*Tabelle II*

| | dyn/cm |
|---|---|
| Iridium | 5000 |
| Wolfram | 3600 |
| Aluminiumoxyd | 2300 |
| Platin | 2100 |
| Eisen | 1800 |
| Gold | 1200 |
| Silber | 930 |
| Quarzglas | 650 |
| Kadmium | 600 |
| Marmor | 400 |
| Blei | 330 |
| Graphit | 120 |
| Paraffin | 27 |
| Wachs | 14 |

zitätsmodul besitzen, haben konsequenterweise entsprechend verschiedene $\sigma$-Werte. So beträgt der $E$-Modul für Quarz in der X-Achse 8700, in der Y-Achse 7900 kg/mm². Daraus errechnen sich die Oberflächenspannungen zu $\sigma = 720$ bzw. 680 dyn/cm.

Die hohen $\sigma$-Werte im festen Zustand bedingen entsprechende Größen für den Kapillardruck und damit eine Abrundung von Kristallkanten im Bereiche des $\mu\mu$.

Das entgegengesetzte Extrem zeigt die Oberflächenspannung im gasförmigen Zustand. Sie liegt bei den meisten permanenten Gasen unter Normalbedingungen in der Größenordnung von 0,005 dyn/cm und ist annähernd dem Druck proportional.

R. AUERBACH

Přísečnice (ČSR), den 17. März 1948.

*Summary*

The preceding empirical relation was found between the surface tension of liquids $\sigma$, the specific weight of liquids $\varrho$, and the velocity of sound: $\sigma = 6{\cdot}3 \cdot 10^{-4}\, \varrho\, v^{3/2}$. In place of the velocity of sound can be used, with suitable changes in the equation, the compressibility or, in the case of solid substances, the elasticity of the material in question. The range of validity of this relation is so large that it is possible by means of it to calculate the surface tension of solid substances and of gases.

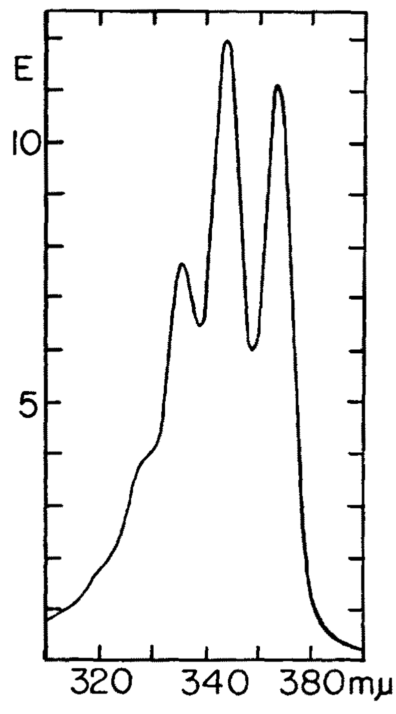
## On Naturally Occurring Colorless Polyenes

The resolution of plant extracts has shown in many instances the presence of the same colorless hydrocarbon, termed phytofluene[1], $C_{40}H_{64}$ ($\pm$ 2 H), which can be easily located on the Tswett column by its brilliant, greenish-gray fluorescence in ultraviolet light. Since phytofluene occurs in tomatoes, carrots, oranges, grape fruits, melons, red pepper, yellow corn, etc., it is a regular constituent of our diet and may occasionally appear also in the yolk of hen's eggs.

Phytofluene shows the molecular weight and the methyl side-chain number of an ordinary $C_{40}$-carotenoid; however, it contains only seven double bonds of which, as indicated by the spectrum, only five can be conjugated in an open chain. Since this compound represents a higher level of hydrogenation than that of the colored carotenoids, it may well constitute an intermediate product in the biosynthesis of these pigments in which the final step appears to be dehydrogenation[1].

Characteristic of this first representative of the structurally carotene-like but colorless polyenes is its occurrence in such higher plant organs (and some Cryptogams) which are rich in carotenoid pigments. Although the chromatograms of many extracts show a broad and intense fluorescing zone, the phytofluene content was regularly found to be much inferior to the pigment quantity. For example, the ratio of colored carotenoids to colorless carotenoid was 100:1 in carrots, 15:1 in ripe tomatoes, and 10:1 in the ripe berries of *Pyracantha angustifolia* SCHNEID. So far we have encountered only a single plant material in which this ratio was inverted, viz. the fresh, anthocyan-containing, sky-blue flowers of the Brazilian tree, *Jacaranda ovalifolia* R. BR. (grown in Southern California), 1 kg of which contained as little as 0·06 mg of polyene pigment (almost exclusively, $\beta$-carotene) but 0·6 mg of phytofluene.

