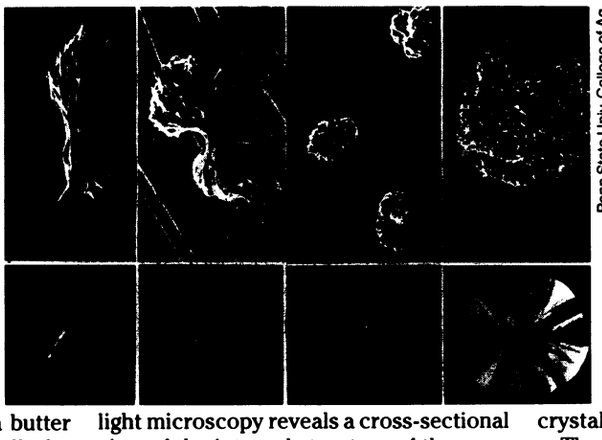
Visions of chocolate: Cocoa crystals and candy quality

The gloss, grittiness and snap, the look, taste and texture of chocolate candy are a matter of bow ties and feathers, according to microscopy studies of cocoa butter crystals. These ties, feathers and other crystalline forms determine characteristics important to the confectionery industry and to consumers in the United States, who eat an average of 8 pounds of chocolate goodies every year.



Penn State Univ. College of Ag.

A surprisingly large number of crystal forms and some striking relationships among them have been revealed by a new method of characterizing free-growing cocoa butter crystals. "The crystal forms are usually defined by melting point, which has been confusing," says Paul S. Dimick of The Pennsylvania State University, in University Park. "We are actually looking at the crystals, and we see more than the six forms reported in the literature. We see about 12 different types." In addition, he has observed one crystal form, called a bow tie, evolve into another, called a feather.

Dimick and Douglas M. Manning have applied two sophisticated microscopy techniques to cocoa crystals. Polarized light microscopy reveals a cross-sectional view of the internal structure of the crystal. Scanning electron microscopy shows the surface.

The crystalline structure of cocoa butter depends on its composition. Cocoa butter is primarily made up of molecules called triglycerides, each of which has three fatty acids attached to a molecule of glycerol. The crystalline structure depends on how the triglycerides are positioned into a rigid pattern.

The formation of a feather crystal at 86°F was observed step-by-step by Manning and Dimick. (In the photographs above, the scanning electron micrographs are on the top and the corresponding polarized light micrographs are on the bottom.) The first crystallization (left) produced a form with a constriction in the center. This bow tie form enlarged primarily on the outer surfaces while the central area remained constricted. Then the crystals spread and eventually assumed a circular shape. The bow tie form has a high concentration of certain triglycerides that are the first to crystallize at this temperature, and then they promote stable crystallization of others, Dimick says.

The chemical composition of the cocoa butter, and thus its crystalline form, depends on the variety of cocoa bean from which it is pressed as well as such environmental factors as the amount of rainfall where the bean was grown. So far Dimick and Manning have been using a pure cocoa butter from the Ivory Coast. But eventually Dimick hopes, with crystal microscopy, to define parameters of cocoa butters from different countries, and even develop methods to determine if chocolate products have been adulterated with cocoa butter substitutes. —*J. A. Miller*

Spacelab delay could mean 'a tremendous sacrifice of science'

After a week of deliberation, National Aeronautics and Space Administration officials announced last week their decision to delay the flight of space shuttle Columbia's first Spacelab mission due to a faulty booster nozzle. The nozzle is the same type that suffered extreme heat damage during Challenger's September flight.

Spacelab, a $1 million scientific research payload built by the European Space Agency (ESA), houses 35 experiments designed by European and U.S. material and life scientists, astronomers and physicists (SN: 10/15/83, p. 246). It was scheduled for launch Oct. 28.

The problem now is deciding the next launch date. NASA estimates the delay is costing "several million dollars a month," and flight schedulers are hoping for a Nov. 28 launch date. But participating scientists, whose experiments depend on low atmospheric light conditions, would rather hold the launch until February's new moon phase when light conditions resemble October's.

Spacelab 1's rescheduling difficulties come from a complex combination of logistical and scientific requirements. Spacelab's orbital inclination (the orbital plane's angle in relation to the equator) is set for 57°. A 28° inclination orbit covers most of the United States, but ESA scientists requested the higher inclination for better views of their continent. Additionally, the high inclination enables scientists to study auroras from a more polar advantage. Further complicating matters, the Columbia must be launched at a time which would permit a daylight emergency landing at the transatlantic abort site in Zaragosa, Spain, where runway lighting is inadequate for a night landing.

Steve Mendae, of the Lockheed Palo Alto Space Center in California, is principal investigator of Spacelab's experiment #3 — Atmospheric Emission Photometric Imagery (AEPI) — in which light-sensitive instruments study the polar auroras. He says, "If the shuttle is launched in November, 50 percent of our experiments would be eliminated, and the other half would suffer greatly."

Charles Redmond of NASA's Public Information Office says a mid-winter launch date is not ideal for most of the astronomy experiments on board Spacelab 1 because earth's albedo (reflectivity) is greatest in mid-winter due to fog and snow cover. The aurora observations would also suffer because the amount of time the craft will orbit in full sunlight is greatest in mid-winter and auroras can only be seen during darkness.

Mendae is by now accustomed to Spacelab delays. His original proposal for AEPI was accepted in 1976 for a launch date of mid-1980. He says, "We have been experiencing delays in this project for six years now. To have waited this long and then have over half of our experiments wiped out, well..."

Redmond admits, "A November 28 launch date would be a tremendous sacrifice of science. Right now NASA and ESA are undergoing a full week of review. I don't expect a joint decision, however, before this time next week." —*M. Wolfe*

Creationists win one

By a 4-to-3 decision, the Louisiana Supreme Court has upheld the state legislature's right to require "balanced treatment" of creation science in those public classrooms teaching evolution. Louisiana is the only state with a creation-science law. Implementation of the law has been suspended, however, pending legal resolution of its constitutionality.

In his dissent, the court's chief justice, John Dixon, argued that though the legislature may have the right to determine school curricula, it could not foster the teaching of religion. And he argued that from what he's read "'creation science' is a religious doctrine, not a course of study." The case now returns to the U.S. District Court in New Orleans for a ruling on just that: whether the law violates a constitutionally mandated separation of church and state. □