North American Egg Parasite Successfully Controls a Different Host Genus in South America

Abstract. Telenomus alsophilae, *a parasite of the eggs of the geometrid* Alsophila pometaria *in North America, was introduced into Colombia, South America, for the biological control of a pest host in another genus,* Oxydia trychiata. *Successful results were obtained with this unorthodox procedure to control a forest insect.*

In the past, biological control of forest insects primarily involved importing known natural enemies for use against exotic insect pests. This classical approach assumes the same parasites, predators, or diseases that keep the insect in check within its area of origin are the ones most likely to control it in a new environment. Pimentel (*1*) suggested that native and foreign insect pests might be more successfully controlled if parasites from allied species and genera were employed. He postulated that parasite-host systems evolve toward homeostasis and that introducing parasites of the same species into the new area does not alter the relationship between the parasite and the host. Therefore, effective control is limited because parasites which have coevolved to an equilibrium with their host will seldom increase sufficiently to suppress the same host in a new area. By contrast, if the association between parasite and host is new, host suppression is often more complete. Pimentel (*1*) cites ten cases in which important agricultural pests have been effectively controlled by insect parasites of different host genera. As yet, similar results have not been ascribed to forest insects. Indeed, the concept of importing parasites of allied host genera to control foreign and native pests in forest environments continues to meet with skepticism (*2*).

In 1975 we began a successful suppression program for a South American forest pest using a North American parasite of a different host genus. The South American insect is the lepidopteran *Oxydia trychiata* (Guenée) in the family Geometridae, subfamily Ennominae; the parasite, *Telenomus alsophilae* Viereck, a hymenopteran in the family Scelionidae. Details on the biologies and introduction of these insects can be found elsewhere (*3*).

Colombia is establishing extensive plantations of exotic tree species in an effort to produce more pulp and paper. Previously unimportant insects are now causing serious problems in the plantations. In 1975, *O. trychiata* threatened a 230-ha plantation of the Mexican pine *Pinus patula* Schlect. and Cham., eventually defoliating 37 ha completely. In previous outbreaks, this defoliator has eliminated plantations of cypress, *Cupressus lusitanica* Miller. Biological control of insects in Colombia has significant advantages because aerial applications of insecticides are unsafe in the rugged Andean terrain.

Selection of the right parasite for biological control is difficult. Pimentel's (*1*) criteria for selecting a control agent included matching the climatic conditions from its original range to its prospective environment. Pschorn-Walcher (*2*) also emphasized this point. In North America, the fall cankerworm, *Alsophila pometaria* (Harris), defoliates broadleaved trees such as oaks, maples, hickories, and elms. This species is a lepidopteran in the family Geometridae, subfamily Oenochrominae. Its range is from the Maritime Provinces west to Alberta in Canada and south throughout most of central and eastern United States. Although *T. alsophilae* lives from Boreal to Austral zones, it had not been found in subtropical rain forests before we introduced it. Our previous research demonstrated that the life cycle of *T. alsophilae* was not disturbed by seasonal changes in photoperiod [8 hours of light and 16 hours of darkness (LD 8 : 16) to LD 15 : 9] or a lack of winter chill. The Colombian geometrid's range includes Costa Rica, Venezuela, Ecuador, Peru, Bolivia, Brazil, and Argentina. *Oxydia trychiata* has three generations per year in the field and develops normally on coffee, citrus, pine, and cypress, which are all introduced species.

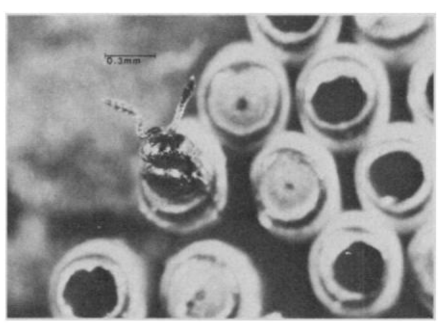

Fig. 1. *Telenomus alsophilae* emerging from eggs of its customary host, *Alsophila pometaria*.

