population is enormous. It can not only affect the sanitary conditions of humans, but also negatively affect one of the most important economic activities in the area. On the other hand, the biogeochemistry of Hg in tropical ecosystems is completely unknown, and taking into account the quantities involved, the study of Hg fate in this region should shed light on the understanding of the global Hg cycle.

This study was made possible by the financial support of SUDECO and Universidade de Rondônia, and the continuous support of LDL and WCP through research grants from Conselho Nacional de Desenvolvimento Científico e Tecnológico—CNPq.

CONSEMA. 1986. Manual do garimpeiro. Orientação para o uso do azougue. Cons. Est. Meio Ambiente., Porto Velho.
DNPM. 1983. Garimpos do Brasil. Dept. Nac. Prod. Mineral Publ. Avulsa no. 5, Brasília.
FEARNSIDE, P. M. 1986. Settlement in Rondônia and the taken role of science and technology in Brazil's Amazonian development planning. Interciência 11: 229–236.
JUNK, W. J., AND K. FURCH. 1980. Química da água e macrófitas aquáticas de rios e iguapés na Bacia Amazônica e nas águas adjacentes. I. Trecho Cuiabá—Porto Velho—Manaus. Acta Amazonica 10: 611–633.
———, AND ———. 1985. The physical and chemical properties. *In* G. T. Prance and T. E. Lavejoy (Eds.). Key environments, Amazonia, pp. 3–17. Pergamon Press, New York.
LACERDA, L. D. 1985. Programa de monitoramento ambiental de mineração de ouro terciário utilizando amalgamação por mercúrio. *In* Relatório final—programa Polo Noroeste, cap. 14, pp. 247–258. Oikos Pesq. Aplic. S/C Lt., Rio de Janeiro.
PFEIFFER, W. C., AND L. D. LACERDA. 1988. Mercury inputs to the Amazonian Basin. Environ. Technol. Lett. 9: 325–330.
LINDQUIST, O. AND H. RODHE. 1985. Atmospheric mercury, a review. Tellus 37B: 136–159.
MALLAS, J. AND N. BENEDICTO. 1986. Mercury and goldmining in the Brazilian Amazon. Ambio 15: 248–249.
SALOMONS, W., AND U. FÖRSTNER. 1984. Metals in the hydrocycle. Springer-Verlag, Berlin.
SCOPE. 1985. International SCOPE metals cycling workshop. Rapporteur's report on mercury. Scientific Committee on Problems of the Environment, Toronto.
UNIR. 1986. I seminário sobre contaminação por mercúrio no Rio Madeira. Univ. Fed. Rondônia, Porto Velho. In press.

Luiz Drude de Lacerda

Departamento de Geoquímica
Universidade Federal Fluminense
Niterói, 24210, RJ., Brazil

Wolfgang Christian Pfeiffer

Laboratório de Radioisótopos
Instituto de Biofísica
Universidade Federal do Rio de Janeiro
Rio de Janeiro, 21941, RJ., Brazil

Ari Teixeira Ott and **Ene Gloria da Silveira**

Universidade Federal de Rondônia
Porto Velho, 69000, RO., Brazil

Mimicry of Flowers by Parasitoid Wasp Pupae

In Costa Rican cloud forests the Rubiaceae are the major component of the shrub flora. Many species have small white flowers (genera containing such species include *Faramea, Hoffmannia, Palicourea, Psychotria, Rudgea,* and *Xerococcus*), and although the greatest flowering is seen in the interface between the wet and dry seasons, one can find small white Rubiaceae flowers in any month of the year (Koptur *et al.,* 1988). This flower type is illustrated by *Psychotria macrophylla* (Fig. 1A).

The endoparasitic wasp *Glyptapanteles* sp. (Braconidae) parasitizes a variety of externally feeding Lepidoptera (including Pieridae, Noctuidae, and Megalopigidae), which are herbivores on mimosoid legume trees of the genus *Inga* (Koptur 1985). The pupae of this parasitoid species are unusual among Braconidae. Braconid pupae are frequently rounded and brown, and encased in a network of silk threads produced by the labial glands (Askew 1971), as in Figure 1B. *Glyptapanteles* sp. pupae are white and appendaged with points at one end (Fig. 1C) and are not bound together, falling away from the host soon after emergence (Fig. 1D).

