9. *Michael* Reactions of α-Unsubstituted Trisubstituted 1*H*-Pyrroles

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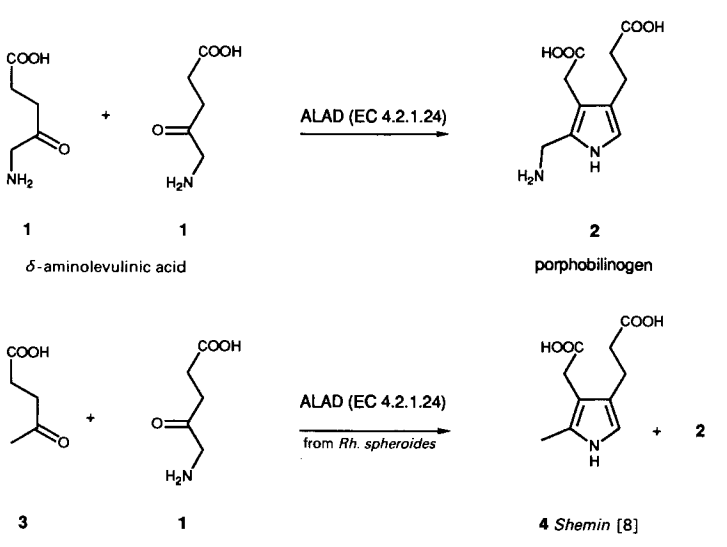
To obtain stable derivatives of α-unsubstituted pyrroles, the reaction of the test pyrrole **9** with a series of chalcones **14a–h** were studied. *Michael* adducts **16b–h** could be isolated. In order to synthesize coloured derivatives, the reaction of different pyrroles **9**, **21**, **23**, and **25** with diphenylpropynone **19** was investigated. In these cases, too, *Michael*-addition products were formed. The intense absorption band around 400 nm makes the identification of these derivatives easy.

Introduction. – The enzyme δ-aminolevulinic-acid dehydratase (ALAD, EC 4.2.1.24) is the second enzyme on the general biosynthetic pathway to the natural tetrapyrroles (*Scheme 1*) [1]. The importance of this enzymatic transformation arises from the fact, that this enzyme has been found in many different organisms [2] [3]. The *Knorr*-type condensation of two molecules of δ-aminolevulinic acid (**1**) leads in a deceptively simple way to porphobilinogen (**2**). Since the detection and the characterization of δ-aminolevulinic-acid dehydratase by the brilliant work of *Shemin* [4] [5], a considerable body of knowledge has been accumulated [6] [7]. He observed the enzymatic condensation of one molecule of levulinic acid (**3**), an unnatural substrate analogue, with one molecule of δ-

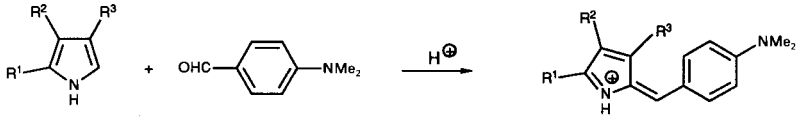
Scheme 1. *Enzymatic Formation of Porphobilinogen* **2** *and Pyrrole* **4** [4] [5] [8]



aminolevulinic acid (**1**), the natural substrate, to the pyrrole **4** (*Scheme 1*) [8]. The structure of the enzymatically formed pyrrole has not been characterized by spectroscopic means, mainly due to the lack of material.

In order to characterize tiny amounts of biosynthetically formed pyrroles, we needed stable derivatives of α-unsubstituted pyrroles. As alkyl-substituted pyrroles are in general unstable [9a] [10], an unambiguous identification is often very difficult. By far the most important analytical way to identify pyrroles **6** is the so called *Ehrlich* reaction with 4-(dimethylamino)benzaldehyde (**7**; *Scheme 2*) [9b] [11a]. The *Ehrlich* reaction is also often used to test the enzymatic activity [7c]. The test is very sensitive because the primary product, the highly coloured azafulvenium salt **8**, is easy to detect [12]. Unfortunately, the

Scheme 2



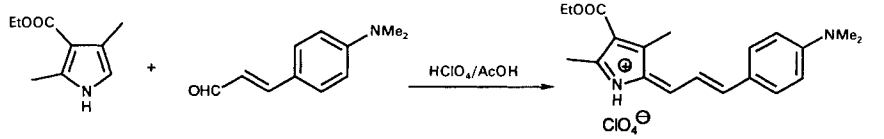
6 **7** **8** λ_{max} 555 nm

first formed product is not stable under the reaction conditions. Subsequent side reactions transform the azafulvenium salt into colourless derivatives [13]. For our studies of the enzyme δ-aminolevulinic-acid dehydratase, we needed derivatives of α-unsubstituted pyrroles which should fulfil the following conditions: the synthesis and the handling of the derivatives must be simple. The derivatives should be easy to detect under the conditions of the enzymatic transformation. Therefore, we were looking for derivatives of pyrroles which should have an intense absorption maximum in the visible light and be stable during chromatography.

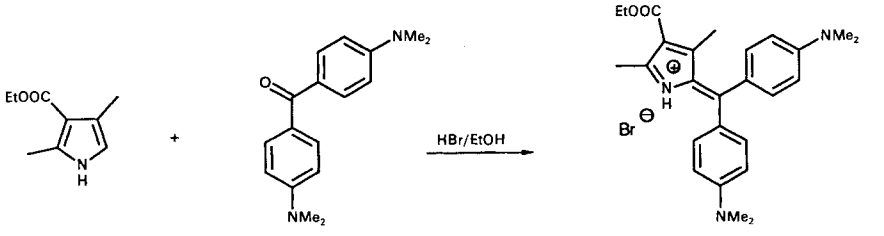
Results. – Two reactions have been described to characterize pyrroles: the diazocoupling and the *Ehrlich* reaction (see above) [11b]. The diazocoupling has two undesired properties: The products are often sensitive against light and air [14a], and the reagent, the diazonium salt itself, has an absorption in the same wavelength region as the product. Therefore, we first concentrated our efforts on the judicious modification of the *Ehrlich* reaction.

Strell and *Kalojanoff* [15] had reported that the condensation product **11** between ethyl 2,4-dimethyl-1*H*-pyrrole-3-carboxylate [14b] (**9**) and 4-(dimethylamino)cinnamicaldehyde (**10**) could be isolated as crystalline perchlorate (*Scheme 3*). This derivative **11** shows a very intense absorption at 368 nm, and, moreover, it displays an intense fluorescence. Unfortunately, this dye **11** also is stable only in the crystalline state, whereas the colour totally fades in solution within two days [16]. A qualitative test showed, that the degradation of the chromophore was most rapid in the presence of light but in the absence of O_2! This result indicated that, beside a general degradation process which was observed under all studied conditions, the chromophore could be destroyed by a photochemical process which was at least three to four times as fast as the thermal degradation. Another interesting reaction was reported by *Treibs* and *Herrmann* [13]. *Michler*s ketone **12** was condensed with pyrrole **9** to form the more stable triarylmethine dye **13**; however, much harsher conditions had to be used to obtain the desired derivatives (*Scheme 3*). The two aryl rings considerably increase the stability of the dye **13**. Thus, using substituted

Scheme 3. *Derivatives of the Test Pyrrole* **9** *According to* Strell *and* Kalojanoff [15] *and* Treibs *and* Herrmann [13]

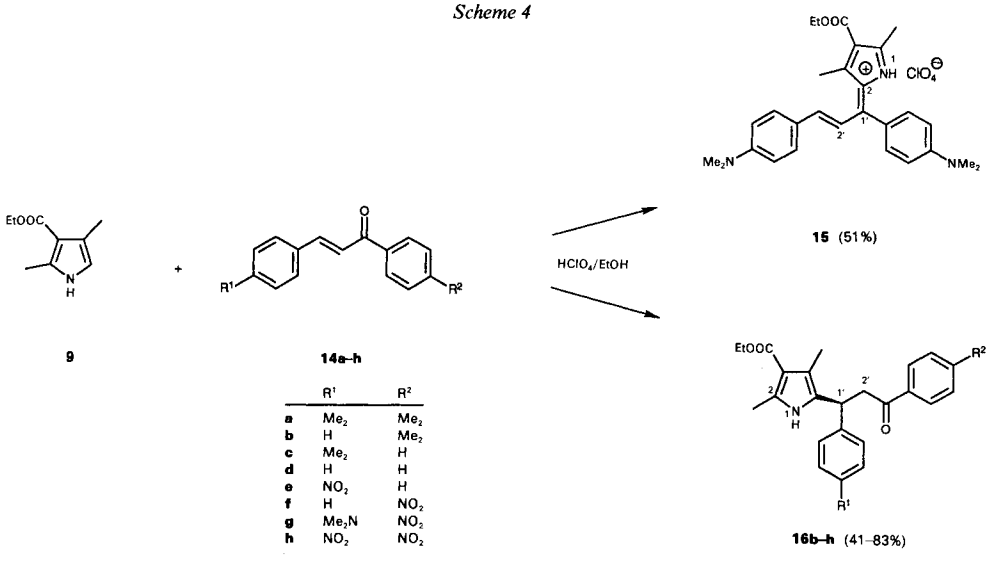


9 **10** **11** *Strell* and *Kalojanoff* [15]



