that a polymer film of uniform depth is developed rather than highly nonuniform deposits (that is, whiskers). A clean glass surface apparently contains about the right amount of initiator (in the form of surface water or basic elements of the glass itself, or both) to allow formation of whiskers. An experimental demonstration of the effect of initiator density can be easily accomplished by exposing to the monomer vapors a glass surface supporting a number of small ice crystals (20 to 30 μm in diameter). The ice crystals, being composed of pure initiator, develop a uniform coating of polymer (this fact, indeed, is what permits the successful replication of ice particles) while the glass surface, even in the immediate area of the ice, allows formation of the whiskers.

It is believed that the polymer grows in the form of filaments (once properly nucleated) because of a greater chemical specificity for the monomer at the ends of the whiskers than over the sides. If there were no differences in chemical specificity over the surfaces of the whisker, then, in order to explain its growth in that geometry, some physical transport mechanism would be necessary. One hypothesis might be that surface tension forces would tend to draw condensed liquid monomer on the fiber surfaces (which would have a certain lifetime before polymerizing) to a spherule at the end of the fiber, which would then generate further growth of the filament. In fact, spherules have been observed on several samples of whiskers. But in all cases, these spherules at the whisker tips were associated with inhibited, not enhanced, fiber growth. For instance, in experiments in which the monomer vapor gradient was increased sufficiently, spherules formed on the tips and the linear growth of the filaments stopped.

Thus it is suggested that the ends of the whiskers have a chemical specificity for the monomer. This specificity would entail a general alignment of the molecules along the growth direction of the whiskers, so that at the exposed ends the very basic unreacted carbanions would provide an attractive site for further polymerization.

Examination in a polarizing microscope revealed that the fibers were too small to give reliable birefringence results. However, the ice crystal replicas exhibited a clear birefringence, indicative of an ordering of the polymer molecules (*1*).

The growth of the cyanoacrylate whiskers is reminiscent of systems of "living polymers" (*5*) in which termination of the polymerization is avoided. These living polymers were developed from solution, whereas in the case reported here the polymer growth occurs by addition of monomeric units from the vapor. Moreover, termination is avoided only as long as the concentration of monomer vapor in the vicinity of the tip is relatively high, and during this time the filament is growing. When the monomer vapor density decreases sufficiently, termination sets in, possibly through capping by hydronium ions.

It is easily demonstrated that the activity of the ends has a finite lifetime after removal of the monomer source. If the flow of monomer vapor is interrupted for 10 seconds, the whiskers lose their ability to grow. Instead spherules form at the tips, as well as here and there along the length of the fiber. It is thought that, during the 10-second interval during which there is no flow of monomer vapor, the fiber ends terminate. Then when the flow of vapor resumes, the monomer condenses as a liquid, forming spherules as a result of surface tension, before polymerizing.

When the source of monomer is removed slowly, the diameter of the growing fiber, having been nearly constant up to that point, gradually diminishes to possibly 10 percent of its original value before terminating. If the monomer supply is removed quickly, the ends of the whiskers may develop a number (on the order of ten) of very small (about 0.1 μm in diameter) fibers. Apparently several areas on the tip remain active longer than others, giving rise to the subsidiary whiskers.

Certain monomers, such as divinyl sulfone, can profoundly alter the growth of the whiskers. In one experiment the vapor of divinyl sulfone was introduced after 10 seconds of whisker growth on a cold slide without removal of the monomer source. The resulting particles showed bulbous formations on top of short whisker stalks (Fig. 2). Since divinyl sulfone can readily copolymerize with the methyl 2-cyanoacrylate, it is believed that the three-dimensional bulbous structures resulted from a cross-linking between the polymers. This cross-linking would disrupt the ordered linear growth of the filaments.

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Disjunct Foliar Veins in Hawaiian Euphorbias

Abstract. *Isolated segments of veins occur in the leaf mesophyll of several Hawaiian species of* Euphorbia. *These anomalous structures appear to consist entirely of tracheids and are a normal feature of the anatomy of species native to mesic and wet areas, but not to xeric, dry habitats.*

The foliar venation of several endemic Hawaiian species of *Euphorbia* (subgenus *Chamaesyce*) is characterized by numerous isolated disjunct veins. This unusual feature has not been reported previously, although on occasion the sporadic occurrence of isolated veins has been reported for stems, leaves, flowers, and fruits of other plants. The two types previously reported in mature angiospermous leaves include: (i) an isolated vein ending associated with a continuous phloem strand (*1*), and (ii) a completely separated vein (*2, 3*).

