marily determines the overall rate of absorption. Thus, the reasons for the marked differences in rates of absorption of different lipid substances in the same species or of the same lipid in different species may be explained in terms of differences in the geometry or physical characteristics of this unstirred layer rather than in differences in the cell membrane.

FREDERICK A. WILSON
VERNEY L. SALLEE, JOHN M. DIETSCHY
Department of Internal Medicine, University of Texas Southwestern Medical School at Dallas, 5323 Harry Hines Boulevard, Dallas 75235

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Desiccation-Tolerant Flowering Plants in Southern Africa

Abstract. *The South African flora contains a unique abundance of higher plants which withstand virtually complete desiccation. Water potentials of field-dry leaves corresponded to 30 to 40 percent relative humidity. Mature leaves survived from 15 to approximately 0 percent relative humidity. Known examples were increased from 4 to 15 species, which for the first time included grasses.*

Extremely few angiosperms ("flowering plants") possess mature foliage that is desiccation-tolerant. Of the ten species reported in the literature, four (*Chamaegigas intrepidus, Craterostigma plantagineum, Myrothamnus flabellifolia,* and *Xerophyta humilis*) occur in southern Africa, together with a number of reputedly drought-tolerant ferns. However, the drought tolerance (*1*) of these species has not been determined. No survival tests have been applied to establish the revival of the foliage beyond resumption of a superficially healthy appearance on rehydration, except for *Myrothamnus*.

In order to investigate these questions further, foliage was collected in a dry condition from the field during the dry season in 1970. Survival of tissue was judged by a combination of tests [regain of turgor on rehydration, neutral red uptake (*2*), exclusion of Evans blue (*3*), photosynthesis in chlorophyllous leaves (*4*), and formation of chlorophyll in nonchlorophyllous leaves], insofar as they were applicable to a particular species. It was found that the four African species survived desiccation under field conditions to water potentials equivalent to 33 percent relative humidity and less [determined by the gravimetric vapor exchange method (*5*); see Table 1]. Moreover, it became apparent that a number of other flowering plants and ferns growing in similar habitats were equally as hardy (see Tables 1 and 2).

The data for *Chamaegigas* (Table 2) was particularly striking; the basal "submerged" leaves of the minute water plant had a drought tolerance of 0 to 5 percent, its floating leaves 5 percent when folded together in the bud, but 96 percent when mature! Although drought tolerances of 0 percent have been reported for mosses and lichens (*6*), the lowest reliable value of drought tolerance previously reported for flowering plants was 85 percent relative humidity for plants of *Hordeum vulgare* 'Kearney' which had been hardened by exposure to low temperatures for several weeks (*7*). Preliminary tests on a number of other flowering plants indicated that they also were endowed with extreme drought tolerance, but time did not allow the tolerance to be measured (for example, *Xerophyta equisetoides* Baker, *X. squarrosa, X. villosa* = *Vellozia villosa* Baker).

The fact that four drought-tolerant grasses were found is particularly important, as no member of this economically important family has previ-

Table 1. Water stress of leaves (given as the relative humidity of air in equilibrium with the leaves at 28°C) collected in a dry condition in the field. Drought tolerance levels were determined by allowing field dry foliage to equilibrate to air of various constant relative humidities, maintained by saturated solutions in equilibrium with solid solute at 28°C (*8*). Mixtures of water and sulfuric acid were employed for relative humidities below 15 percent, and concentrated sulfuric acid was used for establishing approximately 0 percent relative humidity (*8*). Equilibration was extremely slow; in general, 4 to 8 weeks were required for constant weight to be attained. The dry-land ferns tested possessed drought-tolerance values ranging from 15 percent relative humidity for the least hardy species, *Doryopteris concolor* (Langsd. & Fisch.) Kuhn (a value equal to the tolerance found for the American fern *Selaginella lepidophylla*), down to approximately 0 percent relative humidity for *Mohria caffrorum* (L.) Desv. Virtually all of the "resurrection" angiosperms tested possessed drought tolerances of approximately 0 percent relative humidity, that is, 50 percent or more of the leaf tissues survived equilibration over concentrated sulfuric acid (see Table 2).

Plants	Relative humidity (%)
Craterostigma wilmsii Engl.	51
Coleochloa setifera (Ridley) Gilly	39
Xerophyta retinervis Baker	37
Oropetium capense Stapf	33
Myrothamnus flabellifolius Welw.	33
Xerophyta humilis (Baker) Dur. & Schinz	32
Xerophyta viscosa Baker	31
Chamaegigas intrepidus Dinter ex Heil	30
Craterostigma plantagineum Hochst.	15
Xerophyta squarrosa Welw. ex Baker	7

Table 2. Drought tolerance of mature foliage, expressed as the equivalent relative humidity at 28°C.

Plant	Relative humidity (%)
Scrophulariaceae	
Craterostigma wilmsii	0 to 15
C. plantagineum	Approx. 0
Chamaegigas intrepidus	
Submerged leaves	0 to 5
Immature floating leaves	5
Mature floating leaves	96
Myrothamnaceae	
Myrothamnus flabellifolia	Approx. 0
Velloziaceae	
Xerophyta clavata Baker	5
X. viscosa	Approx. 0
X. elegans Baker	Approx. 0
X. retinervis	Approx. 0
X. humilis	Approx. 0
Cyperaceae	
Coleochloa setifera	Approx. 0
Poaceae	
Oropetium capense	Approx. 0

ously been known to possess desiccation-tolerant mature foliage; *Oropetium capense* Stapf (see Table 1), *Sporobolus stapfianus* Gand., *Eragrostis denudata* Hack. ex Schinz, and *Microchloa caffra* Nees were found to endure dehydration to air dryness in the laboratory, that is, approximately 30 to 40 percent relative humidity. In addition, the desiccation-tolerant sedge *Ficinia filiformis* Schrad. was clearly palatable to grazing animals. Unfortunately, time and scarcity of material did not allow a full investigation of these species.