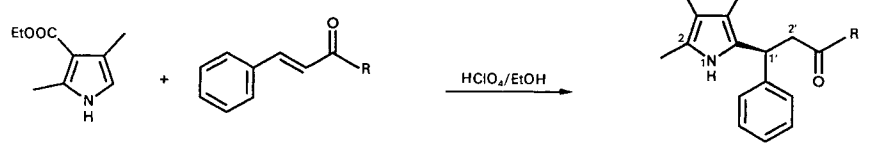
9 **12** **13** *Treibs* and *Herrmann* [13]

Scheme 4



9 **14a–h** **15** (51%) **16b–h** (41–83%)

	R^1	R^2
a	Me_2	Me_2
b	H	Me_2
c	Me_2	H
d	H	H
e	NO_2	H
f	H	NO_2
g	Me_2N	NO_2
h	NO_2	NO_2



9 **17a** R = Me **b** R = Et **18a** R = Me (41%) **b** R = Et (77%)

chalcones as reagents, it should be possible to vary the electronic character of the π-system and, thereby, to further increase the stability of the derivatives.

We decided to test the behaviour of the substituted chalcones **14a–h** and of the α,β-unsaturated ketones **17a,b** towards pyrrole **9** (*Scheme 4*). Surprisingly, only chalcone

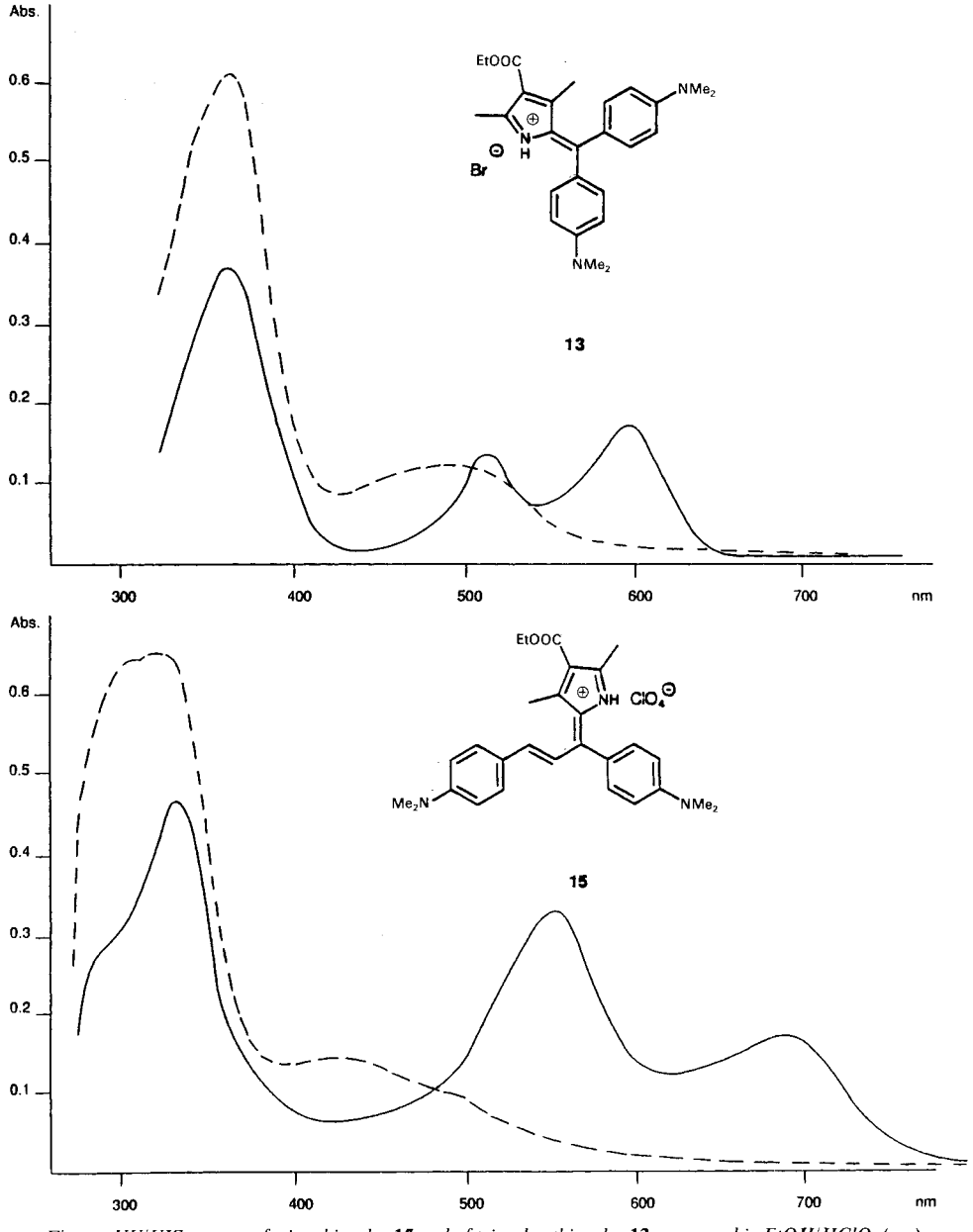


Figure. *UV/VIS spectra of trimethine dye* **15** *and of triarylmethine dye* **13**, *measured in EtOH/HClO$_4$* (—) *and EtOH/NaOH* (----)

14a which is electronically the closest analogue of *Michler*s ketone **12** formed a deeply coloured trimethine dye. Thus, treatment of **14a** with **9** in EtOH and $HClO_4$ as catalyst gave a deep blue solution, and the product **15** was isolated by chromatography (silica gel, $HClO_4$/EtOH 1:200). Even with this polar eluent, **15** migrated as a lengthy spot. The characteristic UV/VIS spectrum of **15** was highly pH-dependent. Under strongly basic conditions, a leuco compound was present, and the solution was only slightly flesh-coloured. If this solution was acidified with $HClO_4$, the deep blue colour of the trimethine dye appeared. Comparing the UV/VIS spectrum of **15** with that of the triarylmethine dye **13**, a characteristic bathochromic shift of all absorption bands could be observed (*Fig.*). The ^{1}H-NMR spectrum showed only broad signals, probably because **15** is a mixture of different diastereoisomers and is present in different protonation states. The ^{1}H-NMR spectrum of the simpler compound **13** showed, under all studied conditions, the presence of at least two species. Going from $CHCl_3$ to pure CF_3COOH solutions, only very complicated spectra could be obtained. So, these compounds are easy to detect due to their strong absorption in the visible region, but they are difficult to characterize.

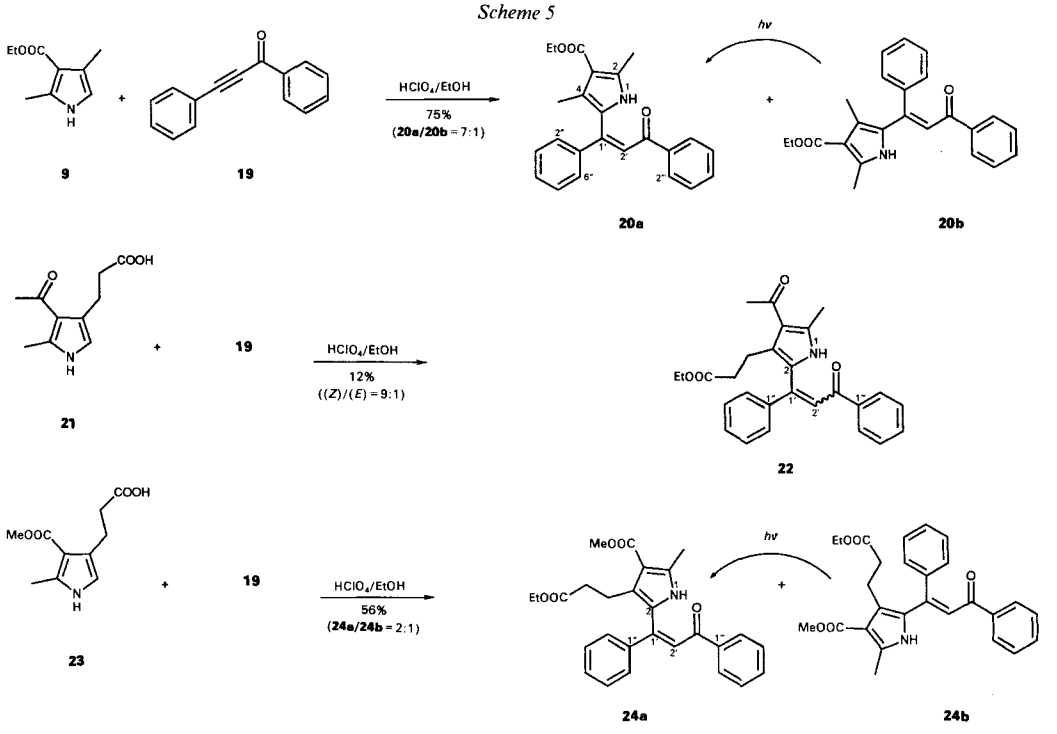
Chalcones **14b–h** and the α,β-unsaturated ketones **17a,b** readily reacted with the test pyrrole **9**. Usually, treatment of the starting materials in EtOH with $HClO_4$ was sufficient to achieve good yields of the products **16b–h** and **18a,b** (*Scheme 4*). The products were not the expected highly coloured trimethine dyes, but the *Michael*-type-addition products. Some of the products (**16d–f**) could be purified by crystallisation, whereas all others had to be chromatographed to obtain analytically pure samples. The products of the *Michael*-type addition could be easily characterized by their ^{1}H-NMR spectra which allowed the unambiguous identification. In all studied cases, the 1,4-addition was a clean reaction, and the products were easy to handle. In principle, this could be a good way to characterize α-unsubstituted pyrroles. Unfortunately, the absorption maxima of **16b–h** and **18a,b** occurred in the short-wavelength region, which makes the identification of the products difficult. Compound **16g** had an absorption maximum at $\lambda = 260$ nm. This compound was the only one which showed a bright yellow colour, at least in the crystalline state.