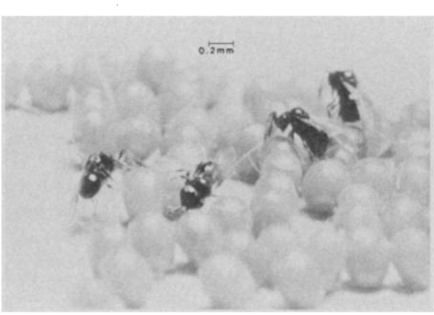

Fig. 2. *Telenomus alsophilae* from the fall cankerworm stinging eggs of the convenient laboratory host, *Abbotana clemataria*. Large populations of the parasite were built in this fashion.

Between 1969 and 1975, we (G.F.F., V.H.F., and A.T.D.) developed techniques enabling us to rear continuous generations of the egg parasite *T. alsophilae* (Figs. 1 and 2). The key to our rearing technique was the successful use of a surrogate host, the geometrid *Abbotana clemataria* (J. E. Smith), which can be easily propagated on an artificial diet developed for another geometrid (*4*).

Egg masses of the fall cankerworm were collected in the field near Haymarket, Virginia. Natural parasitization of the field-collected eggs was augmented in a North American laboratory by exposing the masses to *T. alsophilae* reared on *A. clemataria*. Then the completely parasitized eggs were sent to Colombia under quarantine.

In a Colombian laboratory, Bustillo established that parasites emerging from the North American host attacked and developed on *O. trychiata*. Field trials were conducted in June 1975 in the infested plantations at San Félix, Antioquia, Colombia. *Oxydia trychiata* eggs were caged on branches of cypress, and parasites were introduced. Soon, all eggs were parasitized, and plans were made to liberate *T. alsophilae* in a pine plantation that contained small blocks of cypress. The plantation is located at about 6°N latitude and at an elevation of 2340 m. Temperatures average 16°C (6° to 26°C) throughout the year. In Virginia, the origin of the parasite, comparable data are 39°N latitude, elevation of 370 m, and mean summer and winter temperatures of 24° and 2°C, respectively.

Approximately 18,000 *T. alsophilae* were liberated from the beginning of October to the beginning of December 1975 in a plantation with heavy concentrations of *O. trychiata*. Six weeks later, host egg masses were collected and examined; 56 to 90 percent of the masses sampled in six plots in December were parasitized by 95 to 99 percent per mass. After that, populations of *O. trychiata* were decimated to the extent that few moths could be located during the normal emergence time in April 1976. By then, *T. alsophilae* had undergone three generations, and we assumed the long-lived original parasites could still be reproductively active. In April, only 13 *O. trychiata* masses were found, and parasitization averaged 99 percent. The absence of larvae anywhere in the area in May confirmed the outbreak had been controlled. It is to be hoped that *T. alsophilae* will maintain itself on any of four species of *Oxydia* or other Geometridae found in Colombia.

Our results strongly support Pimentel's (*1*) contention that parasites from allied genera can be used effectively against native pests. We are convinced that biological control specialists should look in the direction of matching parasites from one host to a host in a nearby taxon. Although compatibility with the pest's environment is repeatedly stressed as a criterion for selecting which parasites to introduce, we found that *T. alsophilae* adapted readily from the North American to the Andean terrain despite considerable differences in climatic conditions between locales. As Anderson (*5*) pointed out, research with egg parasites of forest defoliators has been neglected. Our experience with *T. alsophilae* shows that use of egg parasites offers many control possibilities and requires only imagination, cooperation, and support.

A. T. DROOZ
U.S. Forest Service, Southeastern Forest Experiment Station, Post Office Box 12254, Research Triangle Park, North Carolina 27709

A. E. BUSTILLO
Instituto Colombiano Agropecuario–"Tulio Ospina," Apartado Aéreo 51764, Medellín, Colombia

G. F. FEDDE, V. H. FEDDE
U.S. Forest Service, Southeastern Forest Experiment Station, Athens, Georgia 30602

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5. J. F. Anderson, in *Perspectives in Forest Entomology*, J. F. Anderson and H. K. Kaya, Eds. (Academic Press, New York, 1976), p. 233.
6. This report grew out of a Food and Agriculture Organization (United Nations) assignment of A.T.D. to Colombia, and the subsequent graduate study of A.E.B. under H. C. Coppel at the University of Wisconsin. We thank C. L. Morris, J. A. Copony, and T. C. Tigner for assistance with the field collection of parasitized fal. cankerworm eggs; D. C. Ferguson, P. M. Marsh, and C. F. W. Muesebeck for their identifications of the insects used in this study; and D. C. Allen, J. F. Anderson, H. C. Coppel, and D. Pimentel for reviewing the manuscript.

