plasma membrane, whereas in experiments in vitro with isolated tubules primarily the outer tubular membranes are exposed to mevalonate.

The fact that *S*-mevalonate is excreted in the urine (*11*), whereas *R*-mevalonate is not, except after very large doses, such as after 2.7 μmole per gram of body weight in the rat (*1*), suggests the existence of a saturable and stereospecific transport system into the renal tubules for *R*-mevalonate.

Mevalonate is known to be circulating in the blood although at a low level (*12*). Our observations suggest that an impairment of the renal "clearance" of blood mevalonate by either of two metabolic pathways (synthetic and "shunt") could account for the hypercholesterolemia associated with some diseases of the kidneys, since such impairment might lead to increased hepatic synthesis and increased release of cholesterol into the blood. Edgren and Hellström (*12*) reported that, in aminoglycoside-induced nephrosis in rats, associated with hypercholesterolemia, there was a much increased utilization of mevalonate by the liver and an increase in the release of newly synthesized cholesterol into the blood, similar to that seen after nephrectomy.

J. EDMOND
A. M. FOGELMAN
G. POPJÁK

Departments of Biological Chemistry and Medicine, School of Medicine, University of California, Los Angeles, Los Angeles 90024

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Paracytic (Syndetocheilic) Stomata in Carboniferous Seed Ferns

Abstract. *Stomata of the paracytic type have been discovered on the lower pinnule surface of the Carboniferous seed fern foliage species* Alethopteris sullivanti. *The stomatal complex is not visible when the cuticle is in place. This is apparently the first report of paracytic stomata in Carboniferous plants.*

Stomatal types are of interest to taxonomists and structural botanists because of their taxonomic usefulness and, in some instances, because of their phylogenetic significance (*1*). Paleobotanists have generally followed the terminology established by Florin (*2*), who recognized two fundamental stomatal types—haplocheilic and syndetocheilic. Since these terms incorporate developmental patterns in their definitions, their usage when applied to fossils necessarily involves one or more inferences (*3*). We have used the purely descriptive term, paracytic, followed in parentheses by the inferential one, syndetocheilic. The latter term is used because of its familiarity to paleobotanists; in this instance we consider the terms paramesogenous (*3*) and mesoparacytic (*4*) equivalent to syndetocheilic.

To the best of our knowledge, this is the first report of paracytic (syndetocheilic) stomata in a Paleozoic seed fern. The stomata were discovered on the lower (abaxial) surface of the distinctive foliage species *Alethopteris sullivanti*, preserved in middle Pennsylvanian coal balls collected near Cayuga, Indiana. Guard cells average 27 μm in length and are completely enclosed by two subsidiary cells (Fig. 1a). The common end walls of the subsidiary cells meet at the midline through the long axis of the stoma and at each pole. The outer walls of the guard cells are thickened and, consequently, darker in color. The presumed cytoplasmic contents of the guard cells are sometimes withdrawn from the outer wall, leaving a clear area adjacent to the thickened outer wall (Fig. 1c, unlabeled arrow).

Alethopteris sullivanti is one of the most completely known pteridosperm foliage species, and has been studied by Leisman (*5*) and by Faulwell and Schabilion (*6*). In neither study, however, were paracytic stomata detected. We attribute this to a lack of paradermal sections, which would pass just below the surface and which would reveal the slightly sunken guard and subsidiary cells. In both of the previous reports (*5*, *6*), stomata were studied primarily from cuticles macerat-