D. F. GAFF

Botany Department,
Monash University,
Clayton, 3168, Australia

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Melanin Pigmentation: An in vivo Model for Studies of Melanosome Kinetics within Keratinocytes

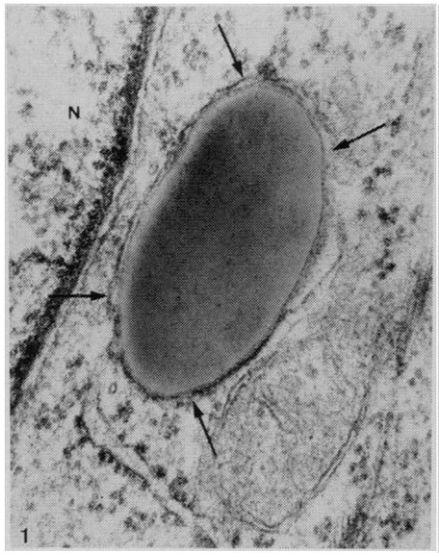
Abstract. *The phagocytosis of latex beads by epidermal cells is proposed as a model for studies on melanosome kinetics within the epidermis. Large latex beads (0.8 micrometer) are ingested singly, whereas small beads (0.1 micrometer) are taken up in groups, results showing that the uptake mechanism depends on the size of the individual particles. This size-dependency may explain the different distribution patterns of melanosomes and thus the differences of skin color in the Caucasoid and Negroid races.*

Most of the knowledge on mechanisms of pigment transfer and on the fate of melanosomes within epidermal cells is derived from experiments with tissue culture (*1*). Studies of pigmented tissues with the electron microscope appear to confirm these data (*2*), but there is still little information on the dynamics of these phenomena in vivo. Since the uptake of melanosomes by keratinocytes is a heterophagic process (*3*), the phagocytosis by epidermal cells of particles resembling melanosomes might prove a useful model for studies on melanosome kinetics within keratinocytes.

Polystyrene latex beads (*4*) are suitable for this purpose because their shape resembles that of melanosomes and their sizes can be adjusted to those of melanosomes. Subepidermal blisters were produced in guinea pigs with a suction blister device (*5*), and suspensions of latex beads were injected percutaneously into the blisters. This provided direct contact between the latex particles and the epithelial cells that, in the healing phase, advanced over the denuded floor of the blisters. Examination with the electron microscope revealed that the latex beads were avidly ingested by the keratinocytes and were incorporated into phagosomes limited by single membranes (Figs. 1 and 2). The mode of uptake and of intracellular transport of the particles and their inclusion into the lysosomal system as shown by the presence of acid hydrolase activity inside the delimiting membrane have been described (*6*). Here we report that (i) uptake of the latex beads into keratinocytes occurred with ease and (ii) the mechanism involved depended on the size of the beads, since large beads (0.8 by 0.4 μm) were always ingested singly (Fig. 1) whereas small ones (0.1 by 0.05 μm) were taken up in groups (Fig. 2). This mode of uptake resembles phagocytosis of latex beads by acanthamoeba, which ingests large particles (1.305 μm) individually and small ones (0.537 μm) together as a compact mass (*7*).

The similarities between this model system and the melanosome system in vivo are striking. Latex beads resemble melanosomes in shape and size, both are incorporated, either singly or in groups, into phagosomes of keratinocytes, and both are exposed to the action of hydrolytic enzymes within lysomes (*6*, *8*). This experimental system can be manipulated at will and thus permits exploration of problems that are difficult to study directly in the melanosome system in vivo.

For example, the model system already provides a significant clue to a fascinating phenomenon of pigmentation: the strikingly different distribution patterns of melanosomes within Caucasoid and Negroid keratinocytes—distribution patterns that are held responsible for the differences of skin color in the two races (*9*). In Negroids



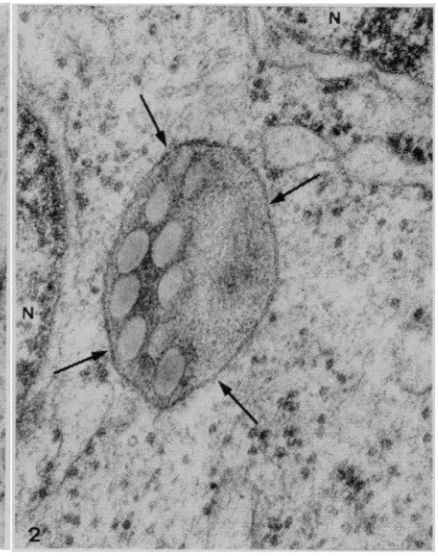


Fig. 1 (left). Large latex particles (0.8 by 0.4 μm) incorporated singly into cells. The arrows denote the delimiting single membrane of a phagosome containing a large latex bead, and *N* denotes the nucleus. ($\times$ 62,000) Fig. 2 (right). Small latex particles (0.1 by 0.05 μm) always taken up in groups and surrounded by a common single membrane (arrows). The phagosomes are approximately equal in size to those in Fig. 1. ($\times$ 62,000)