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# THE ARTHROPODS OF THE ALLOBIOSPHERE (BARREN LAVA FLOWS) OF THE GALAPAGOS ISLANDS, ECUADOR

## By: Stewart B. Peck

## INTRODUCTION

Hutchinson (1965) proposed the term allobiosphere to encompass habitats where photosynthesis is absent because of environmental extremes, and life is supported only by imported food materials. Examples are the animal communities of caves, the ocean depths (Edwards 1988), and above the snow-line on mountains (Edwards 1987). The word is based on the Greek "allo", meaning different or of another kind, suggesting that these habitats are not operating as parts of the normal biosphere. Of interest to us here are young and barren lava flows that have not yet been colonized by plants.

Howarth (1979) was the first to recognize that recent lava flows in the Hawaiian Islands are rapidly colonized by arthropods within months after they have cooled, and long before the appearance of macroscopic plants. The animals scavenge on the wind-born (aeolian) fall-out of organic debris (Swan 1992). The lava flows are barren, xeric, windy, and subject to both high insolation and large daily temperature fluctuations (Howarth 1987). The animals usually are nocturnal foragers and they retreat to deep cracks and crevices in the daytime. They may feed as generalized scavengers but some species may also be remarkably specialized and restricted to such habitats.

Since the work of Howarth on Hawaiian lava flows, allobiosphere arthropod communities have been found to

**Table 1.** Data for arthropod bottle traps in lava flows on the Galápagos Islands.

| Sample | Island | Lava Flow Location | Dates | Elevation | Life Zone |
|---|---|---|---|---|---|
| **Young Barren Lava Flows** | | | | | |
| 91-140 | Fernandina | Cabo Hammond | May 3-10 | sealevel | arid |
| 92-22 | Marchena | Punta Espejo | March 11-24 | sealevel | arid |
| 92-35 | Pinta | Playa Ibbetson | March 13-21 | sealevel | arid |
| 92-99 | Santiago | Playa Espumilla | April 4-14 | 5 m | arid |
| 92-104 | Santiago | Espumilla to Aguacate | April 6-13 | 200 m | transition |
| **Older Forested Lava Flows** | | | | | |
| 92-30 | Marchena | SW Playa | March 12-24 | sealevel | arid |
| 92-57 | Genovesa | Bahia Darwin | March 10-25 | 5 m | arid |
| 92-74 | Santa Cruz | Darwin Research Station | March 6-30 | 10 m | arid |
| 92-89 | Santa Cruz | Darwin Research Station | April 1-17 | 30 m | arid |
| 92-113 | Santiago | Aguacate Camp | April 7-13 | 550 m | humid |

exist in recent lava flows of the Canary Islands (Ashmole and Ashmole 1988, Ashmole et al. 1990, 1992; Martin et al. 1987, 1990) and Anak Krakatau Island, Indonesia (New and Thornton 1988). These workers found that lava-flow arthropods are most successfully collected by baited traps.

I thought it of interest to apply similar sampling techniques to see if such a fauna exists on young and barren lava flows of the Galapagos Islands, Ecuador.

## METHODS AND MATERIALS

Trapping stations were placed in both young and old pahoehoe lava flows on the Galapagos islands of Fernandina, Genovesa, Marchena, Pinta, Santa Cruz, and Santiago. The ages of the young lava flows are not known but they have not been appreciably weathered and are not colonized by macroscopic vegetation. On each flow a total of 10 trap stations was set for a period of at least 7 days. The traps were set at least 4 meters apart, depending on the terrain. For comparison we also set traps on older, weathered, vegetated lava flows.

The trapping procedure was similar to that employed by Ashmole and Ashmole (1988) and Ashmole et al. (1990, 1992). The traps were 250 ml disposable glass or plastic bottles with about 50 ml of Turquin's liquid (which both attracts and preserves arthropods) and a bait of 5 cc of Danish blue cheese. Traps were placed as deep as possible into crevices in the lava, and set at a 45° angle. Small rocks were placed around the tops to ensure easy access for crawling animals. A modified formula of Turquin's liquid was made from 15 g chloral hydrate, 20 ml concentrated formalin (40% formaldehyde), 10 ml glacial acetic acid, 1 ml liquid dish-washing detergent and beer added to make 1 liter of fluid. Turquin (1973) used only 5 ml of formalin, 10 g of chloral hydrate, 5 ml of glacial acetic acid, 1 L of beer, and no detergent. I found that this older formulation has less capacity to preserve the captured arthropods. Turquin fluid itself is a bait as well as a preservative. It attracts a wider diversity of fauna than an exclusively formalin- or a vinegar-based preservative fluid (Borges 1992).

