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β-CAROTENE FILM AT A WATER-AIR INTERFACE

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SUMMARY

The surface pressure-area curve for β-carotene was investigated and found to be different from an earlier report. The extrapolation of the steep part of the π–A curve gives 18Å^2/molecule, which agrees with the cross sectional area of one molecule. A single layer seems to be present at the air-water interface.

INTRODUCTION

The surface pressure-area (π–A) curves for different chloroplast components have been recently investigated at the air-water interface[1]. These values were used as standard in the dipping of mono- or multilayer assemblies on quartz slides. All the pigments studied had a polar group in the molecule. Because of the importance of β-carotene in the chloroplast, we have also investigated the π–A curve of this pigment on the surface of water, for possible incorporation.

EXPERIMENTAL

A simple Langmuir film balance with a sensitivity of 0.10 dyne·cm^{-1}·degree^{-1} was used. Stearic acid and cholesterol served to standardise the apparatus. The experimental technique was the same as that reported earlier[1,2].

RESULTS AND DISCUSSION

The film pressure-area curve given in Fig. 1 compares our result with that of Colmano and McGlone[3], who used a Mann or Rias sample of β-carotene. We have used the same spreading solvent (benzene), the same subphase (phosphate buffer, $1 \cdot 10^{-3}$ M, pH 7.8-8.0), and a fresh Sigma sample (concentration, $1.0 \cdot 10^{-3}$ M, measured by weight, agrees within 5 % with the concentration calculated from the spectrum, $\varepsilon_{465\,\mathrm{nm}} = 1.26 \cdot 10^5$–$1.58 \cdot 10^5$ l·mole^{-1}·cm^{-1}, ref. 4).

The area/molecule values for our curve have been calculated assuming that all the molecules dispensed onto the surface are in contact with the water. We have ob-

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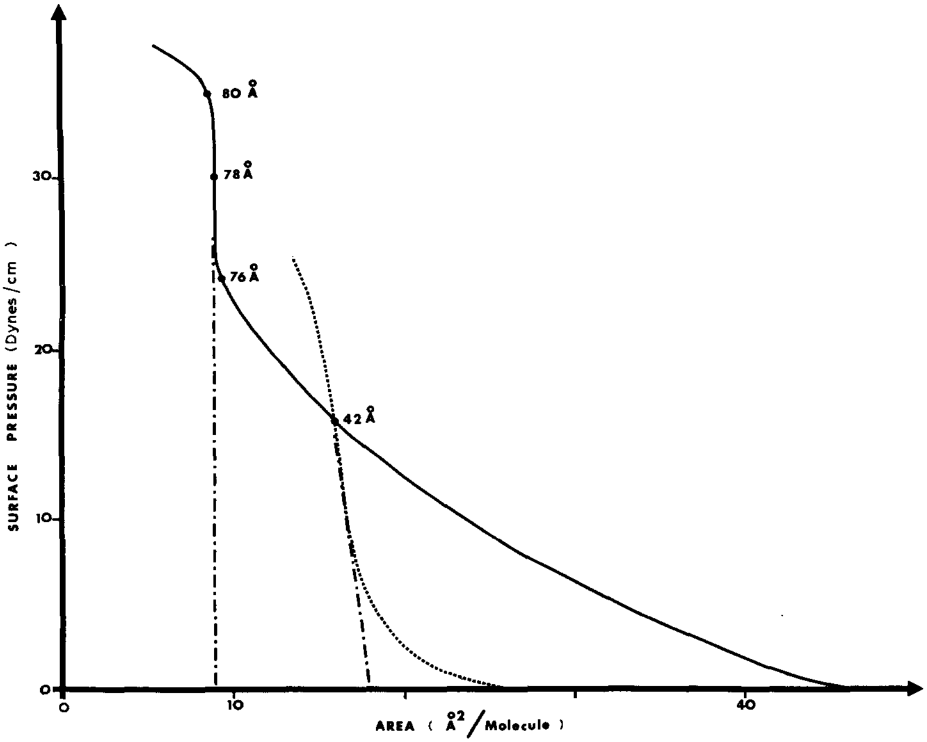

Fig. 1. Surface pressure–area (π–A) isotherms of β-carotene film on triple-distilled water, pH 8.0 (phosphate buffer), at 20°C; – – – –, present work; ————, Colmano and McGlone's[3] result on the same subphase, at 22°C.

served that the film is unstable during compression, and a continuous compression (rate 25 cm²/min) is needed to reproduce the results. β-Carotene has no polar group to orient the molecules on the water surface, and we observed the formation of islands on the subphase at zero film pressure. A similar observation has been mentioned recently[5].

Colmano and McGlone explained their film isotherm by ellipsometric thickness determination on Langmuir–Blodgett slides. They found a thickness of 42 Å at 16 dynes·cm^{-1}, 76 Å at 24 dynes·cm^{-1} per double layer, *etc.* (see Fig. 1). The extrapolation of the steep part of their curve indicated an area of about 9 Å²/molecule per double layer or 18 Å²/molecule per single layer. The latter agreed with the cross sectional area of one molecule derived from models. The extrapolation of the steep part of our curve gives 18 Å² per molecule, in agreement with the above value for molecules in a single layer, and indicates that in our case only a single layer of molecules is present on the water surface. Furthermore, the shape of the π-A curve and the limiting area of 26 Å² per molecule extrapolated to zero pressure which we obtain can reasonably be attributed to the existence of a single layer throughout compression. Colmano and McGlone's limiting area of 47 Å² per molecule presumably also refers to a single layer, with a gradual transformation to a tightly packed double layer occurring on compression. The large difference between these values is not easily explained, but it is clear that the behaviour of the carotene layer at low pressures is complicated by the absence of a stabilising polar group, and will probably depend critically on the experimental conditions.

Our results show that it is possible to obtain a single layer during a continuous compression of β-carotene. However, the instability of the layer when compression is stopped does not permit a uniform deposition of the monolayer on a hydrophobic quartz slide.

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