

STUDIES ON TERPENOIDS AND STEROIDS  
PART 9 [1]: CIRCULAR DICHROISM STUDIES  
OF SOME D:A-FRIEDO-OLEANONES

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الخلاصة :

تمّ قياس ثنائية الضوء الدائرية لمركبات : ١ - أكسو - ، ٣ - أكسو - ٦ - أكسو - ، ٧ -  
أكسو - ، ٢١ - أكسو - ، ٢٢ - أكسو - دي أنريديو أولينانات وقد شرحت تأثيرات كوتون التي  
لوحظت باستخدام قانون الثنية .

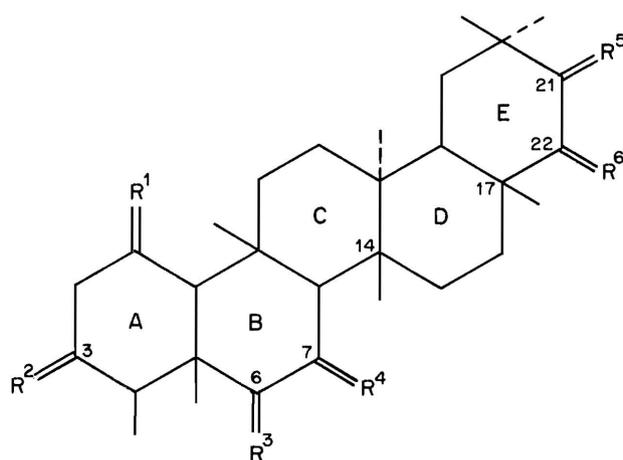
ABSTRACT

Circular dichroism data for 1-oxo-, 3-oxo-, 6-oxo-, 7-oxo-, 21-oxo-, and 22-oxo-D:A-friedo-oleananes have been obtained and the observed Cotton effects interpreted in terms of the octant rule.

## STUDIES ON TERPENOIDS AND STEROIDS PART 9 [1]: CIRCULAR DICHROISM STUDIES OF SOME D:A-FRIEDO-OLEANONES

### INTRODUCTION

Circular dichroism (CD) and optical rotatory dispersion (ORD) data have been obtained [2] and analyzed [3] extensively for conformational and configurational studies of steroids. However, very little CD and ORD data exist for the D:A-friedo-oleanones; only the ORD of 3-oxo-friedo-oleanane (2) [4] and the CD of 7-oxo-D:A-friedo-oleanane (6) [3] have been previously reported. (See Figure 1 for the definition of D:A-friedo-oleanones (1–6).) Further, the location of carbonyl function in D:A-friedo-oleanones has proved to be difficult, and in many instances tedious chemical transformations have had to be performed [5,6]. The availability of a series of natural and synthetic D:A-friedo-oleanones prompted us to study the CD of these molecules and in this paper we present the CD data for D:A-friedo-oleanones (1–5).



|   | R <sup>1</sup> | R <sup>2</sup> | R <sup>3</sup> | R <sup>4</sup> | R <sup>5</sup> | R <sup>6</sup> |
|---|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 | O              | H <sub>2</sub> |
| 2 | H <sub>2</sub> | O              | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> |
| 3 | H <sub>2</sub> | H <sub>2</sub> | O              | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> |
| 4 | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | O              | H <sub>2</sub> |
| 5 | H <sub>2</sub> | O              |
| 6 | H <sub>2</sub> | H <sub>2</sub> | H <sub>2</sub> | O              | H <sub>2</sub> | H <sub>2</sub> |

Figure 1. Definition of D:A-Friedo-Oleanones (1–6)

### RESULTS AND DISCUSSION

Table 1 depicts CD data for the  $n \rightarrow \pi^*$  transition ( $\lambda \approx 295$  nm) of the carbonyl group for D:A-friedo-oleanones (1–5). The big range of CD values shown by these molecules could be used for characterization (which has been difficult by spectral means such as <sup>1</sup>H NMR, <sup>13</sup>C NMR, and infrared spectroscopy).

