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A PRE-VEGETATION POPULATION OF CRICKETS SUBSISTING ON ALLOCHTHONOUS AEOLIAN DEBRIS ON ANAK KRAKATAU

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CONTENTS

The most abundant arthropod on bare lava flows of Anak Krakatau, *Speonemobius* sp. (Orthoptera, Gryllidae), is flightless, nocturnal or crepuscular, and omnivorous. Its role as a key species dependent on arthropod fall-out is discussed.

1. Introduction

The bare ash-covered lava flows of Anak Krakatau were thought by Thornton *et al.* (1988) to support several species of arthropod largely dependent on aeolian debris for food, and thus appearing to parallel the better-documented aeolian-based communities known from lava in Hawaii (Howarth 1979). The major constituent of this community on Anak Krakatau was thought to be a small flightless cricket, 33 individuals of which were captured in ground-level water traps in 1985. During our 1986 visit to Anak Krakatau, the ecological role of this apparently key species was studied in more detail, and the results are presented in this paper.

Anak Krakatau, which emerged from the sea only in 1930, is still 95% barren. It was apparently last sterilized in 1952 and also suffered substantial damage in 1972 and 1973 (Thornton & Rosengren 1988). Other significant eruptions occurred in 1953, 1960, 1975, 1979, 1980 and 1981.

The site used for our 1985 survey (Thornton *et al.* 1988; Thornton & Rosengren 1988) was again investigated. It is a bare area on the western coast, separated from the vegetated eastern foreland by the 195 m high volcanic cone, and from the more sparsely vegetated northern foreland by about 800 m of bare lava and ash. This area (figure 1) averages 5–10 m above sea

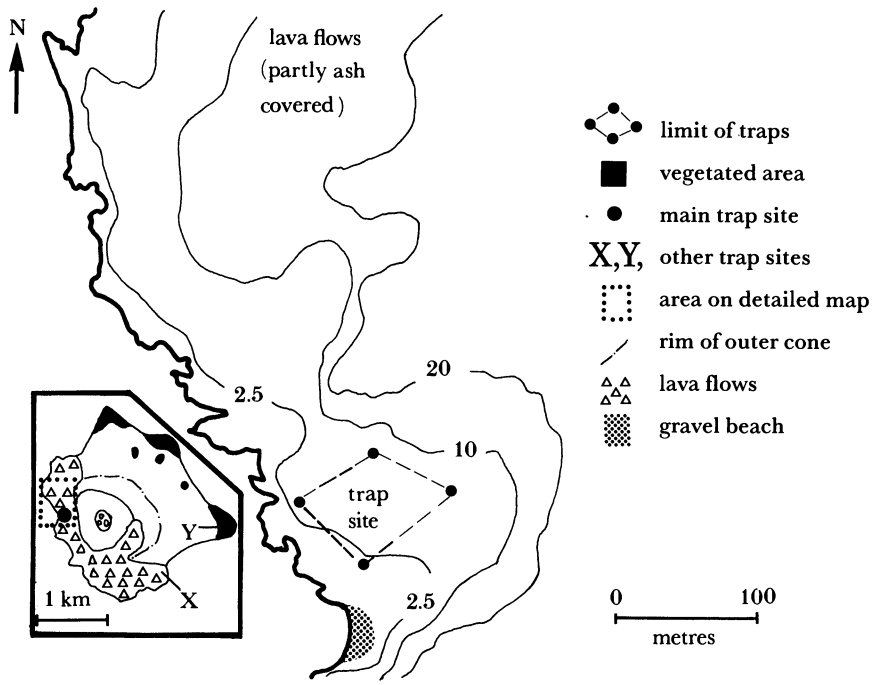

FIGURE 1. Position of major trapping site for *Speonemobius* on Anak Krakatau, 1986.

level, is relatively level (although undulating) and consists of ash-covered lava with numerous lava boulders and small rocks scattered over it. No vegetation occurs on the bulk of the site, although occasional small ferns have established in sheltered cavities beneath a few of the larger boulders. Trapping was concentrated in an area about 50–150 m from the sea, which is below a low cliff, and the site is apparently only rarely affected by spray, and never subject to inundation. The rim of the outer cone (figure 1) and other bare lava flows were also inspected for arthropods, and comparative trapping was undertaken at the east edge of the southern laval fan, nearer to the vegetated zone on the east foreland.

Traps were of two kinds:

(1) 19 $cm^2 \times 10$ cm deep white plastic containers sunk in the ground to their rim, and containing 5–8 cm seawater with a little detergent (Thornton *et al.* 1988);

(2) plastic bottles (0.5 l and 1.0 l), with neck about 2.5 cm in diameter. These were baited with dampened cheese and placed on their side under rocks or on the surface of the ash, and covered with pieces of lava. 'Ramps' were built up to the necks of the bottles. The method was modified from that used in Hawaii by Howarth (1979) only in that light, locally available, plastic bottles were used.

Ten 'water traps' and 35 'bait traps' were placed at the western site on 18 September 1986 and inspected at least daily until 29 September 1986. On each day they were inspected within an hour of dawn, and second visits near dusk were made on five days, in an effort to distinguish nocturnal and diurnal activity of the animals present. All arthropods captured were preserved in alcohol. On five mornings and evenings, counts were made of crickets seen on the lava during 30 min while repeatedly transecting the trapping area. Ten bait traps were also used at the southeastern site, and inspected daily.

