (5·11)	12·69 (12·53)	279, 220 (4·32, 4·31)	3333, 3226 (N–H) 1667 (C=O)

[a] Colourless crystals; [b] A = ethanol, B = petroleum ether, C = benzene, D = ethanol-water 1 : 1; [c] Ethanol; [d] Nujol; * = shoulder.

stants have been determined by integrating the vinyl and methylene protons at 6·36 δ and 4·26 δ; the neat samples have been integrated three times and the average value reported. K = enol/keto = 2x vinyl proton area/methylene protons area = 0·66; NMR (DMSO, $7·5 \times 10^{-2}$ M): 4·21 δ (s,2H,keto), 6·15δ(s,1H,enol); K = 0·25; NMR (DMSO, 14×10^{-2}M): 4·24δ (s,2H,keto), 6·18 δ(s,1H,enol); K = 0·35. (Found: C, 58·63; H, 4·63; N, 17·12. $C_{12}H_{11}N_3O_3$ requires: C, 58·77; H, 4·52; N, 17·14%).

Preparation of 5 - *phenyl* - *N* - (1,2,4 - *oxadiazol* - 3 - *yl*)β - *enaminoester* **3 h** *and* 5 - *phenyl* - *N* - (1,2,4 - *oxadiazol* - 3 - *yl*)β - *ketoamide* **6 b**. 3 - amino - 5 - phenyl - 1,2,4 - oxadiazole **1 b** (5 g) in dry toluene (100 ml) and ethyl benzoylacetate (8 ml) with catalytic amounts of *p*-toluensulfonic acid, were refluxed 80 h, removing azeotropically the reaction water. After keeping 5 days at room temperature, **6 b** was obtained (0·8 g, 8·5%), mp 162°C, after repeated crystallization from ethanol. After removing **6 b** by suction filtration and solvent by evaporation at reduced pressure, the residue is treated with boiling ethanol, from which **3 h** separates (5 g, 48%, physical data in Table 1 and 2). The physical data of **6 b** are as follows: UV (water): 310, 245, 214 nm (log ε: 3·34, 4·44, 4·09); UV (methanol): 306, 280–290, 240 nm (log ε: 4·06, 4·02, 4·40): UV (ethanol): 305, 280–286, 241 nm (log ε: 4·15, 4·12, 4·42); UV (cyclohexane): 308, 269, 241 nm (log ε: 4·25, 4·00, 4·28): IR (Nujol): 3175,3125 cm^{-1} (NH); 1698 cm^{-1} (C=O keto), 1675 cm^{-1} (C=O amido); IR ($CHCl_3$): 3333, 3185 cm^{-1} (NH, OH); 1706 cm^{-1} (C=O keto), 1667 cm^{-1} (C=O amido), 1613 cm^{-1} (C=O chelated); NMR ($CDCl_3$, saturated solution, $6·5 \times 10^{-2}$ M): 4·36 δ (s,2H,keto), 6·45δ(s,1H,enol), 7·40–8·20δ(m,10H, keto and enol), 8·95 δ (s, broad, NH, enol), 10·20 δ (s, broad, 1H, keto); K = 0·53; NMR (DMSO, $12·5 \times 10^{-2}$ M): 4·30 δ (s,2H,keto), 6·22 δ(s,1H,enol); K = 0·28. (Found: C, 66·65; H, 4·37; N, 13·69. $C_{17}H_{13}N_3O_3$ requires: C, 66·44; H, 4·26; N, 13·68%).

Rearrangements of **3 a-h** *into* **9 a-h**, *general procedure.* **3 a-h** (0·01 moles) and sodium ethoxide (0·01 moles) were mixed in dry N,N-dimethylformamide (50 ml) and heated 2·5–3 h at 110°C. At the end of the reaction, the solvent is removed under vacuum and the residue is dissolved in the least amount of water, containing few milliliters of 10% NaOH. The solution is neutralized with acetic acid and the crude product thus obtained is crystallyzed from the proper solvent (see Table 1). Yield: 60–80%.