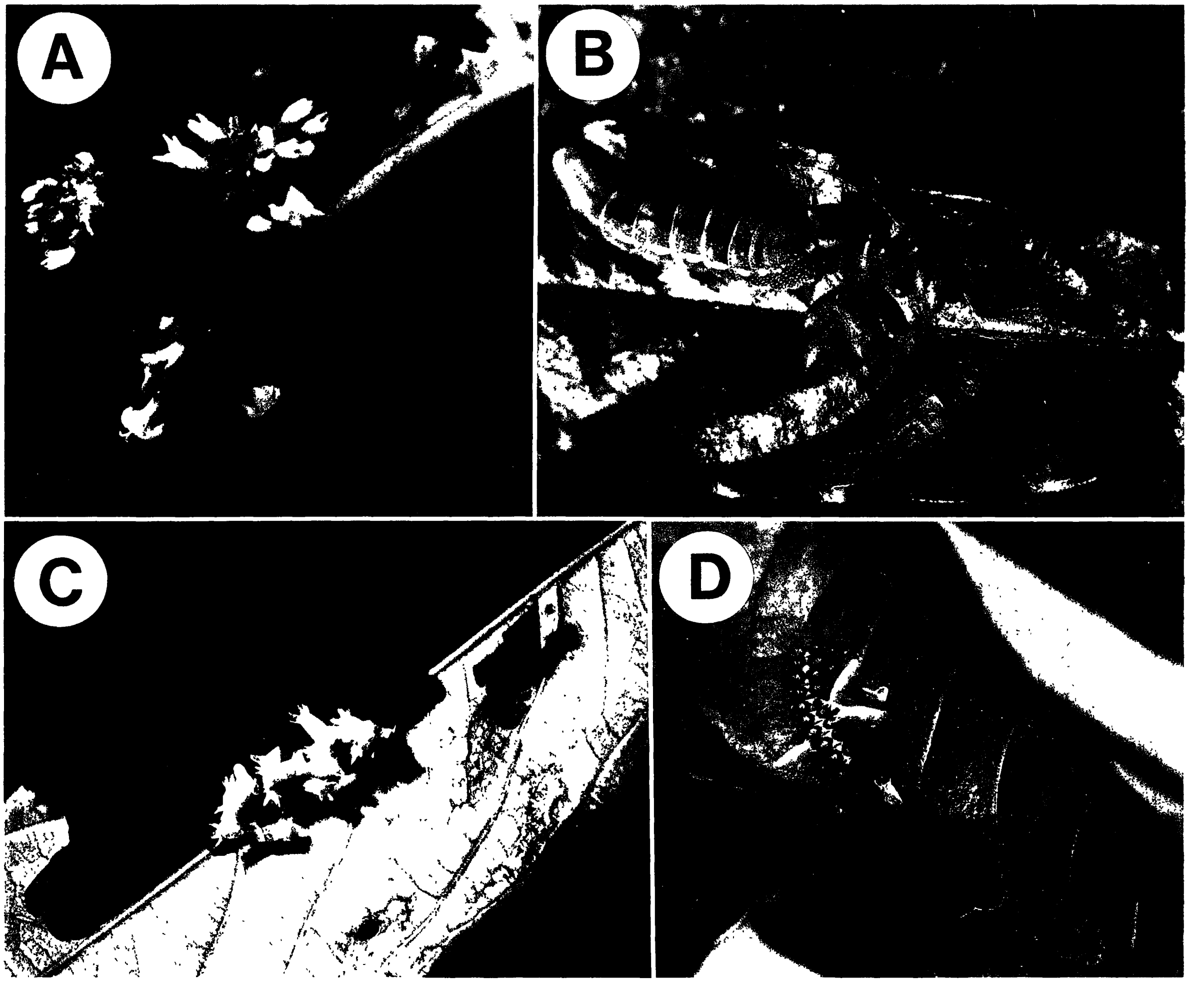

FIGURE 1. All figures are 1×. A. *Psychotria macrophylla* with buds and open flowers. Note points on corollas of closed buds. B. Cocoons of *Apanteles* sp. emerged from caterpillar of *Telemiades centrites gallius* (Hesperiidae) on leaflet of *Inga densiflora*. C. Cocoons of *Glyptapanteles* sp. newly formed outside caterpillar of *Dismorphia crisia lubina* (Pieridae) on leaflet of *Inga mortoniana*. D. Cocoons of *Glyptapanteles* sp. falling away from body of unidentified Megalopigidae (*Plodia* sp.?) on leaflet of *Inga densiflora*.

I propose that this parasitoid has evolved these flower bud-like pupa cases in response to selection by visually oriented predators, perhaps leaf gleaning birds (Greenberg & Gradwohl 1980) or crawling predators. The many species of Rubiaceae plants bearing white flowers and buds provide an abundance of models, for although flowers might be edible for some herbivores, they are not likely to be relished in the diets of insectivores. Falling away from the dead host and vegetation can enable the parasitoid to avoid leaf-gleaning birds and predators that crawl on the surface of plants, and a white parasitoid cocoon on the forest floor might be mistaken for a fallen flower bud, a second line of antipredator defense. Birds may well ignore braconids (Poulton 1931) as potential food items, but other braconid species have pupae that are suspended from vegetation on silken cords, another apparent adaptation for avoiding crawling predators (Askew 1971).

