Table 2. Response to splanchnic-nerve stimulation of liver phosphorylase in adrenalectomized and pancreatectomized rabbits. Bilateral adrenalectomy and pancreatectomy of the rabbits were carried out by laparotomy. Then 15 to 20 minutes later, the splanchnic nerve was electrically stimulated. Results are given as mμmole (P_i) mg^{-1} (protein) min^{-1}. P_i, inorganic phosphate.

Before	After		
	30 sec	1 min	5 min
	Adrenalectomized rabbits		
4.9	10.0	16.3	26.4
6.9	24.0	20.9	29.2
5.7	8.1	12.8	13.7
4.3	12.0	9.6	16.4
	Pancreatectomized rabbits		
9.6	19.9	23.8	32.3
7.9	19.0	13.3	21.1
5.9	13.1	16.5	20.1

or 10-minute incubation at 37°C was determined (*4*).

For assay of glucose-6-phosphatase, each frozen liver was homogenized in a glass homogenizer with nine volumes of cold isotonic KCl solution. The homogenates were centrifuged at 12,000*g* for 10 minutes at 0°C. The reaction mixture contained $0.02M$ glucose-6-phosphate, $0.04M$ sodium maleate buffer (*p*H 6.5), $0.01M$ $MgCl_2$ and a suitable volume of the supernatant fraction of the centrifuged liver homogenate in a total volume of 1 ml. Inorganic phosphate released during 10-minute incubation at 37°C was measured as described above. Liver glycogen was determined as described (*3*).

The activity of the phosphorylase in liver was markedly increased by electrical stimulation of the splanchnic nerve (Table 1), attained nearly the maximum within 30 seconds after the onset of stimulation of the splanchnic nerve, and remained fairly constant at least up to the end of a 5-minute period of stimulation. In each case the stimulation caused an approximately threefold increase in phosphorylase activity ($P <$ .01) as compared with that before stimulation (except in case No. 2, 5-minute stimulation), though minor variations of the activity existed between animals before stimulation. Similar observations on muscle phosphorylase have been reported by Danforth *et al.* (*5*) and Posner *et al.* (*6*). They showed that the activity of phosphorylase *a* of frog sartorius muscle and rat gastrocnemius muscle was rapidly and markedly increased by direct stimulation in vitro of the muscle preparation or by electrical stimulation of the posterior tibial nerve. Independently of their observations, essentially the same results on phosphorylase of rabbit gastrocnemius muscle were obtained in this laboratory by electrical stimulation of the sciatic nerve of rabbits: the phosphorylase *a* of gastrocnemius muscle was increased approximately threefold over that of the control while the total activity of phosphorylase (phosphorylase *a* and *b* combined) was not affected by stimulation of the sciatic nerve (*7*). In the studies reported here, although only active phosphorylase of the liver was assayed, the increased activity of phosphorylase after splanchnic-nerve stimulation might be due to a conversion of inactive phosphorylase (dephosphophosphorylase) into active form during the stimulation.

The activity of liver glucose-6-phosphatase was also increased about 40 percent by stimulation of the splanchnic nerve as compared with that before stimulation in each case ($.02 > P > .01$). The response of this enzyme to splanchnic-nerve stimulation was observed within 30 seconds after the onset of stimulation and the increase in activity continued at least for the 5 minutes following stimulation.

Glycogen content of the liver after a 5-minute period of stimulation of the splanchnic nerve was only slightly decreased as compared with that before stimulation ($.2 > P > .1$). A much greater decrease in liver glycogen has already been observed when the sympathetic area of the hypothalamus was stimulated electrically for a longer period (*3*).

Electrical stimulation of the vagus nerve had, if any, a suppressing effect on liver phosphorylase and glucose-6-phosphatase activities.

Table 2 shows the effect of adrenalectomy and pancreatectomy upon the response of liver phosphorylase to the splanchnic-nerve stimulation. The activity of liver phosphorylase was likewise increased markedly. It is unlikely that the effect of splanchnic-nerve stimulation on liver glycogenolytic enzymes is due solely to hormonal factors such as epinephrine released from the adrenal or glucagon released from the pancreas.

Our results show that sympathetic stimulation results in an acceleration of glycogenolysis in liver; they give a further support, in addition to the findings previously reported (*1, 2*), to the concept that certain liver enzymes are under the control of the autonomic nervous system. In relation to this concept, Suzuki has recently demonstrated with his silver-impregnation method that nerve fibers ending to the liver enclose the surface of the hepatic cells in a reticular form through an intermediation of the "transmittal cells" which lie outside the sinusoid and function as relay stations of the nerve fibers (*8*).