To introduce a chromophore into the *Michael*-type-addition products, one should start not with chalcones but with an alkynone, *e.g.* **19**. The 1,3-diphenylpropynone **19** was synthesized in 79% yield according to *Yamaguchi et al.* [17]. Reaction of **19** with the test pyrrole **9** proceeded smoothly and gave the expected 1,4-adduct as a 7:1 mixture of two diastereoisomers **20a** and **20b** in 75% yield (*Scheme 5*). The diastereoisomers could be separated by chromatography on silica gel, and the minor product **20b** isomerized to **20a** under the influence of light. The yellow product **20a** showed a λ_{max} at 415 nm with an ε value of 8400. So it fulfils all conditions for a useful derivative of α-unsubstituted pyrroles. The structures of **20a** and **20b**, were established by spectroscopic means.

The configuration at C(1′)=C(2′), and the conformation at C(1′)–C(5) and C(2′)–C(3′) in **20a,b** could be determined with NOE experiments (see *Exper. Part*). Thus, the configuration around the double bond of **20a** was shown to be *Z* and the conformation around both single bonds to be s-*cis*. The position of NH in the ^{1}H-NMR spectrum of **20a** was characteristically shifted to low field (*ca.* 13.22 ppm) as compared to the values measured for the 1,4-adducts **16b–h** (8.1–8.9 ppm), a shift probably induced by the carbonyl group.

In order to test whether the success of the reaction depends on the structure of the pyrrole, compounds **21** and **23** [12] were submitted to the reaction with **19** (*Scheme 5*). These reactions proceeded much slower than in the case of the test pyrrole **9**. Thus,

Scheme 5

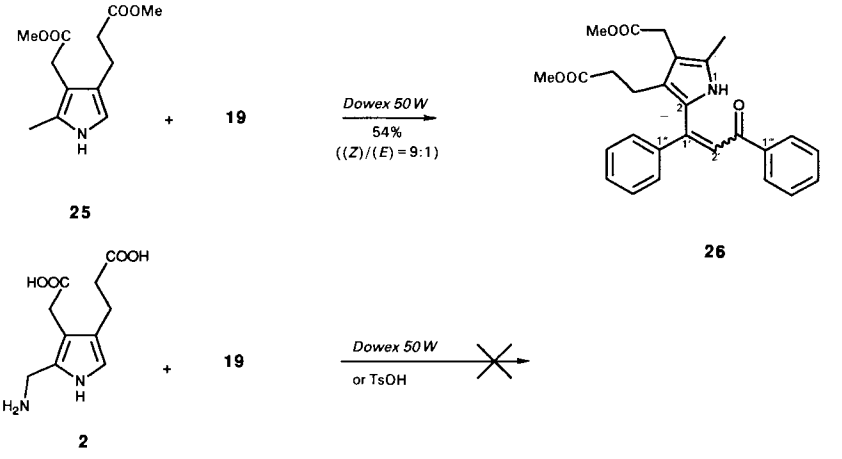


pyrrole **21** yielded, after twenty h, only 12% of the *Michael* adduct **22** as a 9:1 mixture of diastereoisomers, besides 81% of the esterified pyrrole. The reaction with pyrrole **23** was faster and cleaner: after 20 h, a 56% yield of a 2:1 mixture of diastereoisomers **24a** and **24b** was isolated, together with a small amount (12%) of the esterified pyrrole. The diastereoisomers **24a** and **24b** could be crystallized and then separated mechanically. They did not equilibrate on silica gel and could be identified by their R_f values and ^{1}H-NMR data (see *Exper. Part*). On irradiation with UV light at 366 nm, a smooth isomerisation took place.

To check the value of this *Michael*-type addition for the identification of pyrroles, the reaction of alkynone **19** with pyrrole **25** (dimethyl ester of **4**) was carried out [10]. Pyrrole **25** is acid-sensitive and destroyed under the influence of strong mineral acids. Therefore, the conditions for the 1,4-addition had to be modified. After some experimentation, a smooth transformation of **25** to the 1,4-addition product **26** ((*Z*)/(*E*) 9:1) could be obtained using *Dowex 50 W* as acid catalyst (*Scheme 6*); yield 54%, after chromatography and distillation).

Finally, reaction of porphobilinogen (**2**), the natural product of the enzymatic process, with alkynone **19** was studied. Using *Dowex 50 W* as catalyst was unsuccessful because **2** was selectively adsorbed on the resin. With mineral acid, only a very slow transformation took place: after 2 days, **2** had disappeared, and only **19** was left. As **2** is known to be acid-labile [18], no further trials were undertaken to induce the *Michael*-type reaction under the influence of acids.

Scheme 6



Conclusion. – The *Michael*-type addition of α-unsubstituted pyrroles to diphenylpropynone **19** proved to be a useful reaction for the characterization of pyrroles. The reaction has been known for some time, but only a few examples had been reported up to now [9c] [11c]. The products obtained are stable and can be chromatographed and fully characterized by their spectra. Their absorption maximum around 400 nm makes them good candidates for studies of the enzymatic formation of biosynthetically formed pyrroles, *e.g.* **4**. However, porphobilinogen (**2**), the natural product of the enzymatic process, cannot be transformed to a suitable derivative by this reaction. With this exception, the *Michael*-type addition should prove to be a useful method to identify and characterize pyrroles.

We thank *E. Bard, E. Fehr*, and Dr. *T. Jenny* for the measurement of the ^{1}H-NMR and ^{13}C-NMR spectra, *F. Nydegger* for the mass spectra, and *Ciba-Geigy SA*, Division of Plastic and Additives, Marly/Fribourg, for C,H,N analysis. We also thank *H. Bertschy* for the preparation of pyrrole **23**. Finally, financial support by the *Swiss National Science Foundation* and the *Foundation of the Swiss Chemical Industry* for the support of Ph. D. students has to be acknowledged.

Experimental Part

General. Solvents for extraction and chromatography were technical grade and distilled from the indicated drying agents: hexane ($CaCl_2$), Et_2O (Na), AcOEt (K_2CO_3), CH_2Cl_2 ($CaCl_2$), MeOH, and EtOH (CaO). The following compounds were prepared by literature methods: **9** [20], **11** [15], **13** [13], **14a** [21], **14b** [22], **14c** [21], **14e** [23], **14f** [24], **14g** [25], **14h** [26], **17b** [27], **19** [17], **21a** [12], **23a** [12], **25** [10]; **14d** and **17a** were from *Fluka*. Anal. TLC: *Merck* silica gel plates with *QF-254* indicator. Flash chromatography (FC; see [19]): silica gel *60*, 230–400 mesh ASTM, *Merck*. M.p.: *Büchi SMP-20*; uncorrected. UV/VIS spectra: *Perkin-Elmer-320* spectrophotometer; λ_{max} (log ε) in nm. IR spectra: *Perkin-Elmer-599*. IR spectrometer; in cm^{-1}. NMR spectra *Bruker AM 360* (^{1}H: 360 MHz; ^{13}C: 90.6 MHz), equipped with an *Aspekt-3000* computer; chemical shifts in ppm rel. to TMS (= 0 ppm) as internal reference. MS: *VG Micromass 7070 E*, data system *DS 11-250* from *VG Micromass Ltd.*, Manchester, UK; EI-MS with 70 eV ionisation energy; FAB-MS with 6 kV acceleration voltage under Ar bombardment and NBA (*o*-nitrobenzyl alcohol) or ONPOE (*o*-nitrophenyl octyl ether) as matrix; *m/z* (relative intensity).