I thank Bradford Hawkins for discussion and comments.

Askew, R. R. 1971. Parasitic insects. Heineman, London.
Greenberg, R., and J. Gradwohl. 1980. Leaf surface specializations of birds and arthropods in a Panamanian forest. Oecologia 46: 115–124.

Koptur, S. 1985. Alternative defenses against herbivores in *Inga* (Fabaceae: Mimosoideae) over an elevational gradient. Ecology 66(5): 1639–1650.
———, W. A. Haber, G. W. Frankie, and H. G. Baker. Phenological studies of shrub and treelet species in tropical cloud forests of Costa Rica. Journal of Tropical Ecology 4: 323–346.
Poulton, E. B. 1931. Two especially significant examples of insect mimicry. Transactions of the Royal Entomological Society of London 79: 395–398.

Suzanne Koptur

Department of Biological Sciences
Florida International University
Miami, Florida 33199, U.S.A.

Volcanological and Biological Observatory at Arenal Volcano (Alajuela Province, Costa Rica)

Arenal Volcano has been Costa Rica's most explosive volcano over the past 4000 years, with at least nine cataclysmic eruptions. It is interesting to geologists because it is located between two other groups of volcanos, it is relatively young (*ca.* 4000 yr), and because, after a 400-year period of repose, it has been erupting continuously for over 20 years. It is interesting to botanists and ecologists because lava flows of various ages are in close proximity, including flows 400 years old and older. These flows quite often have equivalent rainfall and chemical makeup so that differences in flora are most likely the result of age. In addition, the tephra areas in the 1968 devastated zone have scattered pockets of vegetation with different dominant species. Elsewhere on the slopes are large areas of undisturbed premontane wet forest, and one such area stretches 21 km across rugged topography. W. G. Melson and Rodrigo Saenz (Universidad Nacional, Heredia) have been studying Arenal over the past 20 years and have gathered data on the ages of both recent and prehistoric deposits. These data have been recently augmented by many other geologists, and preliminary maps on the ages of the flows are available.

The climate at Arenal is extremely wet, with over 5000 mm of annual rainfall. The rainy months are predominantly June through November, but any month can be quite wet. The elevation ranges from about 540 to 1633 m at the summit. Because of the high rainfall, erosion is rapid and large mudflows have occurred. The devastated areas and lava flows of Arenal Volcano in Costa Rica present an excellent opportunity to isolate environmental variables influencing vegetation. Furthermore, the frequency and intensity of the current eruptions provide numerous research opportunities for geologists.

A number of projects are under way: (1) vegetative and acid rain studies of permanent 10-m plots on lava flows of different ages (including the 400-yr-old flow), (2) established plots of varying sizes in the main devastated zone west of the volcano to study the islands of vegetation present there, (3) soil development studies, including soil chemistry, (4) studies of the dynamics of past and present eruptions, and (5) comparison of these studies with what is known from other volcanos in Costa Rica.

The facilities are located on a site about 2.5 km south of the volcano and separated from it by the valley of the Rio Agua Caliente. The Observatory is on a ridgecrest facing Arenal at 740 m elevation; from this vantage point one has an excellent view of the volcano. Facilities include three buildings, as well as the elevated observatory platform. The lab building has three rooms, tables and stools and one sink. The dormitory has four rooms, each with six bunkbeds (24-person capacity), and a cold-water bathroom. The dining hall and kitchen are located in the third building, and the entire operation is run by staff. Electricity is available in the evenings.

The Observatory is the result of conversations between Prof. Rodrigo Gamez and Melson at the March 1986 Board meeting of the Organization for Tropical Studies. At this meeting Melson was put in contact with Senora Marigold Genis, who along with her father, Senor Alex Murray, agreed to finance and construct the present laboratory on their property along lines suggested by Melson and Funk. It was completed in April 1987 and first used by the authors in cooperation with Rodrigo Saenz, Jorge Barquero, and Eric Fernandez (Universidad Nacional, Heredia) with an Earthwatch group.

We encourage scientific groups to contact the authors and to write directly to Senora Genis (Apartado 118, 1150 La Uruca, San Jose, Costa Rica) for additional information and reservations. However, please bear in mind that this facility was constructed by Senora Genis out of her deep commitment to conservation and is for research and teaching purposes only. At this time unannounced drop-in visits are not possible. There is a modest charge that includes meals (*ca.* $20/day/person) and a minimum number of six per group.

V. A. Funk and **W. G. Melson**

National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560, U.S.A.

(Contents continued from page 1)