lengths of DNA of approximately 200 nucleotide pairs. Clearly, determination of an exact molecular composition of the histones within ν bodies must await measurements of stoichiometry from isolated chromatin particles.

Our studies (*2, 9*) continue to support the view that the ν bodies are either real structures of native chromatin or represent vestiges of native chromatin periodicities. We employed the low-angle x-ray reflections of chromatin (*1*) as a criterion of the native state and observed that swelling nuclei in low ionic strength solvents and fixing the nuclei with formaldehyde does not destroy these characteristic reflections (*2, 9*). Lyophilization of unfixed chromatin and examination in the dry state does produce perturbations of the x-ray reflections, as described by Pardon and Wilkins (*1*) and by us (*2, 9*). However, rewetting of these chromatin samples results in a return of the x-ray reflections. It is very likely that the dehydrating conditions during electron microscopy lead to specimen shrinkage. [If ν bodies behave as do ribosomes (*10*), the dehydrated volume per particle would be approximately one-half the hydrated volume; that is, 70-Å particles would be derived from hydrated particles about 90 Å in diameter.] Nevertheless, since hydrated formaldehyde-fixed chromatin is sonicated into fragments that resemble monomer ν bodies in the electron microscope, it appears that periodic "weak" points exist in chromatin which do not depend upon dehydration of the material. More definitive verification of the existence of periodic subunits in native chromatin could be obtained by electron microscopic studies of unstained material in a hydration chamber.

Assuming the existence of ν bodies in native chromatin, one could analyze the ways in which a particulate chromatin substructure might relate to the characteristic low-angle x-ray reflections. There are three possible relations that might be envisioned: (i) the x-ray reflections arise solely from interparticle spacings of the packing lattice; (ii) they arise from the structure of the particles (for example, the folding of DNA within each ν body); or (iii) some of the reflections arise from the packing lattice, others from intraparticle structure. Our preliminary observations have shown that pool A exhibits the low-angle reflections; that is, the periodic structure has survived fixation, sonication, and fractionation of the chromatin. A careful study of these low-angle x-ray reflections with changes in concentration of the monomer ν bodies should help one to decide among the suggested models of periodicity within chromatin.

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Coevolutionary Race Continues: Butterfly Larval Adaptation to Plant Trichomes

Abstract. *Plant trichomes can act as effective defenses against herbivores, but at least one species of ithomiid butterfly,* Mechanitis isthmia, *has evolved a unique adaptation for avoiding the trichomes on its spiny* Solanum *hosts. The larvae are gregarious and together they spin a fine silk scaffolding over the tops of the spines on which they can crawl and feed in safety.*

Plants have evolved many different chemicals that act as defenses against herbivore consumption (*1*). Gilbert (*2*) and Levin (*3*) have documented that plant hairs, or trichomes, can act as structural defenses against herbivores. Gilbert (*2*) found that the hooked trichomes on *Passiflora adenopoda* leaves could entrap and fatally wound heliconiine butterfly larvae, thereby acting as an effective defense against larval feeding. Gilbert suggests that the trichomes may be an absolute defense against these larvae and that the coevolutionary race has possibly been won by the plant. We report a previously unknown feeding behavior in a butterfly larva, *Mechanitis isthmia* Bates (Ithomiidae), that is adapted to avoid trichomes. This observation suggests to us that the coevolutionary race has not yet been won by plants with trichomes.

In the American tropics the butterfly family Ithomiidae has radiated extensively on plant species in the Solanaceae (*4*). This adaptive radiation is similar to that of the Heliconiidae on *Passiflora* although far more species are involved. So far as is known ithomiid larvae feed exclusively on solanaceous plants; some species are very specialized feeders while others feed on species in many genera (*4, 5*). The solanaceous plants, in turn, have evolved chemical defenses, including deadly alkaloids (*6*), and many species have evolved trichomes varying from soft pubescence to glandular stinging

Fig. 1. *Solanum* species, possibly *S. hirtum*, showing the hairs and spines on the stems and leaves. One leaf has been turned over to show the larvae feeding on the underside. Scale: approximately 1/6 actual size.

hairs to large spines (*7*). At least one ithomiid, *M. isthmia*, has become adapted to feed on solanaceous species protected by trichomes. This species was reared at Rancho Grande Experimental Station near Maracay, Venezuela. The larvae were observed feeding on a 1-m-tall perennial weedy species of *Solanum*, possibly *Solanum hirtum* Vahl (Fig. 1). The stems of this species are covered with large straight spines and the leaves are tomentose with scattered spines (*8*).