Acid hydrolysis of **9 a** *and* **9 c**. **9 a** or **9 c** (0·01 moles) in ethanol (50 ml) were treated with conc HCl (6 ml) and

Table 2. NMR spectra of N-(1,2,4-oxadiazol-3-yl)β-enaminoketones **3 a-d**, N-(1,2,4-oxadiazol-3-yl)β-enaminoesters **3 e-h** and 2-acylamino-imidazolyl derivatives **9 a-h** (δ values)

3a: 2·08 (s,3H,$COCH_3$); 2·28 (s*, 3H, =C–CH_3); 2·47 (s,3H,Heter–CH_3); 5·31 (s*, 1H,=CH); 12·40 (s, 1H,NH) (A).
3b: 2·32 (s*,3H,=C–CH_3); 2·45 (s,3H,Heter–CH_3); 6·28 (s*,1H,=CH); 7·15–7·85 (m,5H,Ar–H); 12·88 (s,1H,NH) (B).
3c: 2·08 (s,3H,$COCH_3$); 2·31 (s*,3H,=C–CH_3); 5·27 (s*,1H,=CH); 7·10–8·0 (m,5H,Ar–H); 12·50 (br.s, 1H,NH) (A).
3d: 2·43 (s,3H,=C–CH_3); 6·24 (s,1H,=CH); 7·20 – 7·95 (m, 10 H,Ar–H); 13·04 (s,1H,NH) (B).
3e: 1·22 (t,3H,CH_2–CH_3); 2·29 (s*,3H,=C–CH_3); 2·45 (s,3H,Heter–CH_3); 4·10 (q,2H,CH_2–CH_3); 4·84 (s*,1H,=CH); 10·78 (s,1H,NH) (A).
3f: 1·29 (t,3H,CH_2–CH_3); 2·38 (s,3H,Heter–CH_3); 4·19 (q,2H,CH_2–CH_3); 5·19 (s,1H,=CH); 7·34 (s, 5H,Ar–H); 10·34 (s,1H,NH) (A).
3g: 1·30 (t,3H,CH_2–CH_3); 2·42 (s*,3H,=C–CH_3); 4·18 (q,2H,CH_2–CH_3); 4·92 (s*,1H,=CH); 7·40–8·20 (m,5H,Ar–H); 11·02 (s,1H,NH) (A).
3h: 1·28 (t,3H,CH_2–CH_3); 4·18 (q,2H,CH_2–CH_3); 5·18 (s,1H,=CH); 7·20–8·0 (m,10H,Ar–H); 10·50 (s,1H,NH) (A).
9a: 2·02 (s,3H,NH–CO–CH_3); 2·28,2·35 (2s,3H + 3H,$COCH_3$ and Heter–CH_3); 11·02,11·70 (2 br.s,1H + 1H, NH) (B).
9b: 1·92 (s,3H,NH–CO–CH_3); 2·46 (s,3H,Heter–CH_3); 7·40–8·20 (m,5H,Ar–H); 11·35,12·15 (2 br.s, 1H + 1H,NH) (A).
9c: 2·35,2·44 (2s,3H + 3H,$COCH_3$ and Heter–CH_3); 7·20–8·0 (m,5H,Ar–H); 11·75 (very br.s,2H,NH) (B).
9d: 2·45 (s,3H, Heter–CH_3); 7·10–7·80 (m,10 H,Ar–H); 11·5–12·10 (very br.s,2H,NH) (B).
9e: 1·25 (t,3H,CH_2–CH_3); 2·05 (s,3H,NH–CO–CH_3); 2·38 (s,3H,Heter–CH_3); 4·16 (q,2H,CH_2–CH_3); 11·10,11·60 (2 br.s,1H + 1H,NH) (B).
9f: 1·25 (t,3H,CH_2–CH_3); 2·12 (s,3H,NH–CO–CH_3); 4·21 (q,2H,CH_2–CH_3); 7·25–8·0 (m,5H,Ar–H); 11·20,11·68 (2 br.s,1H + 1H,NH) (B).
9g: 1·26 (t,3H,CH_2–CH_3); 2·45 (s.3H,Heter–CH_3); 4·19 (q.2H,CH_2–CH_3); 7·40–8·18 (m,5H,Ar–H); 11·80 (br.s,2H,NH) (B).
9h: 1·24 (t,3H,CH_2–CH_3); 4·22 (q,2H,CH_2–CH_3); 7·30–8·20 (m,10H,Ar–H); 11·95 (br.s,2H,NH) (B).

