($\log \varepsilon = 4.6$) for lumichrome. From the results in Table I, it is evident that the breakdown of riboflavin to lumichrome is quantitative in this system.

Tab. I. Stoichiometry of the hydrolysis of riboflavin

| Time min | Riboflavin disappearance mμ moles | Lumichrome formation mμ moles |
|---|---|---|
| 30 | − 39.2 | + 37.6 |
| 60 | − 55.3 | + 55.1 |
| 90 | − 58.3 | + 58.1 |
| 120 | − 60.3 | + 60.1 |

Reaction mixtures contained 0.4 ml of sodium phosphate buffer, pH 7.2; 0.1 ml of reduced glutathione, 0.2 m$M$; 0.5 ml of riboflavin, 0.02 m$M$; and 1.0 ml of the enzyme in a total volume of 2.0 ml. The reaction mixtures were incubated at 37° for the time intervals specified in Table I.

Tab. II. Distribution of the riboflavin hydrolyzing enzyme in plants

| Plant[a] | Natural order | Activity[b] per mg protein |
|---|---|---|
| *Crinum longifolium* | Amaryllidaceae | 18.3 |
| *Crinum asiatica* | Amaryllidaceae | 16.5 |
| *Crinum amabale* | Amaryllidaceae | 16.5 |
| *Haemanthus multiflorus* | Amaryllidaceae | 17.2 |
| *Polyanthus* Sp. | Amaryllidaceae | 13.5 |
| *Amaryllis* Sp. | Amaryllidaceae | 12.8 |
| *Allium cepa* | Lilliaceae | 6.3 |
| *Canna indica* | Cannaceae | 6.9 |

[a] Hypogeous part processed as described in text.
[b] Activity is expressed as mμ moles of lumichrome synthesized at 37° in 60 min.

A number of plants were screened for the presence of the riboflavin-lumichrome conversion. Although this enzyme does not occur generally in plants, it is found in members of the natural orders *Amarylliaceace*, *Lilliaceace*, and *Cannaceace*. Table II gives the activity per mg protein in extracts of these plants. It is perhaps significant that the enzyme system catalyzing the hydrolysis of riboflavin occurs in monocotyledonous plants, in view of the reported hormonal activity of lumichrome[12]. The optimum conditions for activity in all cases were pH 7.2 and 37°; catalytic amounts of reduced glutathione were also required.

Our observation that certain plant extracts can catalyse the hydrolysis of riboflavin to lumichrome suggests that there are alternate pathways of riboflavin metabolism in plant kingdom[13].

*Résumé.* Il a été prouvé que l'hydrolyse de la riboflavine à l'aide d'une enzyme se produit dans les extraits de plantes appartenant aux familles des *Liliacées*, *Amaryllidacées* et *Cannas* (ou Balisier).

On a trouvé le lumichrome et le ribitole parmi les produits de l'hydrolyse. La réaction est stœchiométrique, les conditions favorisant une activité optimale sont les suivantes: pH 7.4, température 37°, quantités catalytiques de glutathione reduit.

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[12] H. K. Mitchell and M. B. Houlahan, Amer. J. Bot. *33*, 31 (1946).
[13] This work was supported by a grant from the Indian Council of Scientific and Industrial Research. The authors are thankful to Dr. H. R. Cama and Dr. C. S. Vaidyanathan for their valuable suggestions.
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## Asymmetry and Yield in *Cocos nucifera* L.

The leaves of *Cocos nucifera* L. are arranged in a right-handed of left-handed spiral, the angle between corresponding leaves in successive whorls being about 30°. The frequency of lefts among 3028 trees in India was 52.05% (Davis[1]) and among 13842 trees elsewhere it was 52.90%. The asymmetry is not inherited (Davis[1]) and has been regarded as trivial.

Of the 384 trees used at the Central Coconut Research Station, Kayangulam, Kerala (India), for trials of micronutrients, 177 were left-spiralled. They were divided into three groups, healthy, moderately affected by a major Root (wilt) disease, and severely affected. The mean number of nuts per year borne by the right-spiralled and left-spiralled trees in these groups between 1955 and 1960 inclusive are shown in the Table.

The figures for the healthy trees give $t = 2.721$ (126 degrees of freedom). The probability for a difference of that magnitude or more being small ($P = 0.0076$), the assumption that left-spiralled trees give higher yields is strongly substantiated. The figures for the diseased trees, though not quite significantly different, strongly reinforce the significance of those for the healthy trees.

As neither the nuts nor the kernels from the two types of trees were weighed separately, it is, of course, possible that the total mean weight of copra produced by the left-spiralled trees was not greater than that from the right-spiralled. Nor is it claimed that all races of coconut, in all soils and climates, behave in this way. However, the biological fact here presented is, I believe, novel. Many explanations can be suggested for it, of which I hope to discuss some elsewhere[2].

Average number of nuts produced per tree per year

| Condition of trees | No. of trees right | No. of trees left | Nuts per tree/year right | Nuts per tree/year left |
|---|---|---|---|---|
| Healthy | 70 | 58 | 53.93 | 65.25 |
| Moderate disease | 67 | 61 | 32.60 | 35.98 |
| Severe disease | 70 | 58 | 18.58 | 23.15 |

[1] T. A. Davis, J. Genet., *58*, 12 (1962).
[2] Help received from the Indian Central Coconut Committee for my service is gratefully acknowledged.