Table 1. CD Data for D:A-Friedo-Oleanones (1–5)

| D:A-friedo-oleanone | $\lambda_{\max}$ (nm) | $\Delta\epsilon(n \rightarrow \pi^*)$ |
|---------------------|-----------------------|---------------------------------------|
| 1                   | 293                   | -1.17                                 |
| 2                   | 294                   | -3.46                                 |
| 3                   | 293                   | +2.49                                 |
| 4                   | 295                   | +8.98                                 |
| 5                   | 294                   | +2.38                                 |

The X-ray analysis of 3,6-dioxygenated D:A-friedo-oleanane has shown it to have the D and E rings in the boat–boat conformation [7]. The <sup>1</sup>H NMR nuclear Overhauser effect study of D:A-friedo-oleanone (2) [8] has indicated, on the basis of the observed nuclear Overhauser enhancement between the methyl groups at C-14 and C-17 and between those at C-17 and C-20 in a lanthanide shifted spectrum, boat–boat conformation for rings D and E in CDCl<sub>3</sub> solution. A <sup>13</sup>C NMR lanthanide induced shift study [9] of D:A-friedo-oleanone (5) has confirmed the boat–boat

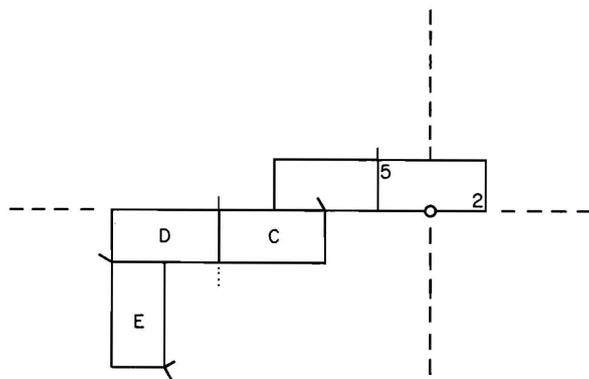


Figure 2. Octant Projection of D:A-Friedo-Oleanone (1)

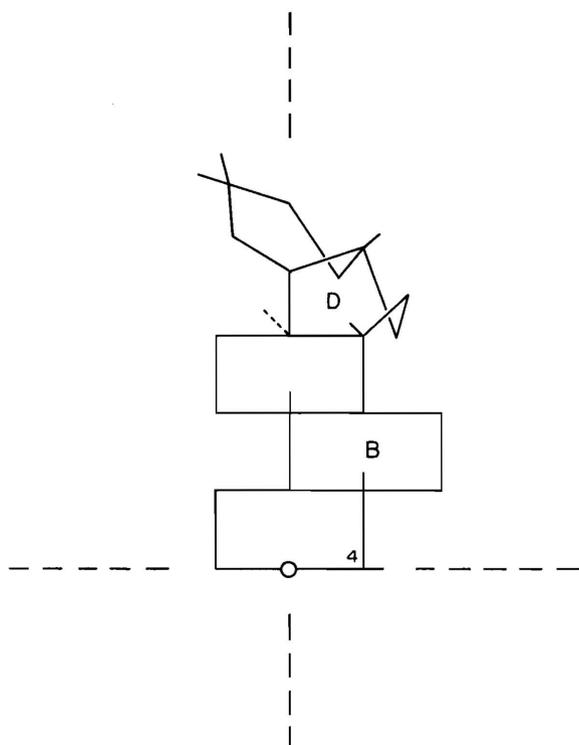


Figure 3. Octant Projection of D:A-Friedo-Oleanone (2)

conformation for rings D and E, on the basis of the relative lanthanide induced shift values of the carbons. It is interesting to verify this conformation in the absence of the coordinating lanthanide shift reagent for D:A-friedo-oleanones (2) and (5), and to check