In addition to trapping we made visual searches for arthropods around the first station at each site: 15 minutes were spent turning over rocks and 45 minutes searching on the surface and in accessible crevices.

The data for trap locations are in Table 1.

## RESULTS

No fauna was found in the daytime visual searches in the new lava flows. This serves to reinforce the general observation that young lava flows are barren of life.

The results of the trap catches are in Table 2. A somewhat higher diversity and much larger number of specimens were caught in the old and vegetated lava flows than in young and barren flows.

The catch numbers have not been adjusted for the different periods of time the traps were operating. The fauna caught on the barren flows are mostly wide-ranging winged species. No distinctive species were found which seem to be specialized to life in or on young lava flows. The cricket *Gryllodes sigillatus*, which is an introduced species, was found on Santiago, Pinta, and Marchena for the first time. It has not been reported in the literature, and was previously otherwise known to me only from CDRS, Isla Santa Cruz, and Bahía Darwin, Isla Genovesa. At present, this species seems to be limited to coastal areas of the arid zone, and is not moving into interior habitats.

## DISCUSSION

An adequate sample is not yet available from young and barren lava flows to definitely determine if they have a distinctive and specialized fauna as is known for the

**Table 2.** Fauna captured in bottle traps place in lava flows of the Galápagos Islands.

| | Young Barren Lava Flows | | | | | Old Vegetated Lava Flows | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Fer.**[1] | **Mar.** | **Pin.** | **San.** | **San.** | **Mar.** | **Gen.** | **S. Cz.** | **S. Cz.** | **San.** |
| | **140**[2] | **22** | **35** | **99** | **104** | **30** | **57** | **74** | **89** | **113** |
| Gastropoda | | | | | | | | | | 8 |
| Crustacea; Decapoda, Brachyura (crab) | | | 1 | | | | | | | |
| Isopoda, Oniscoidea | | | 11 | 1 | 3 | | 18 | 1 | 200 | |
| Aranea | | 1 | | | | | 2 | | 1 | 1 |
| Acari; *Galumna* sp. | | 18 | | | | | | | | 12 |
| Gamesina | | | | | | 2 | 1 | | 1 | |
| *Austrocarabodes* sp. | | | | | | | | | | 3 |
| *Sacculobates "tenuipilosus"* | | | | | | | | | | 1 |
| Diplopoda | | | | | | | | | | 1 |
| Chilopoda, *Scolopendra galapagoensis* | | 22 | 6 | | | 8 | 27 | 4 | | |
| Hexapoda, Collembola | | | 2 | 5 | 5 | 255 | | | 200 | 7 |
| Insecta | | | | | | | | | | |
| Thysanura, Lepismatidae | | | | | | 5 | 2 | | 1 | |
| Orthoptera, Gryllidae, *Gryllodes sigillatus* | | 90 | 119 | 6 | | 1 | 196 | 3 | | |
| *Hygronemobius* sp. | 5 | | | | | | | | | |
| Blattodea, Blatellidae, *Symploce pallens* | | | | | | | 22 | | | |
| Blattidae, *Periplaneta americana* | | | | | | 2 | 104 | 4 | 7 | |
| Hemiptera | | | | | | | | | | |
| Lygaeidae | | | | | | | | | 5 | |
| Anthocoridae | | 1 | 1 | | | | | | | |
| Miridae | | | | | | | | | | 1 |
| Homoptera, Acanaloniidae | | | | | | 1 | | | | |
| Cicadellidae | | | | | 1 | | | | 2 | |
| Delphacidae | | | | | | | | | | 3 |
| Psyllidae | | | | | | 6 | | | 1 | 1 |
| Psocoptera | | | | | | | | | 1 | |
| Thysanoptera | | | | | | | | | 1 | |
| Coleoptera, Carabidae, *Pterostichus* sp. | | | | | | | | 1 | 2 | |
| Histeridae, *Euspilotus* sp. | | | | | | | 825 | | 3 | |
| Hydrophilidae, *Oosternum costatum* | | | | | | | | | | 1 |
| Staphylinidae | | | 1 | 1 | | 7 | | | | 16 |
| Ptiliidae | | | | | | | | | | 4 |
| Scarabaeidae, *Ataenius arrowi* | | | | | | | | | | 1 |
| Dermestidae | | | | | | | | 1 | | |
| Nitidulidae, *Stelidota insularis* | | 1 | | 35 | 11 | | | 1 | | 31 |
| *Acribus* sp. | | | | | | | | | 1 | |
| *Urophorus humeralis* | | | | | | | | 1 | | |
| Tenebrionidae | | | | | | | | | | |
| *Ammophorus* sp. | | | | 5 | 3 | | | | 120 | |
| *Stomion* sp. | | | | 1 | 1 | 2 | 5 | | | |
| Chrysomelidae, *Docema* sp. | | 2 | | | | | | | | |
| Bruchidae, *Scutobruchus* sp. | | | | | | | | 1 | | |
| Scolytidae, *Xyleborus ferrugineus* | | | | 1 | | 9 | 1 | | | |
| *X. spinulosus* | | | | | | | | | | 3 |
| *Hypothenemus cylindricus* | | | | 1 | | 1 | | | | 1 |
| Platypodidae, *Platypus santacrucensis* | | | | | 1 | | | | | |
| Lepidoptera (moths) | 1 | 1 | | 9 | 3 | | 4 | | 1 | |
| Diptera, Muscidae | 9 | 2 | 7 | 76 | 95 | 23 | 9 | 1 | 6 | 44 |
| other families | | | 41 | 19 | | | 49 | | | 23 |
| Hymenoptera, Formicidae | 31 | | | | | | | | | |
| *Solenopsis* sp. | | 1 | 7 | | | 5 | 43 | 1 | 159 | |
| *Tapinoma* sp. | | 2 | | | | | | | | |
| *Paratrichina* sp. | | | 2 | 2 | | 1 | | | 5 | |
| *Wasmannia auropunctata* | | | | 292 | 328 | 134 | | | 48 | 174 |
| *Pheidole* sp. | | | | | | | 4 | | 59 | |
| *Campanotus* sp. | | | | | | | | 1 | 4 | |
| *Crematogaster* sp. | | | | | | | | | 2 | |
| *Monomorium* sp. | | | | | | | | | 1 | |
| Microhymenoptera | | | | 1 | | 1 | | | 2 | 1 |
| Totals | 46 | 141 | 198 | 454 | 451 | 462 | 1312 | 20 | 833 | 336 |