Ontogenetic studies of the foliar vascular tissue of several families have shown an initial acropetal development of both xylem and phloem, followed by a subsequent basipetal wave of differentiation resulting in the formation of major lateral veins of the lamina. The minor veins develop last, completing the familiar reticulate pattern common to dicotyledonous leaves. Characteristically, the phloem differentiates sequentially, but the differentiation of the xylem frequently tends to be disjunct. Eventually a normal, complete reticulum results (*4*).

The differentiation of the minor veins of the Hawaiian euphorbias is erratic,

Table 1. Occurrence of isolated veins in endemic Hawaiian *Euphorbia*.

Species and varieties	Abundance of isolated veins	Distribution of species (including varieties)
E. rockii	Abundant	N.E. Oahu
E. forbesii	Abundant	N.W. Oahu
E. clusiaefolia	Common	E. Oahu
E. arnottiana	Common	S.E. Oahu
*v. integrifolia**	Occasional	W. Maui
E. remyi	Occasional	Kauai
E. hillebrandii	Rare-occasional	Oahu, W. Maui
E. celastroides	Rare	All main islands
*E. halemanui**	Rare	N.W. Kauai
E. atrococca	Rare	Kauai
E. degeneri	Rare	All main islands
E. olowaluana	Rare	W. Maui, Hawaii
E. multiformis	Rare	All main islands
*E. kuwaleana**	None	W. Oahu
E. skottsbergii	Rare	W. Oahu
E. deppeana†		Oahu

* Three leaves from a single specimen available for survey. † No leaves available for study.

Fig. 1. Portion of a leaf of *Euphorbia rockii* cleared with 2.5 percent NaOH and stained with safranin according to the method of Foster and Arnott. A branched secondary vein and the minor venation including the isolated veinlets of an areole are shown. Specimen is from an elevation of 2000 feet (608 m), Punaluu, Koolau Mts., Oahu (Herbst No. 1117, HAW).

leaving isolated groups of tracheids as idioblastic structures in the leaf mesophyll. Subsequently a sheath of large parenchyma cells develops, as is usual in the subgenus *Chamaesyce*, and completely surrounds and further isolates the pieces of veinlet (Fig. 1). The resultant idioblastic veinlet may consist of a single tracheid, a cluster of tracheids, or, less commonly, a short, branched section of reticulum. Studies of paradermal sections reveal that the isolated veins consist solely of tracheids with no associated xylary parenchyma or phloem cells.

The ends of the normal minor veins also consist of tracheids only. Since the xylem in leaves of most angiosperms frequently—but perhaps not as commonly as in these species—differentiates disjunctly, and since the isolated veins generally form a distinct but broken line, they presumably are the result of the failure of certain procambial cells to differentiate.

The native Hawaiian species of *Euphorbia* are believed to have evolved from a single introduction, perhaps from the same ancestral stock as several common Pacific strand species (*5*). Through the use of cleared leaves, I surveyed 112 taxa of *Euphorbia*. Isolated veins were found, if only rarely, in the majority of Pacific members of the subgenus *Chamaesyce* I was able to survey adequately; none was found in other subgenera of the genus. However, future studies may reveal this condition to be more common than this survey indicates. The isolated veins were found in various degrees of abundance in six large-leaved species which grow primarily in mesic to boggy areas on the islands of Oahu and Kauai (Table 1). Conceivably the disjunct tracheary strands could be an adaptation to an increased laminar volume or a response to a wetter environment.

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Synaptic Facilitation: Long-Term Neuromuscular Facilitation in Crustaceans

Abstract. *Continuous stimulation at frequencies equal to or greater than 5 hertz for 20 to 30 minutes results in a two- to fivefold increase in the amplitudes of excitatory postsynaptic potential recorded from certain stretcher and opener muscles of decapod crustaceans. This long-term facilitation appears to result from an accumulation of sodium ions within the nerve terminals. It persists for at least 1 hour after stimulation has stopped.*

The efficacy of synaptic transmission is increased by repeated nerve impulse activity at many synapses. This property is termed facilitation; it results from an enhanced probability of transmitter release following the arrival of an