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Adipose Tissue Regeneration Following Lipectomy

Abstract. *Surgical removal of subcutaneous fat depots in weanling rats leads to a regenerative response. If the rats are fed a diet high in fat, adipose mass and adipocyte number are precisely restored within 7 months of surgery. Thus, under appropriate experimental circumstances, compensatory hyperplasia will occur in adipose tissues of the rat.*

Obesity is a disorder characterized by an excessive accumulation of adipose tissue. Histologic examination reveals excessively large adipocytes and, often, an excessive number of adipocytes. In the accompanying report we have presented evidence that the size of the adipocyte is a major regulatory feature in the control of adipose tissue mass (*1*). Thus, some disorder of this regulation could be responsible for the large adipocyte size component of obesity. This report deals with the regulation involved in the development of adipocyte number, the other histologic feature of concern in human obesity.

It has been proposed that adipocyte number in normal man and rats is determined during some early critical period or periods of adipocyte proliferation (*2*). During such periods, nutritional manipulations may appreciably alter ultimate adipocyte number. In the epididymal fat pad of the Sprague-Dawley rat the proliferative period ends at about 35 days of age (*3*); food restriction before that age causes a permanent deficit of up to 40 percent in epididymal pad adipocyte number, but food restriction thereafter causes no such deficit (*2*). Surgical excision of part of a proliferating organ has often been used to determine whether cellular proliferation is occurring and the degree to which proliferation can be modified. In many organs such surgery has been found to stimulate a rapid and fully compensatory hyperplastic response, which is regarded as proof for the existence of regulated cellular proliferation. The response to partial hepatectomy is one example which has been extensively studied (*4*). Surprisingly, partial removal of the epididymal fat pad during its proliferative phase does not induce any measurable degree of compensatory hyperplasia or regeneration (*5*). In numerous experiments that we have performed with both rats and mice, we have never seen regeneration of epididymal pads, regardless of the age of the animals at the time of surgery or the extent of the lipectomy (*6*).

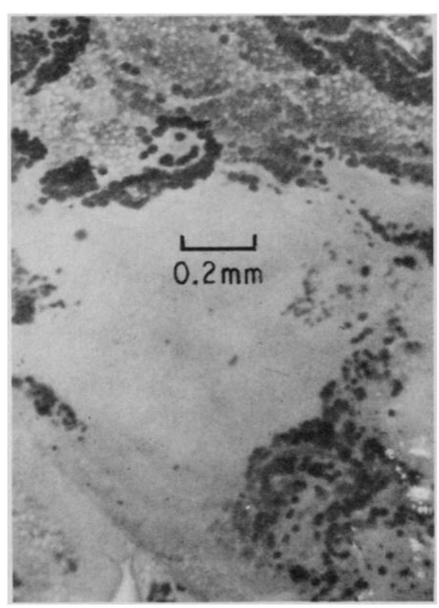

Fig. 1. Photomicrograph, made 4 weeks after surgery, of the outer surface of the collagenous sheath which forms at the site of inguinal area lipectomy. The adipocytes on the sheath surface were stained with oil red O.

This report demonstrates that by excising another site, the subcutaneous inguinal fat depot of the young rat, one can induce a fully restorative cellular response to partial organectomy similar to that seen in other proliferating tissues. The choice of site and timing of excision are both critical.

We removed both inguinal fat depots from each of 31 3-week-old Sprague-Dawley rats by a surgical procedure previously described (*6*). Twenty-one rats identical in age and mean body weight to the experimental rats served as sham-operated controls. Eight experimental rats were killed immediately after surgery to determine the adipose cellularity of the tissue removed as well as of the remaining subcutaneous tissues. Four weeks after surgery we killed two additional experimental rats and examined their subcutaneous inguinal areas. All remaining rats (21 experimental and 21 sham-operated controls) were killed 7 months after surgery. The subcutaneous, mesenteric-omental, and retroperitoneal depots were carefully dissected, weighed, and sampled for cell number and lipid content determinations. Of the rats kept alive for the entire course of the experiment, eight experimental and eight control rats had ad libitum access to only water and Purina Laboratory Chow (low-fat diet or LF). The remaining 13 experimental and 13 control rats had ad