2-{1,3-Bis[4-(dimethylamino)phenyl]prop-2-enylidene}-4-(ethoxycarbonyl)-3,5-dimethyl-1H-pyrrolium Perchlorate (**15**). A mixture of **14** (400 mg, 1.36 mmol), **9** (212 mg, 1.27 mmol), and 70% $HClO_4$ soln. (2.7 mmol) was

refluxed for 5 min in EtOH (10 ml). After 20 h at r.t., the soln. was filtered through silica gel/charcoal and evaporated. The black oil was submitted to FC (silica gel, EtOH/$HClO_4$ 200:1): 280 mg (51%) of a dark oil. R_f (EtOH) 0.76. UV/VIS (EtOH; log ε(highest absorption) = 1.0): At pH 12: 330 (1.0), 430 (br., 0.23); at pH 2 ($HClO_4$): 330 (0.52), 470 (sh, 0.14), 550 (0.50), 685 (0.26).

rac-*Ethyl 5-{3'-[4''-(Dimethylamino)phenyl]-3'-oxo-1'-phenylpropyl}-2,4-dimethyl-1*H-*pyrrole-3-carboxylate* (**16b**). Yield 568 mg (76%). M.p. 198° (EtOH). R_f (AcOEt/hexane 1:1) 0.30. IR ($CHCl_3$): 3450*m*, 2980*m*, 2920*m*, 1675*s* (br.), 1600*s*, 1550*m*, 1525*m*, 1440*m* (br.), 1370*s*, 1330*m*, 1170*s*, 1120*s*, 1100*s*, 980*w*, 950*m*. ^{1}H-NMR ($CDCl_3$): 8.82 (br. *s*, NH); 7.85–7.81 (*m*, *AA'*, H–C(2''), H–C(6'')); 7.25–7.12 (*m*, Ph); 6.61–6.58 (*m*, *BB'*, H–C(3''), H–C(5'')); 4.78 (*t*, ^3J = 6.5, H–C(1')); 4.22 (*q*, ^3J = 7.1, CH_3CH_2O); 3.66 (*dd*, ^2J = 16.5, ^3J(1',2') = 7.0, 1 H–C(2')); 3.56 (*dd*, ^2J = 16.5, ^3J(1',2') = 5.9, 1 H–C(2')); 3.03 (*s*, $(CH_3)_2N$); 2.41 (*s*, CH_3–C(2)); 2.15 (*s*, CH_3–C(4)); 1.30 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 196.8 (*s*, C(3')); 166.5 (*s*, COOEt); 153.5 (*s*, C(4'')); 142.7 (*s*, C(1''')); 134.5 (*s*, C(2)); 130.4 (*d*, C(2''), C(6'')); 128.4 (*d*, C(3'''), C(5''')); 128.1 (*s*, C(5)); 127.3 (*d*, C(2'''), C(6''')); 126.2 (*d*, C(4''')); 124.7 (*s*, C(1'')); 116.6 (*s*, C(4)); 110.7 (*s*, C(3)); 110.6 (*d*, C(3''), C(5'')); 58.9 (*t*, CH_3CH_2O); 42.2 (*t*, C(2')); 39.9 (*q*, $(CH_3)_2N$); 37.5 (*d*, C(1')); 14.5 (*q*, CH_3CH_2O); 14.0 (*q*, CH_3–C(2)); 11.1 (*q*, CH_3–C(4)). FAB-MS (NBA): 421 (9), 420 (46), 419 (100, $[M + H]^+$), 418 (32), 375 (4), 374 (11), 298 (3), 297 (7), 271 (20), 259 (8), 258 (59), 257 (100). Anal. calc. for $C_{26}H_{30}N_2O_3$ (418.26): C 74.66, H 7.17, N 6.69; found: C 74.64, H 7.31, N 6.57.

rac-*Ethyl 5-{1'-[4''-(Dimethylamino)phenyl]-3'-oxo-3'-phenylpropyl}-2,4-dimethyl-1*H-*pyrrole-3-carboxylate* (**16c**). Yield 300 mg (48%). M.p. 152° (EtOH). R_f (AcOEt/hexane 1:1) 0.32. IR ($CHCl_3$): 3340*m*, 2950*m* (br.), 1680*s*, 1622*m*, 1598*m*, 1580*w*, 1518*m*, 1445*s* (br.), 1350*m* (br.), 1120*s*, 1098*s*, 980*w*, 950*w*. ^{1}H-NMR ($CDCl_3$): 8.11 (br. *s*, NH); 7.93–9.89 (*m*, *AA'*, H–C(2'''), H–C(6''')); 7.57–7.52 (*m*, *B*, H–C(4''')); 7.45–7.41 (*m*, *CC'*, H–C(3'''), H–C(5''')); 7.07–7.04 (*m*, *AA'*, H–C(2''), H–C(6'')); 6.67–6.63 (*m*, *BB'*, H–C(3''), H–C(5'')); 4.74 (*t*, ^3J = 6.8, H–C(1')); 4.23 (*q*, ^3J = 7.1, CH_3CH_2O); 3.67 (*dd*, ^2J = 16.9, ^3J(1',2') = 6.9, 1 H–C(2')); 3.60 (*dd*, ^2J = 16.9, ^3J(1',2') = 6.7, 1 H–C(2')); 2.89 (*s* $(CH_3)_2N$); 2.39 (*s*, CH_3–C(2)); 2.17 (*s*, CH_3–C(4)); 1.31 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 198.9 (*s*, C(3')); 166.5 (*s*, COOEt); 149.2 (*s*, C(4'')); 136.9 (*s*, C(1''')); 134.3 (*d*, C(4''')); 133.1 (*s*, C(2)); 129.6 (*s*, C(1'')); 128.5 (*s*, C(5)); 128.5 (*d*, C(2'''), C(6''')); 128.1 (*d*, C(3'''), C(5''')); 127.9 (*d*, C(2''), C(6'')); 116.2 (*s*, C(4)); 112.8 (*d*, C(3''), C(5'')); 110.8 (*s*, C(3)); 58.9 (*t*, CH_3CH_2O); 43.4 (*t*, C(2')); 40.6 (*q*, $(CH_3)_2N$); 36.1 (*d*, C(1')); 14.5 (*q*, CH_3CH_2O); 14.0 (*q*, CH_3–C(2)); 11.1 (*q*, CH_3–C(4)). FAB-MS (NBA): 421 (11), 420 (44), 419 (77, $[M + H]^+$), 418 (44), 374 (8), 316 (5), 300 (100), 253 (50). Anal. calc. for $C_{26}H_{30}N_2O_3$ (418.26): C 74.66, H 7.17, N 6.69; found: C 74.43, H 7.11, N 6.47.

rac-*Ethyl 2,4-Dimethyl-5-(3'-oxo-1',3'-diphenylpropyl)-1*H-*pyrrole-3-carboxylate* (**16d**). *Typical Procedure*: A mixture of **14d** (398 mg, 1.9 mmol), **9** (300 mg, 1.8 mmol), and 70% $HClO_4$ soln. (3.8 mmol) was refluxed in EtOH (5 ml) for 5 min. After keeping the mixture for 30 min at r.t., brine (30 ml) was added followed by extraction with $CHCl_3$ (3 × 40 ml). The combined org. layer was washed with sat. $NaHCO_3$ soln. (50 ml), H_2O, and brine and dried over cotton-wool. The crude product was chromatographed (silica gel, AcOEt/hexane of increasing polarity): 560 mg (83%). M.p. 158° (EtOH, dec.). R_f (AcOEt/hexane 1:1) 0.50. IR ($CHCl_3$): 3440*w*, 2980–2880*w* (br.), 1680*s* (br.), 1595*w*, 1440*m*, 1140*m*, 1095*m*. ^{1}H-NMR ($CDCl_3$): 8.26 (*s*, NH); 7.92–7.90 (*m*, *AA'*, H–C(2'''), H–C(6''') (Ph–C(3')); 7.58–7.54 (*m*, *B*, H–C(4''')); 7.46–7.42 (*m*, *CC'*, H–C(3'''), H–C(5''')); 7.27 (*m*, *AA'*, H–C(2''), H–C(6'')); 7.20–7.16 (*m*, *BCB'*, H–C(3''), H–C(4''), H–C(5'')); 4.82 (*t*, ^3J = 6.6, H–C(1')); 4.23 (*q*, ^3J = 7.1, CH_3CH_2O); 3.70 (*d*, ^3J = 6.6, CH_2(2')); 2.41 (*s*, CH_3–C(2)); 2.17 (*s*, CH_3–C(4)); 1.32 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 198.6 (*s*, C(3')); 166.4 (*s*, COOEt); 142.1 (*s*, C(1'')); 136.8 (*s*, C(1''')); 134.6 (*s*, C(2)); 133.2 (*d*, C(4''')); 128.6 (*d*, C(2'''), C(3'''), C(5'''), C(6''')); 128.0 (*d*, C(3''), C(5'')); 127.6 (*s*, C(5)); 127.2 (*d*, C(2''), C(6'')); 126.5 (*d*, C(4'')); 116.7 (*s*, C(4)); 110.9 (*s*, C(3)); 59.0 (*t*, CH_3CH_2O); 43.1 (*t*, C(2')); 37.0 (*d*, C(1')); 14.5 (*q*, CH_3CH_2O); 14.1 (*q*, CH_3–C(2)); 11.0 (*q*, CH_3–C(4)). FAB-MS (NBA): 378 (8), 377 (36), 376 (64, $[M + H]^+$), 375 (12), 331 (10), 271 (12), 257 (100). Anal. calc. for $C_{24}H_{25}NO_3$ (375.24): C 76.81, H 6.66, N 3.73; found: C 76.81, H 6.76, N 3.50.