The larvae of *M. isthmia* successfully avoid the trichomes on their *Solanum* host by spinning a fine network of silk threads over the tops of the spines (Fig. 2). The larvae can then crawl over the tops of the spines on their silken scaffolding and feed safely on the unprotected edges of the leaves. The larvae always stay on the undersides of the leaves, so they literally hang below the spines.

To our knowledge all other known ithomiid larvae are solitary feeders, but the larvae of *M. isthmia* generally feed in groups of four to six individuals per leaf (Fig. 2). Together the larvae spin and share the webbing laid over the spines. Perhaps this silken bridgework is energetically feasible only if several larvae pool their resources and share the benefit.

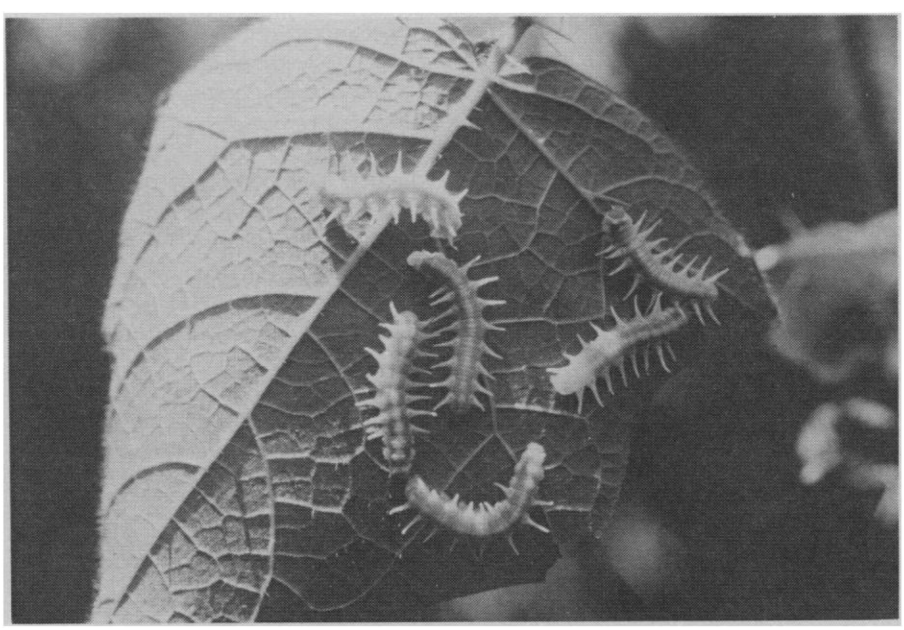

Fig. 2. *Mechanitis isthmia* larvae resting on their silk webbing on the underside of a *Solanum* leaf. The network of silk is very fine and is not visible in this photograph, but the larva on the midrib shows how the larvae are suspended above the spines. Scale: approximately 3/4 actual size.

Trichomes may represent a step beyond chemical defenses (*2, 3*) and they probably are a formidable barrier to lepidopteran feeding because the Solanaceae are poorly represented among the food plants of this taxon (*4*) and trichomes in this family are especially well developed and widespread (*7*). The behavior of *M. isthmia* shows that trichomes are not necessarily an absolute defense against lepidopteran larvae. Furthermore, this adaptation does not involve any drastic new physiological development because the ability to spin silk is widespread among the lepidopterans. Most larvae spin silk to secure themselves while molting or to attach or protect their pupae. Evolution of the feeding web would involve only a further development of an already present ability. However, the increased silk production may necessitate a change in the social behavior from solitary to gregarious.

Although the trichomes of this *Solanum* species are not hooked like those of the *Passiflora* species studied by Gilbert (*2*), this adaptive strategy would probably be equally effective against hooked trichomes. Therefore, the adaptation of this ithomiid species may represent an option that is open to the heliconiine larvae in evolutionary time.

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