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Derivatives of 2,2'-Bipyrrole. Bipyrrolylpyrrolylmethenes (1a)

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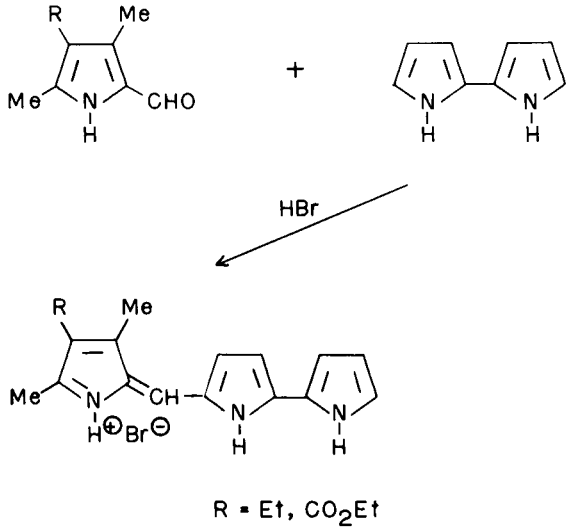
A number of reports (2-10) have been concerned with the synthesis of 2,2'-bipyrroles, which occur as structural units in corrins (11), the bacterial metabolite prodigiosin (5,13,14,16e) and an analog (15,16,22). On the other hand, chemical reactions (4,5,9,13-19) involving representatives of this unique class of compounds remain almost unexplored and for the most part reports have been concerned with degradation studies of natural products. In this connection we are unaware, in fact, of any reported reactions of the parent compound. We describe hereinafter the synthesis of two bipyrrolylpyrrolylmethenes and derivatives of these via the acid catalyzed condensation of 2,2'-bipyrrole with 2-formyl-3,5-dimethyl-4-ethylpyrrole and with 2-formyl-3,5-dimethyl-4-ethoxycarbonylpyrrole. Those compounds of this class synthesized previously have all carried one or more substituents on the bipyrrole part of the molecule (2,5,17,18). However, the salts of the methenes described in this communication are generally more stable than the free bases. Also, the attempted condensation of 2,2'-bipyrrole with 2-formylpyrrole, 2-methyl-3-ethoxycarbonyl-5-formylpyrrole, and 2-formyl-3,5-diethoxycarbonyl-4-methylpyrrole under the same conditions as used for the successful syntheses apparently led initially to methene formation as indicated by the initial color change of the reaction mixture, but attempts to isolate a pure compound were unsuccessful. Furthermore, although the opportunity exists for the formation of bisdipyrrolylmethenes in these examples through condensation of two moles of the aldehyde with one of the bipyrrole at the 5- and 5'-positions of the latter, only the monocondensation products were isolated. This has also been noted in certain of the earlier reported condensations of this type (17) and attributed to the resonance hybrid character of the dipyrrolylpyrrolylmethene salt with canonical forms bearing a positive charge in the terminal ring of the dipyrrolyl moiety, which has also been described earlier by us in a consideration of the spectrum of such a compound (14).



R = Et, CO_2Et

EXPERIMENTAL

2-(5'-Pyrrol-2''-ylpyrrol-2'-yl)methylene-3,5-dimethyl-4-ethyl-2*H*-pyrrolenine.

(a) The Hydrobromide.

A solution of 0.132 g. (1.00 mmole) of 2,2'-bipyrrole (6) and 0.151 g. (1.00 mmole) of 2-formyl-3,5-dimethyl-4-ethylpyrrole (21) in 2.0 ml. of absolute ethanol was gently heated on a steam bath and 0.25 ml. of 48% hydrobromic acid was added. The mixture was stored at room temperature for 2 hours and the methene hydrobromide that had precipitated, 0.259 g. (75%), was filtered from the dark blue mother liquor. Recrystallization from chloroform and petroleum ether (b.p. 30-60°) yielded 0.200 g. of dark blue crystals, which reflect a green color, m.p. 232-233°, dec.

(b) The Perchlorate.

A solution of 0.3 ml. of 60% perchloric acid in 2.0 ml. of water was added to a solution of 0.100 g. of the methene hydrobromide in 40 ml. of 95% ethanol, which was heated on a steam bath. The mixture was evaporated to a volume of *ca.* 15 ml. and stored overnight in a refrigerator. The blue crystals that deposited were recrystallized from 95% ethanol containing a few drops of 5% perchloric acid and the product melted at 233-234.5°, dec.

Anal. Calcd. for $C_{17}H_{20}ClN_3O_4$: Cl, 9.69. Found: Cl, 9.85.

(c) The Free Base.

A 0.100 g. sample of the hydrobromide in 40 ml. of chloroform was shaken with several drops of concentrated ammonium hydroxide. The resulting dark red chloroform solution was washed with water, dried over calcium sulfate and added to a column of Woelm alumina (neutral, activity grade 1). The chromatogram was developed with chloroform, the red band was collected, and the solvent evaporated at reduced pressure. After two successive crystallizations from petroleum ether, 0.020 g. of 2-(5'-pyrrol-2''-ylpyrrol-2'-yl)methylene-3,5-dimethyl-4-ethyl-2*H*-pyrrolenine was obtained as red-violet crystals, m.p. 151-153°, dec.

Anal. Calcd. for $C_{17}H_{19}N_3$: C, 76.98; H, 7.17; N, 15.84. Found: C, 76.82; H, 7.70; N, 15.22.

2-(5'-Pyrrol-2''-ylpyrrol-2'-yl)methylene-3,5-dimethyl-4-ethoxycarbonyl-2*H*-pyrrolenine.

(a) The Hydrobromide.

To a solution of 0.132 g. (1.00 mmole) of 2,2'-bipyrrole and 0.195 g. (1.00 mmole) of 2-formyl-3,5-dimethyl-4-ethoxycarbonylpyrrole (21) in 15 ml. of absolute ethanol at room temperature there was

added dropwise 0.25 ml. of 48% hydrobromic acid. The mixture became dark violet in color and a precipitate formed. After storage for 1 hour in the dark, the precipitate, 0.354 g. (91%), was collected. This was crystallized from chloroform and petroleum ether, without heating, yielding dark blue crystals of the methene hydrobromide, m.p. 245-246°, dec.

(b) The Free Base.

2-(5'-Pyrrol-2''-ylpyrrol-2'-yl)methylene-3,5-dimethyl-4-ethoxycarbonyl-2*H*-pyrrolenine was derived from its hydrobromide essentially as in the preceding series. In this case the base was eluted from the chromatogram with a chloroform-petroleum ether mixture (1:4, vol.). Red crystals of the methene, m.p. 78-80°, were isolated after four crystallizations from petroleum ether. In the crystallization process, a few drops of methanol were added just before cooling the concentrated solution.

Anal. Calcd. for $C_{18}H_{19}N_3O_2$: C, 69.88; H, 6.19; N, 13.58. Found: C, 69.4; H, 5.7; N, 13.9.

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(22) Note added in proof: Wasserman *et al.*, have reported on an additional analog of prodigiosin. See: H. H. Wasserman, G. C. Rodgers, Jr., and D. D. Keith, *Chem. Commun.*, 825 (1966).

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