*Zusammenfassung.* Die Blätter der Kokospalme (*Cocos nucifera* L.) sind in links- oder rechtsdrehenden Spiralen angeordnet. Zählungen an einem grossen Material indischer und nichtindischer Palmen (3028 bzw. 13842 Bäume) ergab ein geringfügiges Überwiegen der linksdrehenden Blattspiralen (52,05% bzw. 52,90%). Der Drehsinn der Spiralen erwies sich, wie Kreuzungsversuche zeigten, als genetisch nicht fixiert. In fünfjährigem Feldversuch (1955–1960) lieferten Palmen mit linksdrehenden Blattspiralen einen signifikant grösseren Ertrag an Kokosnüssen.

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## Histoenzymologic Behaviour of the Giant Cell of Foreign Body Granuloma as Compared with the Osteoclast

Earlier publications have shown that osteoclasts and chondroclasts possess great enzymatic activity. Large quantities of acid phosphatase[1,2], succinic-dehydrogenase[3,4], cytochrome oxidase[4] and β-glucuronidase[5] have been found in these cells.

From these findings it can be assumed that some relationship may exist between these enzymes and bone and cartilage absorption processes. The morphological similarity of the osteoclast and foreign body giant cell induced us to make a comparative study of these two elements. Only isolated data are available on the histoenzymologic behaviour of foreign body granuloma multinucleated cells[6].

We studied the histoenzymologic pattern of: (1) Osteoclasts and chondroclasts under normal conditions in C3H mice, Wistar rats, Hamster and man, using enchondral and membranous growth zones (areas of enchondral growth of femur and tibia and membranous growth of maxilla). (2) The same material in Wistar rats that received 1000 U. of parathyroid hormone subcutaneously and killed 60 h later[7]. (3) A series of pathologic processes characterized by abundant multinucleated giant-cells (osteoclastoma, solitary and aneurysmal) bone cysts and giant cell of foreign body granuloma. (4) Giant cells of foreign body granuloma induced by the introduction of a cellulose sponge into Wistar rats and C3H mice killed one month later and by the presence of detritus in experimentally provoked wounds in tongue of Wistar rats.

Fragments of tissue were fixed in neutral formalin in order to demonstrate acid phosphatase (GOMORI's method[8], RUTENBURG and SELIGMAN's method[9]), phosphamidase (MEYER and WEINMAN's method[10]); in chloralhydrate formalin to show β-glucuronidase (FISHMAN and BAKER's method[11]). In all techniques frozen sections were used. Other fragment was kept at −20°C; sections being prepared with the cryostate to determine the presence of succinic-dehydrogenase (PEARSON and DEFENDI's method[12], NACHLAS et al.[13]). The calcified material was treated for the demonstration of acid phosphatase with our pro-

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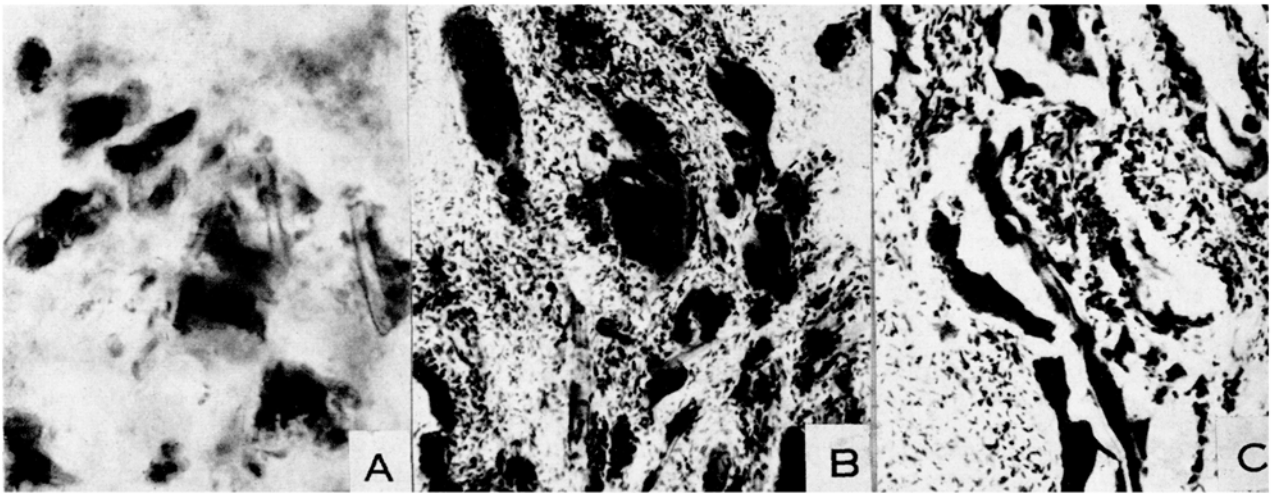


Foreign body granuloms produce bay cellulose sponge. The giant cells appears intensely stained. A = succinic-dehydrogenase demonstration (NACHLAS et al.[13]). B = phosphamidase demonstration (MEYER and WEINMAN[10]). C = acid phosphatase demonstration (GOMORI[8]). In B and C the stromal fibroblastic cells react moderately.