Considering the great variations in the oxygen content of common carotenoids, it seemed likely that O-containing representatives of the phytofluene class would also occur in nature. After numerous materials had been tested with negative result, we found that such a compound, termed phytofluenol, is contained in some ripe tomatoes, although, because of the small quantities, it has not yet been prepared in analytically pure state. Upon repeated chromatographic fractionations on lime, alumina, and calcium carbonate, for example, 12 mg of crude but practically colorless phytofluenol was obtained from 30 kg of commercial canned tomato paste, corresponding to 75–90 kg of fresh fruit (harvested in California). This yield, i. e. about 0·15 mg per kg of fresh tomatoes, amounts to less




Extinction curve of phytofluenol in hexane as taken in the Beckman photoelectric spectrophotometer ($E$ relative extinction).

[1] L. ZECHMEISTER and A. POLGÁR, Science *100*, 317 (1944). – L. ZECHMEISTER and A. SANDOVAL, Arch. Biochemistry *8*, 425 (1945); J. Amer. Chem. Soc. *68*, 197 (1946); Science *101*, 585 (1945). – L. ZECHMEISTER and F. HAXO, Arch. Biochemistry *11*, 539 (1946). – A. SANDOVAL, E. R. MESERVE, H. J. DEUEL, Jr., and L. ZECHMEISTER, Arch. Biochemistry *11*, 373 (1946). – J. BONNER, A. SANDOVAL, Y. W. TANG, and L. ZECHMEISTER, Arch. Biochemistry *10*, 113 (1946).

[1] Cf. V. N. LUBIMENKO, Mém. Acad. Sci. Pétrograd, VIII. s. *33*, No. 12 (1916). – L. ZECHMEISTER and L. CHOLNOKY, Liebig's Ann. Chem. *465*, 288 (1928). – R. KUHN and W. WIEGAND, Helv. chim. acta *12*, 499 (1929).

than 2% of their usual phytofluene content, and represents but a negligible fraction of the total polyenes which are built up in the fruit during the ripening process.

The polyene nature of phytofluenol is indicated by the appearance of a dark bluish-green coloration when its hexane solution is filtered through acid earths (filtrol). It is more sharply characterized by the spectral curve, the shape of which is practically identical with that of phytofluene, showing in hexane solution two steep main maxima, at 348 m$\mu$ and 367 m$\mu$ respectively (see figure).

Phytofluenol and phytofluene may be easily differentiated by their behavior in partition or adsorption tests.

When partitioned between equal volumes of hexane and 83% ethanol, the ratio of concentration in the upper phase to concentration in the lower phase was found to be 6:1 for phytofluenol but 100:0 for phytofluene. In the partition between hexane and 95% methanol, the corresponding ratios were 2·2:1 for phytofluenol and 100:1 for phytofluene.

As we reported earlier, phytofluene shows strong adsorption affinity. This is, however, much surpassed by that of phytofluenol. The following top-to-bottom sequences on a calcium hydroxide column are typical:

| Developed with petroleum ether (b. p. 60–70°) containing 15%acetone: | Developed with petroleum ether containing 1–3% acetone: |
|---|---|
| Lycopene | $\gamma$-Carotene |
| Neo-lycopene A | $\beta$-Carotene |
| Phytofluenol | $\alpha$-Carotene |
| Cryptoxanthin | Phytofluene |
| $\gamma$-Carotene | Neo-$\alpha$-carotenes |

Evidently, the strength of the adsorption affinity of polyenes (with carotene-like carbon skeletons), cannot generally be predicted, even for hydrocarbons, solely on the basis of the number of all double bonds or conjugated double bonds present. When compared to the chromophore of carotenoid pigments, the conjugated systems of phytofluenol and phytofluene appear to be "incomplete", in the sense that they leave a considerable part of the aliphatic chain in the saturated state. This particular feature seems to be responsible for the surprisingly high adsorbability of the two colorless polyenes under discussion as well as for their strong fluorescence in solutions and adsorbates.

L. Zechmeister and J. H. Pinckard

California Institute of Technology, Gates and Crellin Laboratories of Chemistry, Pasadena, California, U.S.A., August 10, 1948.