rac-*Ethyl 2,4-Dimethyl-5-[1'-(4''-nitrophenyl)-3'-oxo-3'-phenylpropyl]-1*H-*pyrrole-3-carboxylate* (**16e**). Yield 625 mg (83%). M.p. 189° (acetone, dec.). R_f (AcOEt/hexane 1:1) 0.41. IR (KBr): 3230*s*, 3200*s*, 2980*m*, 2920*m*, 1688*s*, 1655*s*, 1598*s*, 1520*s* (NO_2), 1480*s*, 1445*s*, 1382*m*, 1345*s* (NO_2), 1255*s*, 1200*m*, 1185*m*, 1130*s*, 1100*m*, 1045*w*, 1018*w*, 1003*w*, 988*m*, 860*m*, 790*m*, 760*m*, 750*m*, 710*m*, 690*m*. ^{1}H-NMR ((D$_6$)DMSO): 11.06 (br. *s*, NH); 8.23–8.19 (*m*, *AA'*, H–C(3''), H–C(5'')); 8.06–8.03 (*m*, *AA'*, H–C(2'''), H–C(6''')); 7.74–7.70 (*m*, *X*, H–C(4''')); 7.66–7.59 (*m*, *XX'*, *YY'*, H–C(2''), H–C(6''), H–C(3'''), H–C(5''')); 4.88 (*t*, ^3J = 7.4, H–C(1')); 4.17 (*q*, ^3J = 7.1, CH_3CH_2O); 4.08 (*dd*, ^2J = 17.8, ^3J(1',2') = 7.6, 1 H–C(2')); 3.93 (*dd*, ^2J = 17.8, ^3J(1',2') = 7.4, 1 H–C(2')); 2.41 (*s*, CH_3–C(2)); 2.20 (*s*, CH_3–C(4)); 1.29 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ((D$_6$)DMSO): 197.1 (*s*, C(3')); 165.1 (*s*, COOEt); 151.4 (*s*, C(1'')); 145.7 (*s*, C(4'')); 136.4 (*s*, C(1''')); 134.4 (*s*, C(2)); 133.2 (*d*, C(4''')); 128.6 (*d*, C(2'''), C(6''')); 128.3 (*d*, C(3'''), C(5''')); 127.8 (*d*, C(2''), C(6'')); 127.0 (*s*, C(5)); 123.4 (*d*, C(3''), C(5'')); 115.3 (*s*, C(4)); 109.7 (*s*, C(3)); 58.2 (*t*,

CH_3CH_2O); 41.8 (*t*, C(2')); 36.4 (*d*, C(1')); 14.3 (*q*, CH_3CH_2O); 13.4 (*q*, CH_3–C(2)); 10.8 (*q*, CH_3–C(4)). FAB-MS (NBA): 423 (5), 422 (20), 421 (32, $[M + H]^+$), 420 (10), 376 (14), 302 (40), 105 (100). Anal. calc. for $C_{24}H_{24}N_2O_5$ (420.24): C 68.59, H 5.71, N 6.66; found: C 68.30, H 5.83, N 6.47.

rac-*Ethyl 2,4-Dimethyl-5-[3'-(4''-nitrophenyl)-3'-oxo-1'-phenylpropyl]-1*H-*pyrrole-3-carboxylate* (**16f**). Yield 350 mg (47%). M.p. 160° (EtOH). R_f (AcOEt/hexane 1:1) 0.43. IR ($CHCl_3$): 3450*w*, 1690*m* (br., ester, ketone), 1605*w*, 1530*m* (NO_2), 1425*w* (br.), 1355*m* (NO_2), 1125*m*, 1100*m*, 860*w*. ^{1}H-NMR ($CDCl_3$): 8.28–8.25 (*m*, *AA'*, H–C(3''), H–C(5'')); 8.06 (br. *s*, NH); 8.04–8.01 (*m*, *BB'*, H–C(2''), H–C(6'')); 7.32–7.28 (*m*, *AA'*, H–C(3'''), H–C(5''')); 7.23–7.18 (*m*, *BCB'*, H–C(2'''), H–C(4'''), H–C(6''')); 4.83 (*t*, ^3J = 6.8, H–C(1')); 4.23 (*q*, ^3J = 7.1, CH_3CH_2O); 3.74 (*dd*, ^2J = 17.6, ^3J(1',2') = 6.4, 1 H–C(2')); 3.71 (*dd*, ^2J = 17.6, ^3J(1',2') = 7.0, 1 H–C(2')); 2.41 (*s*, CH_3–C(2)); 2.18 (*s*, CH_3–C(4)); 1.32 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ((D_6)DMSO): 197.1 (*s*, C(3')); 165.2 (*s*, COOEt); 149.8 (*s*, C(4'')); 143.3 (*s*, C(1'')); 141.1 (*s*, C(1''')); 134.0 (*s*, C(2)); 129.2 (*d*, C(2''), C(6'')); 128.3 (*d*, C(3'''), C(5''')); 128.1 (*s*, C(5)); 127.1 (*d*, C(2'''), C(6''')); 126.0 (*d*, C(4''')); 123.8 (*d*, C(3''), C(5'')); 114.7 (*s*, C(4)); 109.5 (*s*, C(3)); 58.1 (*t*, CH_3CH_2O); 42.9 (*t*, C(2')); 36.5 (*d*, C(1')); 14.4 (*q*, CH_3CH_2O); 13.5 (*q*, CH_3–C(2)); 10.8 (*q*, CH_3–C(4)). FAB-MS (NBA): 423 (5), 422 (20), 421 (28, $[M + H]^+$), 420 (6), 376 (6), 257 (100). Anal. calc. for $C_{24}H_{24}N_2O_5$ (420.24): C 68.59, H 5.71, N 6.66; found: C 68.34, H 5.86, N 6.50.

rac-*Ethyl 5-{1'-[4''-(Dimethylamino)phenyl]-3'-(4'''-nitrophenyl)-3'-oxopropyl}-2,4-dimethyl-1*H-*pyrrole-3-carboxylate* (**16g**). Yield 570 mg (69%). M.p. 119° (EtOH/hexane 1:1; dec.). R_f (AcOEt/hexane 1:1) 0.28. UV/VIS (MeOH): 260 (33.8), 310 (sh, 3.0). IR ($CHCl_3$): 3440*w*, 2950*w* (br.), 1685*s*, 1605*m*, 1523*s* (NO_2), 1435*m*, 1350*s* (NO_2), 1260*w*, 1120*s*, 1095*s*, 980*w*, 945*w*, 858*w*. ^{1}H-NMR ($CDCl_3$): 8.28–8.25 (*m*, *AA'*, H–C(3'''), H–C(5''')); 8.04–8.00 (*m*, *BB'*, H–C(2'''), H–C(6''')); 7.98 (br. *s*, NH); 7.08–7.06 (*m*, *AA'*, H–C(2''), H–C(6'')); 6.69–6.67 (*m*, *BB'*, H–C(3''), H–C(5'')); 4.74 (*t*, ^3J = 7.0, H–C(1')); 4.23 (*q*, ^3J = 7.1, CH_3CH_2O); 3.72 (*dd*, ^2J = 17.0, ^3J(1',2') = 7.4, 1 H–C(2')); 3.62 (*dd*, ^2J = 17.0, ^3J(1',2') = 6.6, 1 H–C(2')); 2.91 (*s*, $(CH_3)_2N$); 2.39 (*s*, CH_3–C(2)); 2.17 (*s*, CH_3–C(4)); 1.31 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 197.4 (*s*, C(3')); 166.4 (*s*, COOEt); 150.1 (*s*, C(4''')); 149.4 (*s*, C(4'')); 141.3 (*s*, C(1''')); 134.5 (*s*, C(2)); 129.0 (*d*, C(2'''), C(6''')); 128.9 (*s*, C(1'')); 128.0 (*s*, C(5)); 127.8 (*d*, C(2''), C(6'')); 123.7 (*d*, C(3'''), C(5''')); 116.3 (*s*, C(4)); 112.8 (*d*, C(3''), C(5'')); 110.9 (*s*, C(3)); 59.0 (*t*, CH_3CH_2O); 44.0 (*t*, C(2')); 40.5 (*q*, $(CH_3)_2N$); 36.2 (*d*, C(1')); 14.5 (*q*, CH_3CH_2O); 14.0 (*q*, CH_3–C(2)); 11.1 (*q*, CH_3–C(4)). FAB-MS (NBA): 466 (8), 465 (30), 464 (39, $[M + H]^+$), 463 (24), 448 (2), 419 (4), 344 (7), 300 (100). Anal. calc. for $C_{26}H_{29}N_3O_5$ (463.26): C 67.40, H 6.26, N 9.06; found: C 67.29, H 6.41, N 8.96.