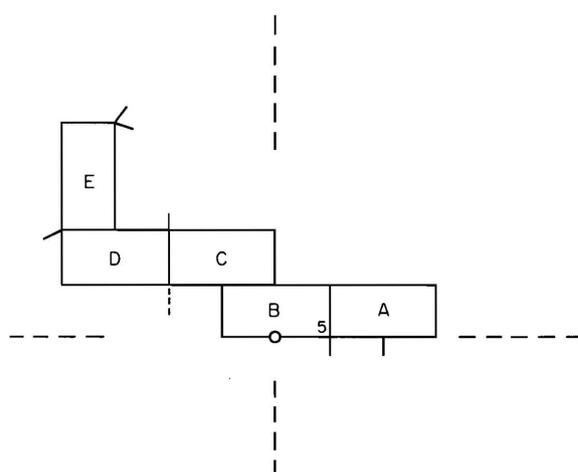
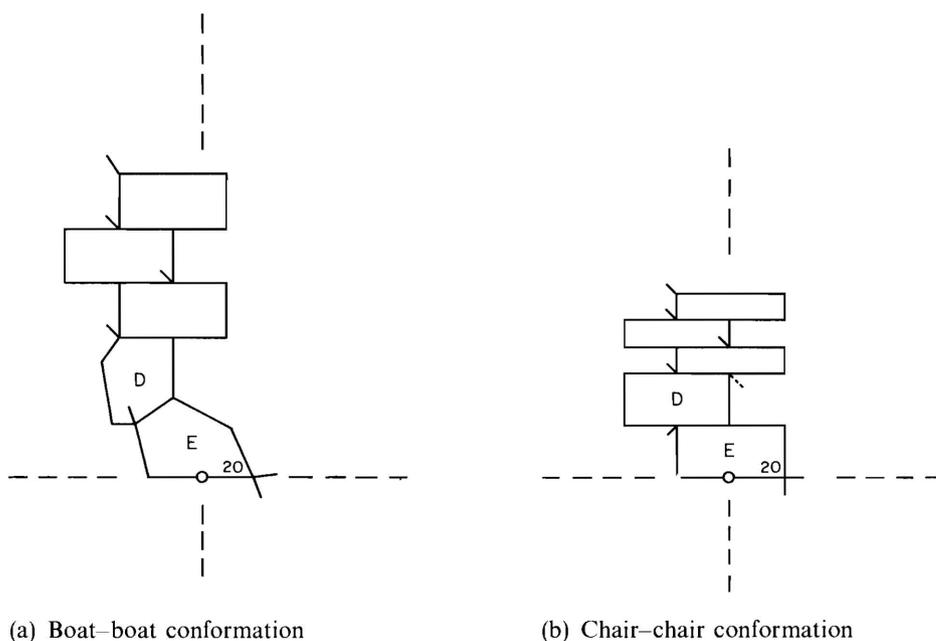


Figure 4. Octant Projection of D:A-Friedo-Oleanone (3)

whether this holds true for other D:A-friedo-oleanones as well.

CD data do not suffer from background effects, as do ORD data, and are more suitable for comparative purposes. It has been shown [10] that when comparing the CD data for closely related compounds bearing the same chromophore, the value of  $\Delta\epsilon$  serves as a reliable measure of the rotation strength, if the half-band widths and  $\lambda_{\max}$  are similar. A second chromophore is absent in D:A-friedo-oleanones (1–5); the CD data from measurements made under identical conditions will be suitable for comparison. Some useful generalizations on empirical analysis of the