*Zusammenfassung*

Die farblosen, lebhaft fluoreszierenden Polyene, Phytofluen und Phytofluenol, wurden in Pflanzenextrakten aufgefunden. Sie werden spektroskopisch sowie chromatographisch gekennzeichnet und ihre Beziehung zu carotinoiden Farbstoffen wird besprochen.

## Mikrofibrillenbau der pflanzlichen Zellwände

Durch eine geeignete Zerkleinerungsmethode ist es gelungen, hinreichend dünne Fragmente von pflanzlichen Zellwänden *mit ungestörtem Feinbau* zu erhalten, die nach der Metallbedampfungsmethode präpariert[1], im Elektronenmikroskop einen wundervollen Fibrillenbau zeigen[2]. In Dutzenden von Aufnahmen, von denen hier vier reproduziert sind, kann festgestellt werden, daß sowohl die zum Flächenwachstum befähigten Primärwände als auch die durch Apposition niedergelegten Sekundärwände aus Mikrofibrillen[3] mit auffallend konstantem Durchmesser von 250–300 Å aufgebaut sind.

In den Primärwänden zeigen die Mikrofibrillen Streuung um eine Hauptrichtung (Abb. 1), wie dies für die

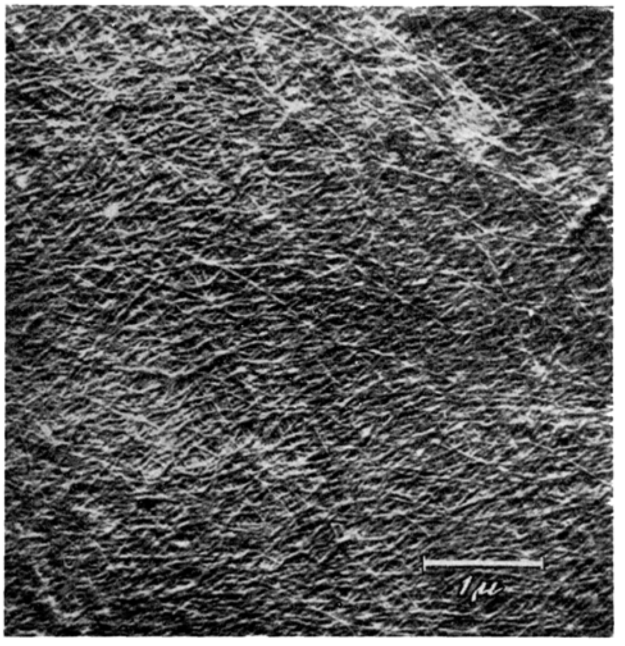



Abb. 1. Primäre Zellwand aus dem Wurzelmeristem von *Zea Mays*.

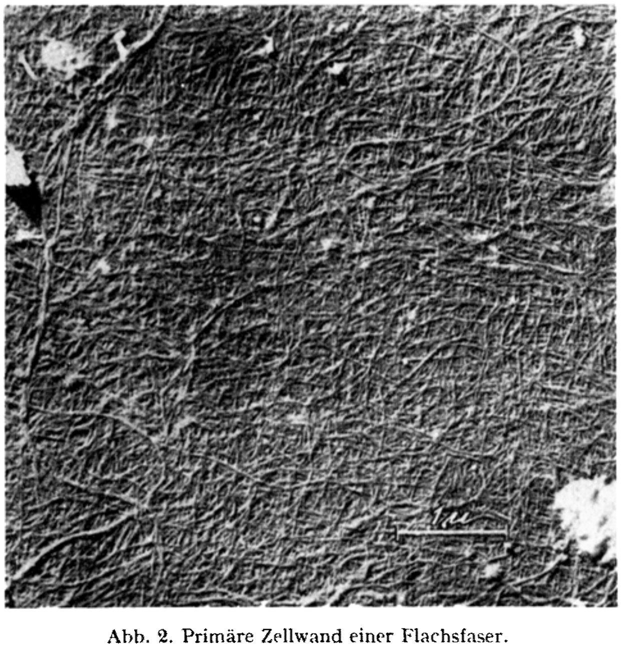



Abb. 2. Primäre Zellwand einer Flachsfaser.

[1] R. C. Williams und R. W. G. Wykoff, J. Appl. Physics *17*, 23 (1946).
[2] K. Mühlethaler, Biophysica acta, im Druck.
[3] A. Frey-Wyssling, Protoplasma *27*, 402 (1937).