rac-*Ethyl 5-[1',3'-Bis(4-nitrophenyl)-3'-oxopropyl]-2,4-dimethyl-1*H-*pyrrole-3-carboxylate* (**16h**). Yield 420 mg (51%). M.p. 205° (acetone). R_f (AcOEt/hexane 1:1) 0.38. IR (KBr): 3290*s* (br.), 3120*w*, 3080*w*, 3050*w*, 2980*m*, 2920*m*, 2860*m*, 1690*s*, 1655*s*, 1600*s*, 1520*s* (NO_2), 1480*s*, 1425*s*, 1345*s* (NO_2), 1255*s*, 1205*s*, 1110*s* (br.), 1040*m*, 1015*m*, 990*m*, 860*s*, 790*m*, 775*m*, 750*s*, 705*m*, 695*m*. ^{1}H-NMR ((D_6)DMSO): 11.05 (br. *s*, NH); 8.43–8.41 (*m*, *AA'*, H–C(3'''), H–C(5''') (Ar–C(3'))); 8.26–8.24 (*m*, *BB'*, H–C(2'''), H–C(6''')); 8.23–8.21 (*m*, *AA'*, H–C(3''), H–C(5'')); 7.66–7.64 (*m*, *BB'*, H–C(2''), H–C(6'')); 4.88 (*t*, ^3J = 7.4, H–C(1')); 4.17 (*q*, ^3J = 7.1, CH_3CH_2O); 4.12 (*dd*, ^2J = 18.0, ^3J(1',2') = 7.2, 1 H–C(2')); 4.06 (*dd*, ^2J = 18.0, ^3J(1',2') = 8.0, 1 H–C(2')); 2.41 (*s*, CH_3–C(2)); 2.19 (*s*, CH_3–C(4)); 1.29 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ((D_6)DMSO): 196.6 (*s*, C(3')); 165.1 (*s*, COOEt); 151.2 (*s*, C(1'')); 149.9 (*s*, C(4''')); 145.8 (*s*, C(4'')); 140.9 (*s*, C(1''')); 134.5 (*s*, C(2)); 129.3 (*d*, C(2'''), C(6''')); 128.4 (*d*, C(2''), C(6'')); 126.8 (*s*, C(5)); 123.8 (*d*, C(3'''), C(5''')); 123.5 (*d*, C(3''), C(5'')); 115.6 (*s*, C(4)); 109.8 (*s*, C(3)); 58.2 (*t*, CH_3CH_2O); 42.5 (*t*, C(2')); 36.4 (*d*, C(1')); 14.3 (*q*, CH_3CH_2O); 13.5 (*q*, CH_3–C(2)); 10.8 (*q*, CH_3–C(4)): FAB-MS (NBA): 468 (4), 467 (13), 466 (17, $[M + H]^+$), 465 (6), 450 (3), 421 (4), 344 (4), 302 (54). Anal. calc. for $C_{24}H_{23}N_3O_7$ (465.24): C 61.96, H 4.94, N 9.03; found: C 61.88, H 5.01, N 8.89.

rac-*Ethyl 2,4-Dimethyl-5-(3'-oxo-1'-phenylbutyl)-1*H-*pyrrole-3-carboxylate* (**18a**). Yield 227 mg (41%). M.p. 90° (EtOH). R_f (AcOEt/hexane 1:1) 0.36. IR ($CHCl_3$): 3450*m*, 2980*m*, 2930*m*, 1685*s* (br.), 1600*m*, 1440*s*, (br.), 1365*m*, 1335*m*, 1165*m*, 1125*s*, 1100*s*. ^{1}H-NMR ($CDCl_3$): 8.37 (br. *s*, NH); 7.30–7.26 (*m*, *AA'*, H–C(3''), H–C(5'')); 7.21–7.17 (*m*, *B*, H–C(4'')); 7.15–7.12 (*m*, *CC'*, H–C(2''), H–C(6'')); 4.60 (*t*, ^3J = 6.7, H–C(1')); 4.23 (*q*, ^3J = 7.1, CH_3CH_2O); 3.19 (*dd*, ^2J = 16.6, ^3J(1',2') = 7.2, 1 H–C(2')); 3.11 (*dd*, ^2J = 16.6, ^3J(1',2') = 6.2, 1 H–C(2')); 2.41 (*s*, CH_3–C(2)); 2.18 (*s*, CH_3–C(4)); 2.08 (*s*, CH_3(4')); 1.32 (*t*, ^3J = 7.1, CH_3H_2O). ^{13}C-NMR ($CDCl_3$): 207.8 (*s*, C(3')); 166.4 (*s*, COOEt); 141.7 (*s*, C(1'')); 134.6 (*s*, C(2)); 128.6 (*d*, C(3''), C(5'')); 127.3 (*s*, C(5)); 127.1 (*d*, C(2''), C(6'')); 126.6 (*d*, C(4'')); 116.7 (*s*, C(4)); 110.8 (*s*, C(3)); 59.0 (*t*, CH_3CH_2O); 48.0 (*t*, C(2')); 37.0 (*d*, C(1')); 30.6 (*q*, C(4')); 14.5 (*q*, CH_3CH_2O); 14.0 (*q*, CH_3–C(2)); 11.0 (*q*, CH_3–C(4)). FAB-MS (ONPOE): 316 (10), 315 (52), 314 (100, $[M + H]^+$), 313 (18), 271 (10), 270 (7), 269 (20), 258 (19), 257 (88). Anal. calc. for $C_{19}H_{23}NO_3$ (313.19): C 72.86, H 7.34, N 4.47; found: C 72.38, H 7.40, N 4.34 (contains *ca.* 0.3 equiv. of H_2O, as calculated from ^{1}H-NMR).

rac-*Ethyl 2,4-Dimethyl-5-(3'oxo-1'-phenylpentyl)-1*H-*pyrrole-3-carboxylate* (**18b**). Yield 450 mg (77%). M.p. 96° (EtOH). R_f (AcOEt/hexane 1:1) 0.42. UV/VIS (MeOH; log ε (highest absorption) = 1.0): 230 (1.0), 262 (0.38). IR ($CHCl_3$): 3450*m*, 2980*m*, 2940*m*, 1685*s* (br.), 1595*m*, 1440*s* (br.), 1385*m*, 1370*m*, 1335*m*, 1120*s*, 1100*s*. ^{1}H-NMR ($CDCl_3$): 8.47 (br. *s*, NH); 7.30–7.25 (*m*, *AA'*, H–C(3''), H–C(5'')); 7.21–7.16 (*m*, *B*, H–C(4'')); 7.14–7.11 (*m*, *CC'*,

H–C(2″), H–C(6″)); 4.61 (*t*, ^3J = 6.6, H–C(1′)); 4.24 (*q*, ^3J = 7.1, CH_3CH_2O); 3.19 (*dd*, ^2J = 16.2, ^3J(1′,2′) = 7.3, 1 H–C(2′)); 3.06 (*dd*, ^2J = 16.2, ^3J(1′,2′) = 5.9, 1 H–C(2′)); 2.43 (*s*, CH_3–C(2)); 2.40 (*dq*, ^2J = 18.0, ^3J(4′,5′) = 7.3, 1 H–C(4′)); 2.27 (*dq*, ^2J = 18.0, ^3J(4′,5′) = 7.2, 1 H–C(4′)); 2.16 (*s*, CH_3–C(4)); 1.32 (*t*, ^3J = 7.1, CH_3CH_2O); 0.95 (*t*, ^3J = 7.3, CH_3(5′)). ^{13}C-NMR ($CDCl_3$): 210 (*s*, C(3′)); 166.5 (*s*, COOEt); 142.1 (*s*, C(1″)); 134.7 (*s*, C(2)); 128.6 (*d*, C(3″), C(5″)); 127.5 (*s*, C(5)); 127.1 (*d*, C(2″), C(6″)); 126.5 (*d*, C(4″)); 116.6 (*s*, C(4)); 110.8 (*s*, C(3)); 59.0 (*t*, CH_3CH_2O); 46.8 (*t*, C(2′)); 37.1 (*d*, C(1′)); 36.8 (*t*, C(4′)); 14.5 (*q*, CH_3CH_2O); 14.0 (*q*, CH_3–C(2)); 11.0 (*q*, CH_3–C(4)); 7.6 (*q*, C(5′)). FAB-MS (ONPOE): 330 (11), 329 (52), 328 (100, $[M + H]^+$), 327 (20), 283 (19), 271 (16), 258 (17), 257 (90), 256 (6), 255 (9). Anal. calc. for $C_{20}H_{25}NO_3$ (327.20): C 73.41, H 7.64, N 4.28; found: C 73.21, H 7.83, N 4.11.