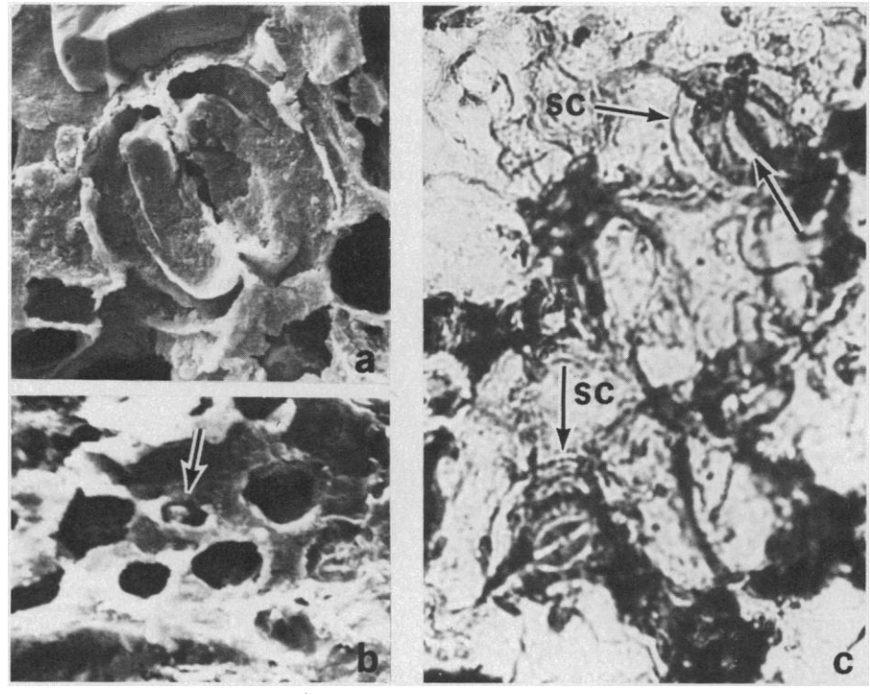

Fig. 1. (a) Stomatal complex of *A. sullivanti* showing subsidiary cells completely enclosing guard cells (× 850). (b) Pinnule surface showing ring of papillae bases surrounding stomatal aperture (arrow). Stomatal complex is out of sight below surface (× 550). (c) Light microscope photograph of lower epidermis beneath cuticle; *SC* arrows touch subsidiary cells; clear area (unlabeled arrow) was created by withdrawal of guard cell cytoplasm from thickened outer guard cell wall; stoma are closed (× 480).

ed from the pinnule surface. These characteristically show a ring of papillate epidermal cells surrounding the sunken stomatal complex, which is out of sight below the surface (Fig. 1b). We prepared material for the scanning electron microscope (Fig. 1, a and b) by mounting a portion of a pinnule to the specimen stub, etching the specimen surface, rinsing, coating with gold-palladium, and observing the surface directly.

Barthel (*7*), working with compression fossils, illustrated the lower surface of *Alethopteris davreaxi* and *A.* cf. *grandini*, both of which have a similar ring of papillae surrounding sunken stomata. Cuticles from compression fossils when viewed from the outside may not reveal all the stomatal features when they are sunken below the surface. Therefore, it is probable that paracytic stomata and other stomatal types are more prevalent among seed ferns than has been reported.

Paracytic stomata are present in a variety of extant plants (*1*). Several taxonomists now accept the paracytic and not the anomocytic stomatal type as primitive in the angiosperms (*8*, *9*). Baranova (*8*) cites the Bennettitales (Mesozoic) as the oldest fossil group to show clearly the paracytic type. The occurrence of paracytic stomata in Carboniferous seed ferns is of interest in this context since seed ferns, if only by default, are widely conceived of as ancestors of angiosperms.

L. L. OESTRY STIDD
Department of Botany,
University of Illinois, Urbana 61801
B. M. STIDD
Department of Biological Sciences,
Western Illinois University,
Macomb 61455

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Cryptoses choloepi: A Coprophagous Moth That Lives on a Sloth

Abstract. *The larvae of the sloth moth,* Cryptoses choloepi, *live in the dung of the three-toed sloth,* Bradypus infuscatus. *Adult female moths apparently leave the fur of the sloth to oviposit when the sloth descends, once a week, to the forest floor to defecate. Newly emerged moths fly from the dung pile into the forest canopy to find a sloth.*

The story of the moth that lives in the fur of tree sloths has long enjoyed the status of an entomological anecdote, and has been mentioned in many texts of entomology and parasitology (*1*). The various life cycles proposed for this insect differ in detail but support the belief that all stages of the moth live continuously in the dense coat of the host, where the larvae presumably feed on sloth hair or on the algae peculiar to sloth hair, or both. While this life cycle has been generally accepted, no investigation of the fur of a living sloth has revealed any life stage but the imago (*2*). We have recently elucidated the life cycle of the Panamanian sloth moth, *Cryptoses choloepi* Dyar (Pyralidae: Chrysauginae), and find that it differs from the one generally proposed.

