The Configurational Correlation Between Two Series of Dihydroquinaldine Dimers (1)

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Reductions of quinaldine (I) by (a) zinc in hydrochloric acid or (b) electrolysis at a mercury cathode in alcoholic potassium hydroxide, followed by catalytic reduction, are reported to afford two different isomeric dimers, II and III respectively (2,3). The gross structure of dimer II (Heller's dimer) was provisionally assigned on the basis of the nmr spectrum, and the head-to-head arrangement was suggested by relative pKa values for both the dimer and monoacetyl derivative. Beyond the appearance in the nmr spectrum of two equivalent ABX patterns, associated with the 2,2,4-trisubstituted-1,2,3,4-tetrahydroquinoline ring systems, there were no discernable couplings of protons to permit further stereochemical assignments. In the choice of *cis-* or *trans*-isomers, models and conformational arguments indicated the *trans* form to be sterically preferable.

In the synthesis of dimer III, an intermediate dihydroquinoline dimer (IV) is first isolated from the electrolytic reduction of quinaldine in base (4). Structure IVa was originally assigned to this compound, but Russell and co-workers (5) have presented cogent evidence for a revised constitution (IVb) for a dimer with the same properties that they prepared by reduction of quinaldine by lithium in THF. The intermediate IV is converted to III either by sodium borohydride or catalytic hydrogenation.

The dipole moments of Heller's dimer (II) and the electrolytic dimer (III) have now been determined along with that for 1,2,3,4-tetrahydroquinaldine (IV), and these data are summarized in Table I. Dreiding models of the most plausible isomers, including *cis* and *trans* head-to-head and head-to-tail constitutions, were constructed and dipole moments were estimated using tetrahydroquinaldine as the basis for vector calculations.

The calculated dipole moments are as follows: (a) head-to-head, *trans:* 2.94D; head-to-tail, *cis:* 2.05; head-to-tail, *trans: ca.* 0; head-to-head, *cis:* 3.58. The head-to-head *trans* model gives the best fit to the dipole moment for Heller's dimer (II).
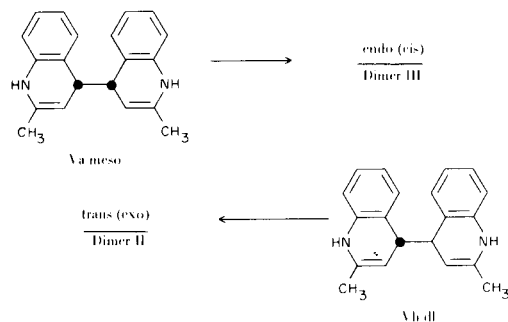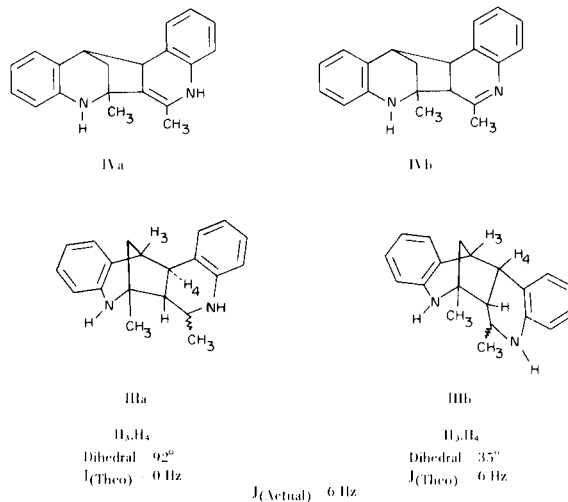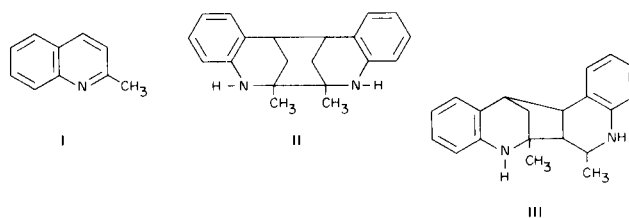

TABLE 1

Dipole Moments
(From Dielectric Constants in Benzene at 20°)

1,2,3,4-Tetrahydroquinaldine (IV)	1.79D
Heller's dimer (II)	2.68
Electrolytic dimer (III)	3.01

The structure of Heller's dimer (II), including the stereochemical features, has since been recorded from X-ray crystallographic analysis, and this report confirms the *trans*, head-to-head configuration (6).

In the case of the electrolytic dimer (III), the dipole moments calculated from models suggested that the head-to-head arrangement was more probable than structures with the coupling head-to-tail; but even for this mode of coupling there are two stereoisomers, an *exo* (IIIa) and *endo* (IIIb) form. The greater flexibility in this series of models rendered ambiguous a decision between IIIa and IIIb. The decisive pair of hydrogens for choosing between the *exo* and *endo* isomers are arbitrarily labeled H_3 and H_4, and the coupling constants for this pair were reported earlier (3) from the nmr spectrum of III. The Karplus relation between the dihedral angle and coupling constant provides an alternative method for establishing the stereochemistry for this dimer, and the experimental data, when compared with the models IIIa and IIIb, permit a clear choice of the *endo* configuration (IIIb) for the dimer from electrolytic reduction.

An attractive hypothesis for the formation of the two series of dimers would focus on the common 4,4′-linkage in both II and III (*cf.* Ref. 5). Plausible steps can be written to describe the production of either II or III from a common intermediate (V). Our study shows that the configuration of dimer II differs from that of III at this critical juncture. Moreover, examination of models of 1,4,1′,4′-tetrahydrobiquinolyl (Va and b) reveals that such a coupled intermediate has built into it the stereochemical features that determine the nature of the final product. With the models, the meso intermediate (Va) can lead only to the dimer with *endo* (or *cis*) configuration whereas the dl-isomer (Vb) can only be folded into the *trans* (or *exo*) structure. A similar argument can be mounted for the stereospecific formation of dimer II, but not dimer III, if the initial reductive coupling is at the 2,2-positions.

EXPERIMENTAL

Preparation of Dimers II and III.

Dimer II was prepared as described by Heller (7) and extracted from the crude reduction mixture and recrystallized from ligroin (b.p. 90-120°) as colorless prismatic crystals, m.p. 183-184°; lit. (2) m.p. 183-184°. The preparation of dimer III followed the method outlined previously (3), and III was recrystallized from ethanol as colorless prisms, m.p. 132-133°; lit. (3) m.p. 132-133°.

Dielectric Constant Measurements and Dipole Moment Calculations (8).

The dielectric constants of solutions of reference compounds and the dimers were determined by the bridge method using a Dipolmeter DM-01 (Kahl Scientific Instrument Company, El Cajon, California) equipped with a DFL-1 cell (9). The calculations followed standard procedures described in Ref. 8.

REFERENCES

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