(a) Boat-boat conformation

(b) Chair-chair conformation

Figure 5. Octant Projection of D:A-Friedo-Oleanone (4): D/E Rings Conformation

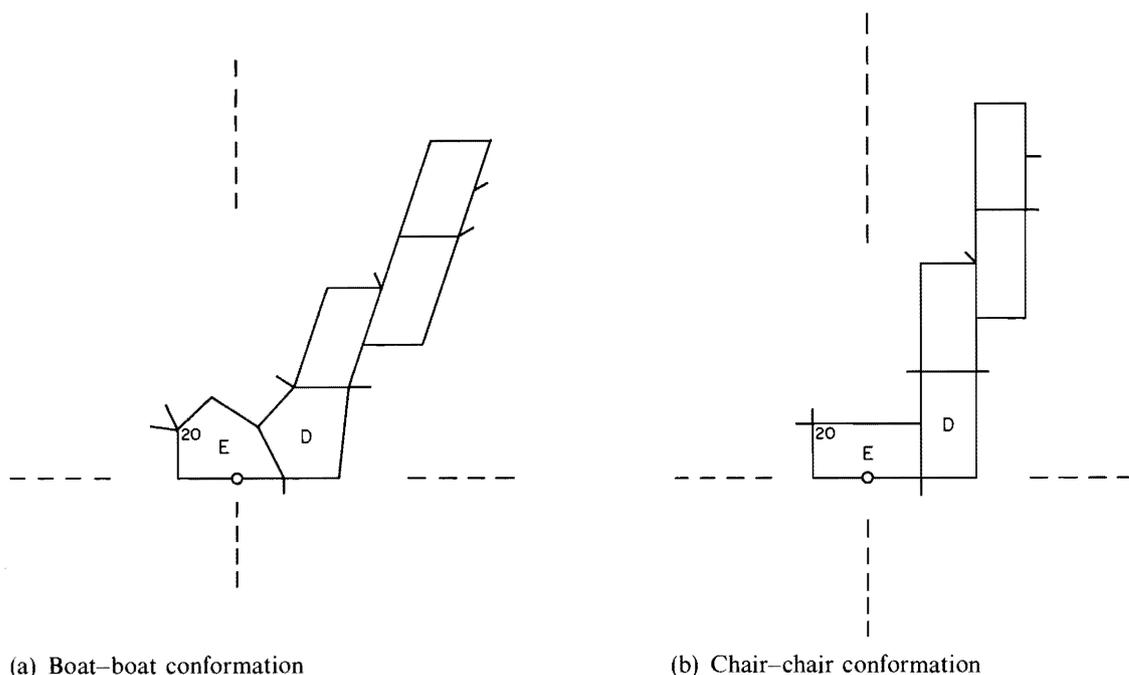


Figure 6. Octant Projection of *D:A-Friedo-Oleanone* (5): *D/E Rings Conformation*

contribution of key structural features to the CD of a molecule in the region of its  $n \rightarrow \pi^*$  transition ( $\lambda \approx 290$  nm) have been published [3]. However, several shortcomings in the analysis have recently been highlighted [11]. In this paper, we have attempted to provide a qualitative analysis of the data presented.

Octant projections of *D:A-friedo-oleanones* (1), (2), (3), (4), and (5) are shown in Figures 2 to 6, respectively. In 1-oxo-*D:A-friedo-oleanane* (1), the  $\beta$ -axial methyl group at C-5 has a small positive contribution; the negative  $\Delta\epsilon$  arises owing to the contributions from C, D, and E rings in the negative quadrant. The conformations of D and E rings should have no influence on the Cotton effect. The negative Cotton effect observed for 3-oxo-*D:A-friedo-oleanane* (2) may also be explained by considering the octant projection (see Figure 3). In this molecule, the entire B and D rings are in the negative quadrant and only some

portions of the distant C and E rings are in the positive quadrant. The D and E rings may be assumed to be in boat-boat conformations, as evidenced by NMR studies [1]. Octant projection for 6-oxo-*D:A-friedo-oleanane* (3) clearly predicts the observed positive Cotton effect for this molecule (see Figure 4). Figures 5(a) and 5(b), respectively, depict the octant projections for 21-oxo-*D:A-friedo-oleanane* (4) with boat-boat and chair-chair conformations for the D and E rings. It is difficult to explain the large positive Cotton effect exhibited by *D:A-friedo-oleanone* (4), but it seems to favor the boat-boat conformation for the D and E rings. It is known [12] that the 4,4-dimethyl effect in  $\beta$ -amyrenone (7) is responsible for its positive Cotton effect, whereas in 3-oxo-lanostane (8) the 4,4-dimethyl effect produces a negative Cotton effect (see Figure 7). It is noteworthy that *D:A-friedo-oleanone* (4) has a structure similar to that of (8)

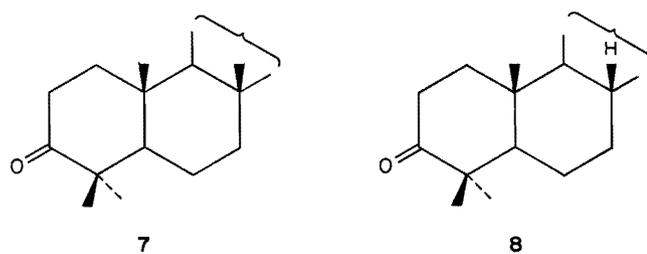


Figure 7. Partial Structures of  $\beta$ -Amyrenone (7) and 3-oxo-Lanostane (8)

Octant projections for 22-oxo-D:A-friedo-oleanane (5) with boat–boat and chair–chair conformations for the D and E rings are shown, respectively, in Figures 6(a) and 6(b). Unfortunately, the sign of the Cotton effect does not distinguish between the two forms. The positive contribution from  $\alpha$ -axial methyl and  $\beta$ -methyls appears to be greater than the negative contribution made by distant rings.

## EXPERIMENTAL

Care was taken to ensure the same experimental conditions in all measurements. Measurements were all performed in chloroform as solvent, giving Cotton effect curves without fine structure. The determinations were made at room temperature (27°C), using a 0.1 cm sample cell; concentrations were all 5 mg/ml. The JASCO instrument used was at the Indian Institute of Science (Bangalore).

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