*Ethyl 2,4-Dimethyl-5-(3′-oxo-1′,3′-diphenylprop-1′-enyl)-1*H*-pyrrole-3-carboxylate* (**20**). A mixture of **9** (300 mg, 1.8 mmol), **19** (369 mg, 1.8 mmol), and 70% $HClO_4$ soln. (3.8 mmol) in EtOH (10 ml) was refluxed for 5 min. After 2 h at r.t., sat $NaHCO_3$ soln. (50 ml) was added, followed by extraction with Et_2O (3 × 40 ml). The combined org. layer was washed with H_2O (50 ml) and brine and dried (Na_2SO_4). FC (silica gel, CH_2Cl_2/Et_2O 20:1) afforded 445 mg (66%) of (*Z*)-diastereoisomer **20a** and 60 mg (9%) of (*E*)-diastereoisomer **20b**.

(Z)-Diastereoisomer **20a**: M.p. 120–120.5° (EtOH). R_f (AcOEt/hexane 1:1) 0.45. UV/VIS (EtOH): 222 (26.2), 274 (17.4), 289 (sh, 14.4), λ_{max} 415 (8.4). IR (KBr): 3060*w*, 2980*w*, 2920*w*, 1698*s*, 1620*m*, 1592*w*, 1570*w*, 1535*m*, 1498*s* (br.), 1430*s*, 1365*s*, 1335*s*, 1340*s*, 1302*m*, 1280*m*, 1250*s*, 1210*m*, 1185*m*, 1135*w*, 1088*s*, 1018*m*, 1000*w*, 988*w*, 962*m*, 785*w*, 768*w*, 702*m*, 692*m*. ^{1}H-NMR ($CDCl_3$): 13.22 (*s*, NH); 7.99–7.97 (*m*, *AA′*, H–C(2‴), H–C(6‴), (Ph–C(3′))); 7.55–7.51 (*m*, *B*, H–C(4‴)); 7.47–7.45 (*m*, *CC′*, H–C(3‴), H–C(5‴)); 7.45–7.39 (*m*, H–C(2″), H–C(3″), H–C(4″), H–C(5″), H–C(6″)); 6.65 (*s*, H–C(2′)); 4.25 (*q*, ^3J = 7.1, CH_3CH_2O); 2.63 (*s*, CH_3–C(2)); 1.63 (*s*, CH_3–C(4)); 1.32 (*t*, ^3J = 7.1, CH_3CH_2O). NOE: CH_3–C(4)/H–C(2″) 2%; H–C(2′)/H–C(6″) 7.1%; H–C(2′)/H–C(2‴) 13.1%; H–C(2″)/CH_3–C(4) 1.7%; H–C(6″)/H–C(2′) 2.8%; H–C(2‴)/H–C(2′) 6.7%. ^{13}C-NMR ($CDCl_3$): 190.4 (*s*, C(3′)); 165.5 (*s*, COOEt); 150.1 (*s*, C(1′)); 143.0 (*s*, C(1‴)); 139.8 (*s*, C(1″)); 138.6 (*s*, C(2)); 132.4 (*d*, C(4‴)); 131.1 (*s*, C(4)); 128.8 (*d*, C(4″)); 128.3 (*d*, C(2″), C(3″), C(5″), C(6″), C(2‴), C(3‴), C(5‴), C(6‴)); 126.2 (*s*, C(5)); 118.1 (*d*, C(2′)); 114.8 (*s*, C(3)); 59.3 (*t*, CH_3CH_2O); 14.9 (*q*, CH_3–C(2)); 14.4 (*q*, CH_3CH_2O); 13.5 (*q*, CH_3–C(4)). EI-MS: 374 (27), 373 (100, M^+), 359 (21), 358 (94), 356 (21), 344 (9), 328 (23), 310 (23), 300 (14), 296 (11), 282 (20), 268 (39), 250 (12), 240 (12), 222 (38), 208 (10), 194 (18), 180 (12), 105 (82), 91 (15), 77 (57), 69 (18), 51 (11). Anal. calc. for $C_{24}H_{23}NO_3$ (373.24): C 77.23, H 6.16, N 3.75; found: C 77.05, H 6.32, N 3.47.

*Ethyl 4-Acetyl-5-methyl-2-(3′-oxo-1′,3′-diphenylprop-1′-enyl)-1*H*-pyrrole-3-propanoate* (**22**). A mixture of **21** (300 mg, 1.53 mmol), **19** (348 mg, 1.69 mmol), and 70% $HClO_4$ soln. (3.3 mmol) was refluxed in EtOH (10 ml) for 5 min. After 20 h at r.t., sat. $NaHCO_3$ soln. (50 ml) was added followed by extraction with Et_2O (3 × 40 ml). The combined org. layer was washed with H_2O (50 ml) and brine and dried (Na_2SO_4). FC (silica gel, Et_2O/pentane 9:1) afforded 276 mg (81%) of ethyl ester of **21** and 100 mg (12%) of **22** ((*Z*)/(*E*) = 9:1). *(Z)-Diastereoisomer* **22**: R_f (Et_2O) 0.44. ^{1}H-NMR ($CDCl_3$): 12.53 (br. *s*, NH); 7.99–7.97 (*m*, *AA′*, H–C(2‴), H–C(6‴) (Ph–C(3′))); 7.57–7.52 (*m*, *B*, H–C(4‴)); 7.48–7.44 (*m*, *CC′*, H–C(3‴), H–C(5‴)); 7.43–7.39 (*m*, H–C(2″), H–C(3″), H–C(4″), H–C(5″), H–C(6″)); 6.75 (*s*, H–C(2′)); 3.93 (*q*, ^3J = 7.1, CH_3CH_2O); 2.64 (*s*, Ac or CH_3–C(5)); 2.42 (*s*, Ac or CH_3–C(5)); 2.39–2.35 (*m*, CH_2CH_2COO); 2.22–2.18 (*m*, CH_2CH_2COO); 1.22 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 194.7 (*s*, CH_3CO): 191.2 (*s*, C(3′)); 172.8 (*s*, COOEt); 148.7 (*s*, C(1′)); 142.1 (*s*, C(1‴)); 139.0 (*s*, C(1″)); 136.6 (*s*, C(5)); 132.7 (*d*, C(4‴)); 130.8 (*s*, C(3)); 129.1 (*d*, C(4″)); 128.4, 128.2 (*d*, C(2″), C(3″), C(5″), C(6″), C(2‴), C(3‴), C(5‴), C(6‴)); 125.9 (*s*, C(4)); 123.3 (*s*, C(2)); 121.2 (*d*, C(2′)); 59.8 (*t*, CH_3CH_2O); 34.9 (*t*, CH_2CH_2COO); 31.1 (*q*, CH_3CO); 21.5 (*t*, CH_2CH_2COO); 15.9 (*q*, CH_3–C(5)); 14.1 (*q*, CH_3CH_2O).

*Ethyl 4-(Methoxycarbonyl)-5-methyl-2-(3′-oxo-1′,3′-diphenylprop-1′-enyl)-1*H*-pyrrole-3-propanoate* (**24**). A mixture of **23** (300 mg, 1.33 mmol), **19** (302 mg, 1.55 mmol), 70% $HClO_4$ soln. and (2.66 mmol) was refluxed in EtOH (10 ml) for 5 min. After 6 h at r.t. further $HClO_4$ soln. (2.66 mmol) was added. After 20 h at r.t. sat. $NaHCO_3$ soln. (50 ml) was added followed by extraction with Et_2O (3 × 40 ml). The combined org. layer was washed with H_2O (50 ml) and brine and dried (Na_2SO_4). FC (silica gel, AcOEt/hexane 1:4) afforded 227 mg (37%) of (*Z*)-diastereoisomer **24a** and 113 mg (19%) of (*E*)-diastereoisomer **24b**.

