n-π^* TRANSITIONS IN PYRIMIDINE CYCLONUCLEOSIDES†

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Received 6 April 1970

Our optical studies on nucleosides [1, 2] quickly led to the realisation that the sign and magnitude of the Cotton effect was related to the conformation of the nucleoside about the glycosidic bond (*syn* or *anti*) [3]. We formulated a rule for predicting the sign of the Cotton effect in pyrimidine nucleosides [4], for which detailed evidence was presented [5]. Our rule is an empirical one and has been slightly modified in the light of experience [6], but is clearly based on the relationship between the direction of the transition moment and nucleoside conformation. The results now reported show that the small long wave-length Cotton effect in O^2,2′- and O^2,5′-cyclouridines is due to an n-π^* transition, and confirm that the B_{2u} Cotton effect has the sign predicted by our rule.

This rule has been criticised by Miles et al. [7]. They found that, corresponding to the positive Cotton effect centred at 246 mμ in the ORD of O^2,2′-cyclouridine (I), there are two Cotton effects in the C.D.: a small negative one at 270 mμ, and a large positive one at 240 mμ. Miles et al. assumed that the small long wave-length Cotton effect was due to a B_{2u} transition, but no evidence of any kind was presented in support of this opinion. In view of the important place occupied by O^2,2′- and O^2,5′-cyclouridines in our previous studies, we have carried out a careful investigation of the C.D. spectra of three compounds: O^2,2′-Cyclouridine diacetate (I), O^2,5′-cyclo-2′, 3′-isopropylidine uridine (II), and O^2,5′-cyclothymidine (III).

Compound I in dioxan gives a small negative Cotton effect at 281 mμ (fig. 1). In acetonitrile, this shows a small blue shift, and in water it disappears altogether. It is obvious from the ultraviolet spectrum (fig. 1) that this small negative C.E. is associated with a transition of very low intensity. All the above evidence suggests that the C.E. at 280 mμ is due to an n-π^* transition (see preceding paper). On going from acetonitrile to water one would expect a blue shift of 15 mμ, and the resultant C.E. at 263 mμ would, because of its low intensity, be hidden by the large positive Cotton effect. (The latter is probably due to an overlap of the B_{1u} and B_{2u} C.E.'s).

Compound II in dioxan gives a small positive long

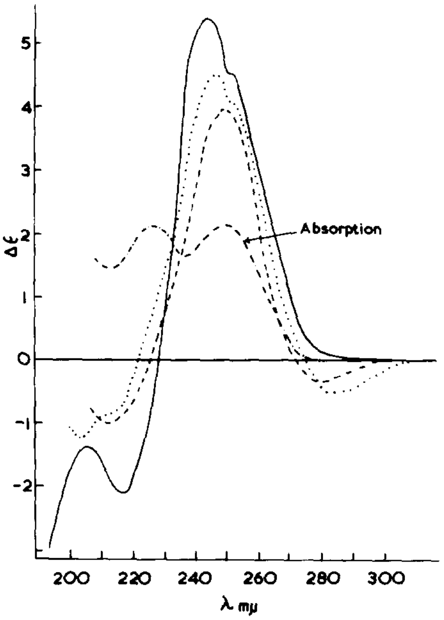

Fig. 1. U.V. Absorption (-.-.-) and C.D. Spectra (——) in Water pH 7.0; (...) in Dioxan; (- - -) in Acetonitrile. Of 3′,5′-diacetyl O^2,2′-cyclouridine (I).

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† Optical Rotatory studies on Nucleic Acid Derivatives, Part XIII. Part XII: Preceding Paper.

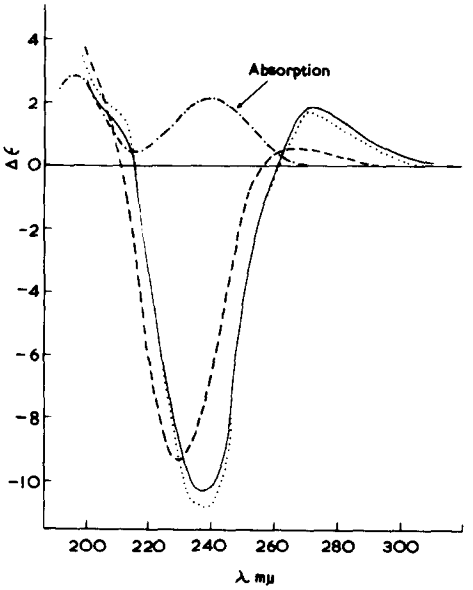
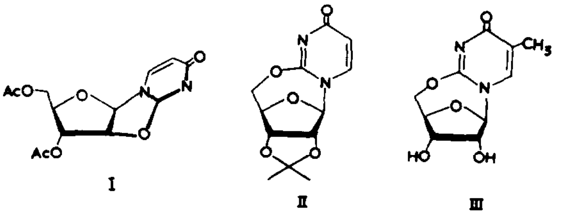


Fig. 2. U.V. Absorption (-.-.-) and C.D. Spectra (- - -) in Water; (——) in Dioxan; (.....) in Acetonitrile of Isopropylidine O^2,5-cyclouridine (II).



Scheme.

wave-length C.E. at 272 $m\mu$ (fig. 2) (though small compared with the large negative C.E. in the 230 $m\mu$ region, it is larger than the corresponding negative C.E. in Compound I). This peak shows a small blue shift in acetonitrile, and a further blue shift in water. It should be noted that, in water, the peak is of much lower intensity. One would expect this n-π^* transition to give rise to a C.E. at about 254 $m\mu$ in water, but because of the overlap with the large negative Cotton effect, only the tail of the n-π^* C.E. is visible.

That the n-π^* C.E. of II is still visible in water, whereas in I it is not, it due to two reasons:

(i) the n-π^* C.E. in II is more intense than in I and

(ii) there is a wider wave-length separation between the two C.E.'s so that the overlap is less.

The results with III were very similar to those given by II, showing that the presence of an isopropylidene group has little significant effect.

Our results show that the small long wavelength Cotton effect in the pyrimidine cyclonucleosides I–III is due to an n-π^* transition. The B_{2u} Cotton effect in I is positive, and in II and III is negative, in accord with our rule for predicting the sign of this C.E. in pyrimidine nucleosides [6].

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