Adults of *C. choloepi* were taken from sloths captured on Barro Colorado Island (BCI) and surrounding mainland areas in the Panama Canal Zone (*3*). On the three-toed sloth, *Bradypus infuscatus*, populations of moths per sloth ranged from 19 to 132 individuals (mean = 49; $N = 7$). On the two-toed sloth, *Choloepus hoffmanni*, moths were less abundant; no more than 12 moths were collected from a single sloth (mean = 8; $N = 3$). Careful examination of the sloths revealed no signs of eggs, larvae, or pupae of *C. choloepi*. The sex ratio of male to female moths in populations from three-toed sloths was roughly 3:1 (177 to 61), while that from two-toed sloths was 7:1 (21 to 3).

Gravid female moths removed from the host to screen cages readily oviposited on any hard substrate. We offered larvae newly hatched from these eggs a variety of diets, including the hair and dung of three-toed sloths and the leaves of *Cecropia eximia*, *Poulsenia armata*, and *Lacmellea panamensis*—the three tree species which these sloths most often frequent (*4*). The larvae did not feed on the sloth hair or leaves, but commenced feeding as soon as they were placed on sloth dung.

Sloth dung consists of hard, ovoid pellets about 8 mm in diameter. Sloths descend from the forest canopy to its floor at about weekly intervals to defecate, where, hanging to a vine by their forelegs, they dig a depression with their hind claws, deposit about a cupful of these pellets, and then cover the dung loosely with leaf litter (*4*). Early larval stages of *Cryptoses* spin silken threads between two or three pellets, forming "nets" in which they feed. Later stages spin silken, frass-encrusted tubes which are extended by the larvae as they grow. Mature larvae seal off a section of their feeding tube in which to pupate. Three to 4 weeks are required for development from egg to adult, at ambient temperatures of the forest floor.

We collected and examined sloth dung piles from the floor of rain forest on BCI and from a second area on Cerro Azul, Panama. Of 19 dung piles on BCI, four bore definite signs of infestation by *Cryptoses*. One or more sloth moths emerged from each of 16 of 31 sloth dung piles collected on Cerro Azul. This probably represents a minimum estimate of infestation (*5*).

In contrast to the sex ratio skewed toward males among moths on sloths, moths that emerged from a dung pile in the laboratory showed a 1:1 sex ratio (16 males to 17 females), while the sex ratio among 52 sloth moths attracted to a light trap at Las Cumbres, Panama, was approximately 1:1.4 (22 males to 30 females) (*6*).

Three-toed sloths on BCI were captured, cleaned of moths, and released with radio collars (*7*), which enabled us to locate them. They were recaptured at intervals to measure rates of reinfestation with sloth moths. Three sloths recaptured after 11 days yielded one, two, and nine moths each (totals of three males and nine females), while a sloth recaptured after 39 days had 40 moths (27 males and 13 females).

The following life cycle, which we propose for *C. choloepi* on *B. infuscatus*, may also apply to other sloth moths, including those that live on *Choloepus*. When a sloth descends to the rain-forest floor to defecate, gravid female moths leave the sloth and oviposit on fresh dung. The differential loss of female moths from sloths, resulting in a skewed sex ratio, may be caused by the failure of some females to return to the host after oviposition. Alternatively, the females may simply have a shorter life-span than the males. Mortality of female moths may occur through exposure to predation during oviposition. Larvae develop and pupate in the dung pile. Several weeks after oviposition, adults emerge and fly