A = $CDCl_3$
B = DMSO
*By scale expansion singlets for =C–CH_3 and =CH are a doublet and a quadruplet ($J \leq 0.5$ Hz), respectively.

refluxed 25–30 h. Solvent was removed under reduced pressure, the residue is treated with water (50 ml) and filtered. The filtrate is neutralized with 20% NaOH (in the case of **9 c** benzoic acid or ethyl benzoate are removed by previous extraction with ether) and evaporated to dryness under reduced pressure. The residue is treated with absolute ethanol, the mixture filtered from inorganic salts, and the ethanol removed under vacuum. After crystallization from ethyl acetate-ethanol 10:1, the residue yields (10) (0·3 g), m.p. 224°, identical (m.p. in mixture, IR spectrum) with an authentic sample.[11] IR (Nujol): 3333, 3125 cm^{-1} (NH, NH_2); 1639, 1634 cm^{-1} (C=O); NMR (DMSO): 2·19, 2·24 δ (2s, 3H + 3H, $COCH_3$,CH_3), 5·67 δ (s,2H,NH_2).

Acid hydrolysis of **9 b** *and* **9 d**. **9b** or **9 d** (0·01 moles) in ethanol (50 ml) and conc HCl (6 ml) are refluxed 30 h. After removing the solvent at reduced pressure, the residue is dissolved with water (50 ml) and filtered. The filtrate is slightly alkalized (in the case of **9 d**, benzoic acid or ethyl benzoate is removed by previous extraction with ether) with 20% NaOH and **11** is obtained (1·1 g), m.p. 235° after recrystallization from ethanol. IR (Nujol): 3344, 3185, 3021 cm^{-1} (NH,NH_2), 1634 (C=O); NMR (DMSO): 2·04 δ (s,3H,CH_3), 5·92 δ (s,2H,NH_2), 7·30–7·90 δ (m,5H,ArH), 10·60 δ (s, broad, 1H, NH). (Found: C, 65·57; H, 5·62; N, 20·77. $C_{11}H_{11}N_3O$ requires: C, 65·67; H, 5·51; N, 20·88%). Nitrate of **11**, m.p. 206° dec., after crystallization from water (lit.[10] m.p. 204°).

Degradation of **9 e** *to* **12**. **9 e** is refluxed 1 h in 20 ml of 5% KOH. Then the solution was acidified with conc. HCl, concentrated to one-third of its volume, ethanol added (20 ml) and conc HCl (2 ml), and refluxed again 30 h. Then the ethanol was evaporated under vacuum and the residue is added with water, neutralized and treated with picric acid in ethanol, yielding the picrate of **12**, m.p. 185°, equal to an authentic sample.[9]

2 - *Phenylazo* - 4(5) - *methyl* - 5(4) - *acetylimidazole* **14**. The solution of **13**[11] 1 g in 10% Na_2CO_3 (40 ml) and water (40 ml), kept stirred and cooled, by treating with phenyldiazonium chloride solution obtained from aniline (0·8 g), yields **14** (0·7 g) as red-brown crystals, m.p. 205°C, after recrystallization from ethyl acetate. IR (Nujol): 3247 cm^{-1} (NH); 1656 cm^{-1} (C=O). (Found: C, 63·36; H, 5·42; N, 24·60. $C_{12}H_{12}N_4O$ requires: C, 63·14; H, 5·30; N, 24·55%).

Preparation of **10** *from* **14**. **14** (1·4 g) in ethanol (100 ml) was added with 10% Pd/C (0·4 g) and hydrogenated 4 h with a Parr apparatus at initial 45 psi. After standing overnight under hydrogen, the catalyst was removed by suction and the solvent evaporated under reduced pressure. The residue was triturated with ethyl acetate and filtered. The insoluble residue is **10**, identical with that previously described. The ethyl acetate solution contained aniline, characterized as its acetyl derivative, m.p. 114°.

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