TAKASHI SHIMAZU
AOI FUKUDA
Department of Anatomy, Osaka University Medical School, Osaka, Japan

References and Notes

1. T. Shimazu, *Biochim. Biophys. Acta* **65**, 373 (1962); *J. Biochem.* **55**, 163 (1964); *Gann* **56**, 143 (1965); *Biochim. Biophys. Acta* **105**, 377 (1965).
2. T. Shimazu, *Proc. Symp. Chem. Physiol. Pathol.*, in press.
3. T. Shimazu, A. Fukuda, T. Ban, *Nature*, in press.
4. T. Takahashi, *Protein Nucleic Acid Enzyme Tokyo* **2**, 464 (1957).
5. W. H. Danforth and E. Helmreich, *J. Biol. Chem.* **239**, 3133 (1964).
6. J. B. Posner, R. Stern, E. G. Krebs, *ibid.* **240**, 982 (1965).
7. T. Shimazu and A. Fukuda, unpublished.
8. K. Suzuki, *Proc. Gen. Assembly Japan Med. Congr. 16th* **4**, 13 (1963).

8 October 1965

Caterpillar Feeding on a Sundew Plant

Abstract. *The caterpillar of a plume moth* (Trichoptilus parvulus) *was found feeding on a sundew plant* (Drosera capillaris) *in Florida. The larva eats the stalked glands with their sticky secretion, the leaf blades, and even dead insects trapped by the plant.*

Appropriately known as sundews because of the glistening droplets of secretion borne by the stalked glands on their leaves, the species of the family Droseraceae are among the more fascinating of carnivorous plants. Their mechanism of capture of prey is well known: insects or other small animals, when trapped in the viscid secretion, eventually succumb and are digested by the plant. We now report the discovery of a remarkable moth larva that actually lives and feeds on a sundew plant.

The caterpillars were found on specimens of their host plant, *Drosera capillaris*, collected on open sandy terrain, among tall grasses and sedges, near Lake Placid, Florida. What follows is based on observation of six larvae. Two of them, which initially measured only 1.5 mm in length and might have been in their late first or early second instar, were observed almost daily during the remaining 8 days of their larval life. The other four were already fully grown (5 mm) and near pupation when first discovered.

The larvae are active only at night. During the day they remain in hiding, presumably beneath the leaves or elsewhere under the plant. After dusk they emerge to feed, and are then found on the upper surface of the leaves. The principal food, certainly for the younger larvae, is the stalked gland itself. This is consumed in its entirety. First, the larva reaches up so as to imbibe the droplet of secretion (Fig. 1*A*), then it eats the glandular knob, and finally it chews its way downward along the stalk. Having completed the job, it moves to feed on an adjacent gland. The entire central surface of a leaf may be denuded in a matter of hours. Oddly, the longer peripheral glands are either ignored or they are eaten last. This may have adaptive value, since the outer fringe of glands could effectively shield the larva against foraging ants or other small predators. Partially denuded leaves, littered with the larva's fecal remains, are a convenient clue to the presence of the caterpillars in nature. Most of our larvae were discovered by following up such clues.

Older larvae also feed on glands, but they may in addition eat the blade of the leaf. By the end of 8 days of captivity, one specimen had consumed several entire leaves and deglanded a number of others. Even the partially digested remains of insects trapped by the plants may be eaten. This was observed twice, and involved in each case an older larva feeding on a dead staphylinid beetle of about its own size. No parts of the beetle were spared; even the thick skeletal capsules of head and thorax were consumed.

Although the larvae are ordinarily grayish-brown in color, the overall hue varies with the nature of the gut contents, which are visible through the semitranslucent body wall. A reddish color reflects a gut replete with intensely purple glandular tissue. Older larvae tend to be greenish because of ingested leaf blade.

The integument of the larva seems to adhere as readily to the viscid secretion as does that of other insects. When a small caterpillar was placed onto a close cluster of glands, it stuck to the droplets and had to be extricated. However, entrapment is not likely to occur in nature. The young larva ordinarily restricts contact with the droplets to the tips of the long bristles that stick out from its body. This in no way impedes the animal, and the bristles are readily withdrawn from the droplets as the larva moves along. Whether the bristles actually serve to "feel" the presence of the droplets, thus enabling the larva to assume a proper orientation relative to them, is an intriguing possibility (*1*). In Fig. 1*A* note how the larva is positioned midway between two droplets, with some of its hairs directly or nearly contacting both of them. Older larvae, by virtue of their larger size, cannot avoid occasional body contact with the secretion, but they are stronger and break away without difficulty.

