Gas-phase Synthesis of *N*-Alkenyl-3-hydroxypyrroles by Sequential Collapse of Two Dipolar Intermediates

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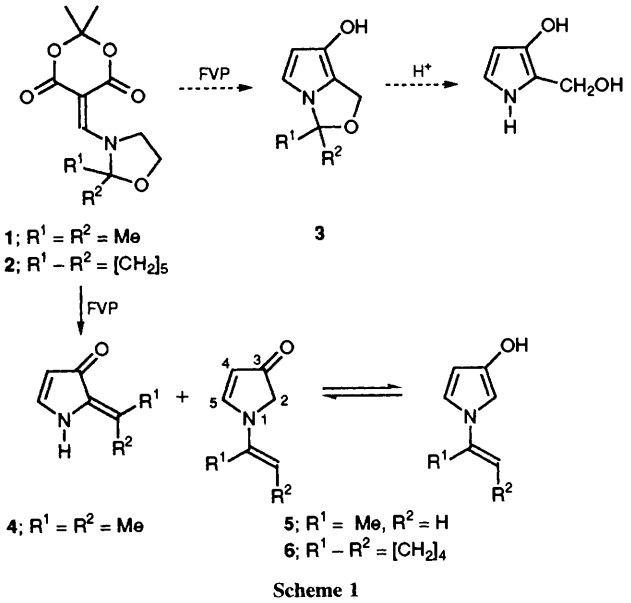
Flash vacuum pyrolysis (FVP) of the oxazolidinylmethylene derivatives of Meldrum's acid **1** and **2** gives alkenylpyrroles **5** and **6** respectively, by a mechanism which involves collapse of a bicyclic intermediate **3**; FVP of the related compound **9** (which cannot undergo this process) gives the tricyclic compound **11**, probably *via* an intramolecular Diels–Alder reaction.

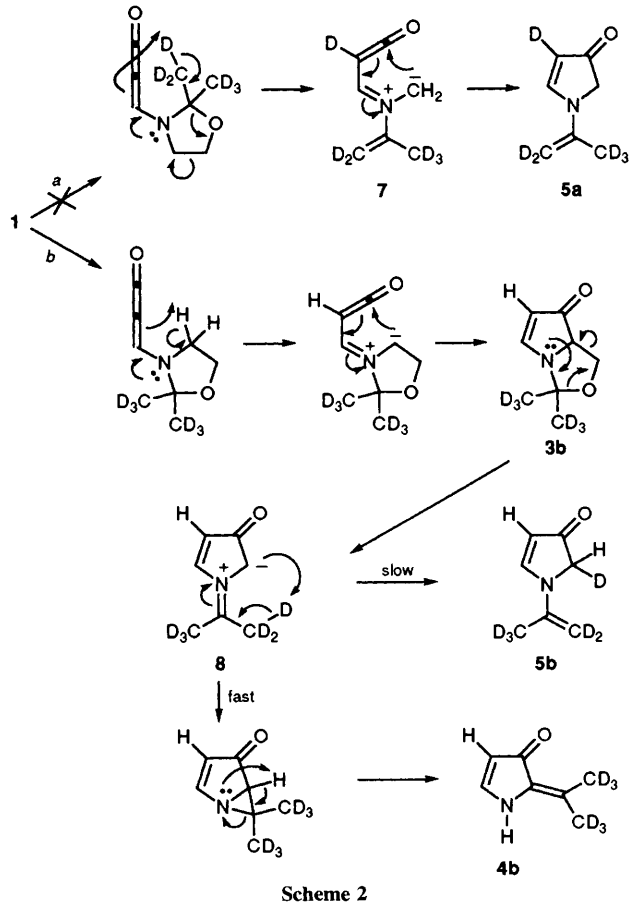
In connection with potential routes to analogues[1] of the prodigiosin series of antibiotics,[2] we required a synthesis of 2-functionalised *N*-unsubstituted-3-hydroxypyrroles. As one potential route we made the oxazolidine derivatives **1** and **2**† by standard methods,[3] anticipating that hydrolysis of the primary pyrolysis products **3** should release the appropriate functionality (Scheme 1). In the event, flash vacuum pyrolysis (FVP) of the dimethyl derivative **1** at 600 °C (10^{-3} Torr; 1 Torr = 133.3 Pa) gave none of the expected bicyclic derivative **3**, but instead the two products **4** and **5** were obtained in 1.0:2.7 ratio (total yield 70%), and were identified by their spectra: **2** gave the *N*-alkenylpyrrole **6** (70%) as the only isolable product.



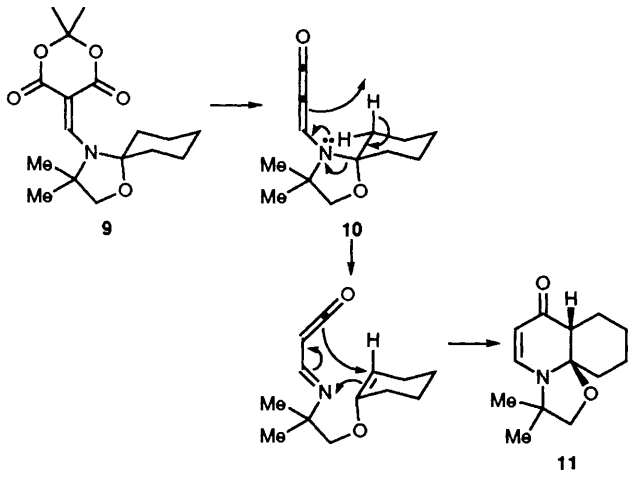
Scheme 1

† All new compounds have been characterised by their spectra, and by elemental analysis (solids) or accurate mass measurement (liquids).

We considered two mechanisms for the formation of the *N*-alkenylpyrroles **5** and **6**, which were distinguished by the deuterium labelling experiment shown in Scheme 2. In the concerted mechanism (route *a*), product **5a** is formed *via* a single dipolar intermediate **7**, which is generated by intramolecular hydrogen transfer from one of the methyl groups. In the



Scheme 2



Scheme 3

stepwise mechanism (route *b*), standard pyrrolone formation gives the bicyclic intermediate **3b**, which can extrude CH_2O in a well-precedented manner[4–6] under the conditions of the pyrolysis to give the azomethine ylide intermediate, **8**, which leads to the alkenylpyrrole **5b** by intramolecular hydrogen transfer. The deuterium labelling experiment revealed two features of the reaction. First, no label was detected at the 4-position of the pyrrolone, and so route *a* can be discounted. Secondly, it was found that the proportion of the minor isomer **4b** was substantially increased (1.0 : 1.3 ratio) which suggests that **4** and **5** are derived from the same intermediate and that the hydrogen shift from **8** to **5** is rate determining (k_H/k_D is *ca.* 2.1, which is in line with other values obtained under FVP conditions[7]). Partition of azomethine ylides (such as **8**) between aziridines and enamines under FVP conditions has been reported.[6]

Finally, we note that hydrogen abstraction similar to that of Scheme 2 route *a* can indeed be observed if the precursor contains no α-hydrogen atoms. Thus, pyrolysis of **9** gave a single product which was isolated in 50% yield, and, from its mass spectrum was clearly isomeric with the initial methyleneketene **10**. The structure was assigned as the tricycle **11** on the basis of a series of one- and two-dimensional NMR experiments: in particular the two alkene protons show $^3J_{HH}$ 7.1 Hz, which is consistent with a six-membered rather than a five-membered ring enone unit. The formation of **11** can be rationalised by a hydrogen transfer–intramolecular cycloaddition mechanism (Scheme 3).

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