(Z)-diastereoisomer **24a**: M.p. 89° (EtOH). R_f (AcOEt/hexane 1:1) 0.54. UV/VIS (CH_2Cl_2; log ε (highest absorption) = 1.0): 265 (1.0), λ_{max} 425 (0.95). IR (KBr): 3260*m*, 3150*w*, 3080*w*, 3060*ws*, 2980*w*, 2940*m*, 1725*s*, 1705*s* (br.), 1648*s* (C=C), 1600*m*, 1568*m* (br.), 1480*m* (sh), 1445*s*, 1422*m*, 1370*m*, 1322*w*, 1298*m*, 1270*m* (sh), 1255*s*, 1230*m*, 1210*s*, 1185*m*, 1160*m* (sh), 1120*s*, 1088*s*, 1040*m*, 1020*m*, 870*w*, 790*m*, 768*m*, 725*w*, 702*m*, 690*w*, 655*w*. ^{1}H-NMR ($CDCl_3$): 12.82 (br. *s*, NH); 8.00–7.97 (*m*, *AA′*, H–C(2‴), H–C(6‴), (Ph–C(3′))); 7.56–7.52 (*m*, *B*, H–C(4‴)); 7.48–7.43 (*m*, *CC′*, H–C(3‴), H–C(5‴)); 7.43–7.40 (*m*, H–C(2″), H–C(3″), H–C(4″), H–C(5″), H–C(6″)); 6.69 (*s*, H–C(2′)); 3.94 (*q*, ^3J = 7.1, CH_3CH_2O); 3.78 (*s*, COOMe); 2.61 (*s*, CH_3C(5)); 2.38–2.33 (*m*, CH_2CH_2COO); 2.23–2.19 (*m*, CH_2CH_2COO); 1.12 (*t*, ^3J = 7.1, CH_3CH_2O). ^{13}C-NMR ($CDCl_3$): 190.6 (*s*, C(3′));

172.6 (*s*, *C*OOEt); 165.3 (*s*, *C*OOMe); 148.9 (*s*, C(1′)); 142.3 (*s*, C(1‴)); 139.1 (*s*, C(1″)); 138.4 (*s*, C(5)); 132.4 (*d*, C(4‴)); 131.6 (*s*, C(3)); 128.8 (*d*, C(4″)); 128.3, 128.1 (*d*, C(2″), C(3″), C(5″), C(6″), C(2‴), C(3‴), C(5‴), C(6‴)); 125.6 (*s*, C(2)); 120.0 (*d*, C(2′)); 113.2 (*s*, C(4)); 59.6 (*t*, CH_3CH_2O); 50.4 (*q*, CH_3O); 35.1 (*t*, CH_2CH_2COO); 21.3 (*t*, CH_2CH_2COO); 14.6 (*q*, CH_3CH_2O); 14.02 (*q*, CH_3–C(5)). FAB-MS (NBA): 447 (9), 446 (12.5, $[M + H]^+$), 445 (3), 415 (15), 401 (3), 373 (3), 346 (10), 345 (45), 105 (100), 77 (55). Anal. calc. for $C_{27}H_{27}NO_5$ (445.27): C 72.82, H 6.06, N 3.14; found: C 72.53, H 6.25, N 2.85.

(E)-Diastereoisomer **24b**: M.p. 129° (EtOH). R_f (AcOEt/hexane 1:1) 0.47. UV/VIS (CH_2Cl_2; log ε (highest absorption) = 1.0): λ_{max} 393 (1.0); after irradiation for 3 min with light of 366 nm: 265 (1.37), λ_{max} 422 (1.21). IR (KBr): 3220*m*, 3120*w*, 3055*w*, 2990*w*, 2960*w*, 2930*w*, 1735*m*, 1725*m*, 1698*s*, 1630*m*, (C=C), 1600*m*, 1580*m*, 1540*m*, 1485*m*, 1450*m*, 1430*m* (sh), 1375*w*, 1340*m*, 1298*m*, 1250*m* (sh), 1230*s*, 1178*m*, 1160*m*, 1125*m*, 1088*s*, 1050*m*, 1022*m*, 980*w*, 860*w*, 845*w*, 770*m* (br.), 730*w*, 720*w*, 705*w*, 655*w*, 640*m*, 618*w*. ^{1}H-NMR ($CDCl_3$): 7.89–7.87 (*m*, H–C(2‴), H–C(6‴), (Ph–C(3′))); 7.83 (br. *s*, NH); 7.48–7.41 (*m*, H–C(4‴)); 7.38–7.34 (*m*, H–C(3‴), H–C(5‴)); 7.34–7.28 (*m*, *AA′B*, H–C(2″), H–C(4″), H–C(6″)); 7.23–7.20 (*m*, *CC′*, H–C(3″), H–C(5″)); 6.97 (*s*, H–C(2′)); 4.07 (*q*, ^3J = 7.1, CH_3CH_2O); 3.83 (*s*, CH_3O); 3.14–3.09 (*m*, CH_2CH_2COO); 2.62–2.58 (*m*, CH_2CH_2COO); 2.42 (*s*, CH_3–C(5)); 1.17 (*t*, ^3J = 7.1, CH_3CH_2O).

*Methyl 4-[(Methoxycarbonyl)methyl]-5-methyl-2-(3′-oxo-1′,3′-diphenylprop-1′-enyl)-1*H*-pyrrole-3-propanoate* (**26**). A mixture of **25** (195 mg, 0.815 mmol), **19** (840 mg, 4.1 mmol), and MeOH (5 ml) was kept at r.t. for 6 h in the presence of *Dowex 50 W* (100 mg; *Fluka*). The resin was separated by filtration, and sat. $NaHCO_3$ soln. (50 ml) was added. The soln. was extracted with Et_2O (3 × 50 ml) and the extract washed with H_2O and brine (50 ml) and dried (Na_2SO_4). The crude product was submitted to FC (silica gel, hexane/AcOEt 4:1) and distilled with a mercury diffusion pump at 200–220°/$4 \cdot 10^{-4}$ Torr: 196 mg (54%), (*Z*)/(*E*) = 9:1. *(Z)-Diastereoisomer* **26**: R_f (hexane/AcOEt 2:1) 0.29. UV/VIS (EtOH): 432 (14.5), 290 (sh, 8.3), 263 (12.0). IR (CCl_4): 3070*w*, 3030*w*, 3000*w*, 2960*w*, 1745*s*, 1630*w*, 1620*w*, 1600*w*, 1580*w*, 1550*w*, 1515*m*, 1490*m*, 1440*m*, 1420*m*, 1360*m*, 1335*w*, 1305 (sh), 1290*m*, 1250*m*, 1220*m*, 1165*m*, 1125*m*, 1095*m*, 1045*w*, 1025*m*, 970*w*, 930*w*, 920*w*, 900*w*, 710*m*. ^{1}H-NMR ($CDCl_3$): 13.95 (br. *s*, NH); 7.95–7.93 (*m*, *AA′*, H–C(2‴), H–C(6‴) (Ph–C(3′))); 7.51–7.48 (*m*, *B*, H–C(4‴)); 7.44–7.36 (*m*, H–C(3‴), H–C(5‴), H–C(2″), H–C(3″), H–C(4″), H–C(5″), H–C(6″)); 6.42 (*s*, H–C(2′)); 3.65, 3.52 (2*s*, 2 CH_3O); 3.41 (*s*, CH_2–C(4)); 2.39 (*s*, CH_3–C(5)); 2.07–2.03 (*m*, CH_2CH_2COO). ^{13}C-NMR ($CDCl_3$): 189.2 (*s*, C(3′)); 172.8, 172.0 (*s*, 2 *C*OOMe); 150.4 (*s*, C(1′)); 142.9 (*s*, C(1‴)); 140.5 (*s*, C(1″)); 132.9 (*s*, C(5)); 131.9 (*d*, C(4‴)); 131.1 (*s*, C(3)); 128.3 (*d*, C(2‴), C(6‴), C(3″), C(5″)); 128.1 (*d*, C(3‴), C(5‴), C(2″), C(4″), C(6″)); 125.8 (*s*, C(2)); 116.9 (*s*, C(4)); 115.3 (*d*, C(2′)); 51.9, 51.2 (*q*, 2 CH_3O); 35.6 (*t*, CH_2CH_2OO); 30.1 (*t*, CH_2–C(4)); 20.6 (*t*, CH_2CH_2COO); 12.2 (*q*, CH_3–C(5)). FAB-MS (NBA): 446 (14, $[M + H]^+$), 445 (43), 414 (7), 386 (10), 372 (15), 371 (29), 359 (42), 358 (100), 340 (21), 312 (12), 280 (10), 267 (12), 266 (46), 220 (13), 208 (10), 106 (7), 105 (89), 77 (30). Anal. calc. for $C_{27}H_{27}NO_5$ (445.3): C 72.83, H 6.06, N 3.14; found: C 72.62, H 6.05, N 3.05.

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