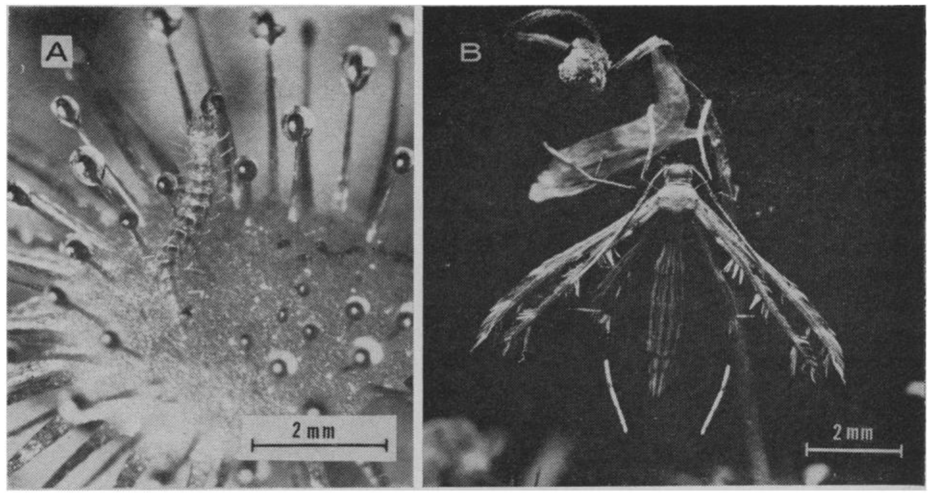

Fig. 1. (*A*) Larva of *Trichoptilus parvulus*, on leaf of its host plant (*Drosera capillaris*), imbibing the secretion at the tip of a stalked gland. (*B*) Adult moth, shortly after emergence, clinging to the floral stalk beside the empty pupal shell.

With one exception, involving a larva that pupated on a blade of grass, pupation always occurred near the tips of the long upright floral stalks that grow from the center of the plant. This site is clearly an advantageous one, since the base of the stalk is protectively encircled by leaves and their glands. The pupae, which are light green in color, hang head-down from their abdominal tips. Adult emergence takes place 10 to 11 days later (Fig. 1*B*). The moth, *Trichoptilus parvulus*, a member of the Pterophoridae (plume moths), was hitherto known only from the type specimen (Vernon Parish, Louisiana) and from several others taken near Lake Placid and at Palmdale, Florida.

Although a number of arthropods are known to be associated with pitcher plants and other carnivorous species (*2*), very few live on sundews. A moth larva of the family Noctuidae feeds on *Drosera*, but it crawls only on the glandless portions of the plant (*3*). Certain Australian Hemiptera of the family Capsidae suck the juices of arthropods caught by *Drosera*, and apparently move about the leaves unhindered by the secretion (*4*).

There are obviously many questions about the life cycle of *Trichoptilus* left unanswered. Almost nothing was learned about the adults, which died shortly after emergence. One wonders how the female oviposits on *Drosera* without being trapped. Might the detachable scales on her body—which are known to protect moths against adhesion to spider webs (*5*)—also serve to prevent her from sticking to the plant?

THOMAS EISNER*
Division of Biology, Cornell University, Ithaca, New York 14850
JULIAN SHEPHERD
Biological Laboratories, Harvard University, Cambridge, Massachusetts

References and Notes

1. Some insect bristles, by virtue of the sense cells at their base, can serve as tactile organs; see V. G. Dethier, *The Physiology of Insect Senses* (Wiley, New York, 1963).
2. F. E. Lloyd, *The Carnivorous Plants* (Chronica Botanica, Waltham, Mass., 1942).
3. H. D. Hooker, Jr., *Entomol. News* **30**, 61 (1919).
4. W. E. China, *West. Austral. Naturalist* **4**, 1 (1953).
5. T. Eisner, R. Alsop, G. Ettershank, *Science* **146**, 1058 (1964).
6. Supported in part by NIH grant AI-02908 and by an unrestricted gift from the Upjohn Company. The observations were made largely at the Archbold Biological Station, Lake Placid, Florida. We thank its director, Richard Archbold, for his hospitality. Dr. L. J. Brass identified *Drosera* and offered useful advice. The moth was identified by Dr. R. W. Hodges. Dr. W. L. Brown, Jr., and Dr. J. G. Franclemont read the manuscript.
* John Simon Guggenheim Memorial Foundation fellow.

15 September 1965