[1] Islands: Fer. = Fernandina, Mar. = Marchena, Pin. = Pinta, San. = Santiago, Gen. = Genovesa, S. Cz. = Santa Cruz.
[2] Collection sites, see Table 1 for descriptions.

Canary Islands and Hawaii. On those islands it is known that the distinctive fauna vanishes as biotic succession proceeds, and that some of the specialized fauna is present only near the sea coast. In both those island groups a more diverse fauna also occurs on new lava flows at higher elevations, where there is more wind-borne detritus as a base to the food chain.

If this allobiosphere sampling program can be continued, especially on other islands, it will be possible to state more conclusively whether or not a specialized pioneer fauna exists on or in new lava flows. Then it will also be possible to analyze the makeup of the fauna, from the viewpoint of detritivores and predators. At some sites the biomass of the predaceous centipede *Scolopendra* exceeded the biomass of all the rest of the catches combined. The other notable predators are the anthocorid bugs, the *Pterostichus* carabids and the *Euspilotus* histerids. The *Euspilotus* came from a very large population which was feeding on fly larvae in dead sea-birds in a nearby colony on Isla Genovesa. The scavenger arthropods themselves are all broadly-feeding generalists. The Hemiptera (not Anthocoridae) and Homoptera are probably phytophages. They were more abundant on the forested lava flows. Their attraction to the traps is not understood, but most may be aerial waifs and part of the food supply rather than members of the community.

In addition to an aeolian source of organic detritus in the young lava flows, there may be a sea-borne source of debris and food. This idea is supported by the fact that some of the specialist fauna of new lava flows in the Hawaiian and Canary Islands is found only in coastal areas, and not far inland. We found that there is only a general decline in numbers of individuals and of species away from the coast.

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