Eighty adult crickets, mainly from the lava surface and preserved immediately in alcohol, were dissected to examine gut contents. The latter were teased apart on microscope slides in water, and identified as far as possible.

2. Results

The captures in the two series of traps (table 1) suggest that the arthropod fauna of the lava is dominated by a single species of cricket, *Speonemobius* sp. (Gryllidae, Nemobiini). It constituted 84% of the total captures, the remainder including a range of other taxa including several small crabs. The latter were frequently observed, and are perhaps the most abundant animals (besides crickets) on the bare lava close to the sea. The Coleoptera and Diptera are regarded as 'casual occurrences', but the earwig and spider (a large lycosid) are almost certainly part of the resident fauna.

The bait traps placed at the southeastern site yielded eight crickets representing four species. Only two individuals were *Speonemobius* sp. No *Speonemobius* were taken in the vegetated campsite area.

At the western site, no crickets were captured during the day. Crickets were found in traps every morning through the survey period, but were not present on any evening inspection. Overall, 27 of the 35 bait traps and 7 of the 10 water traps were successful. The greatest daily catch was 27. Many juveniles, of several instars, were captured. The 71 adults comprised 32

Table 1. Arthropods trapped on bare lava on western Anak Krakatau, 18–29 September 1986

	bait trap	water trap	total
Orthoptera: *Speonemobius* sp.	137	20	157
Coleoptera (3 spp.)	1	5	6
Dermaptera (1 sp.)	8	2	10
Diptera (2 spp.)	—	2	2
Araneae (1 sp.)	2	4	6
Decapoda	4	1	5
totals	152	34	186

Table 2. Fore- and midgut contents of adult *Speonemobius* sp. captured on bare lava on Anak Krakatau, September 1986

($n = 80$.)

(*a*) gross contents	number of individuals
empty, or with only traces of material	14
containing plant material	4
containing arthropod fragments	62
(*b*) arthropod contents†	
unrecognizable chitin fragments	34
Coleoptera	21
Diptera	8
Lepidoptera	6
Hemiptera	5
Psocoptera	1
Hymenoptera	3

† Some individuals entered into more than 1 category.

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males and 39 females and the sample of larger nymphs also suggested a sex ratio close to unity (28 male, 27 female).

Inspections of the lava surface showed all stages of *Speonemobius* to be common in the area, and up to 60 individuals were seen each day on the lava. Few were found under rocks or in crevices, and no aggregations were seen.

Gut contents of dissected adults are summarized in table 2.

3. Discussion

The genus *Speonemobius* is in need of revision (F. Willemse, personal communication 1987), and a specific name for our species is not yet available. It appears to be by far the smallest cricket on Anak Krakatau, and adults are only some 7–10 mm long. Both sexes of *Speonemobius* are flightless, but move actively by running and jumping across the lava surface. Adults repeatedly leapt distances of 30–40 cm when pursued, and even the smallest instars jumped 10–15 cm. The cricket appears to be predominantly surface dwelling, and is active only at night and during the coolest parts of the day. It is cryptic: the banded legs and mottled body render it very difficult to see when still. Yet the rapid movement gives it the potential for considerable dispersal. *Speonemobius* is widely distributed on Anak Krakatau and is clearly the most abundant, conspicuous arthropod frequenting this harsh habitat. Although found along the rim of the outer cone, to a height of about 130 m above sea level, *Speonemobius* appears to be rare in vegetated areas where other, larger, crickets were abundant.

The wide spectrum of growth stages present suggests that *Speonemobius* may breed continuously.

Many individuals of *Speonemobius* contained little recognizable food material in their guts. However, most (62 out of 80) contained arthropod fragments, in varying amounts, and several fragments were recognizable to insect order (table 2). No other arthropod groups were recognized. Gut contents of *Speonemobius* indicate its opportunistic feeding habits, with a wide range of available foodstuffs being taken. Many different kinds of invertebrates are deposited in considerable numbers on Anak Krakatau (Thornton *et al.* 1988). Most will not survive, and many will not be active after settling. Fragments of both small (e.g. aphids, psocids) and large (beetles, moths) insects were found in cricket guts, and only very few contained plant material. No concentration of crickets was noted around the sporadic small ferns, and their general habit seems to be one of foraging on the lava–ash surface. As in Hawaii, lycosid spiders share the habitat, but they appear to be relatively rarer than in Hawaii. Conversely, earwigs may be relatively more common: Howarth (1979) recorded a single specimen of *Euboriella annulipes* (Lucas). Crabs are likely to occur only relatively close to the sea, and were not found high on the outer cone. The micropterous *Nysius* bugs, evidently restricted to the higher elevations of Mauna Kea on Hawaii (Ashlock & Gagne 1983), which also feed on airborne insect debris, had no analogue on Anak Krakatau.

The biology of *Speonemobius* on Anak Krakatau shows extraordinary parallels with another nemobiine, *Caconemobius fori* Gurney & Rentz, in Hawaii (Howarth 1979), and it appears to be well adapted to exploit this seemingly adverse habitat. Nocturnal or crepuscular activity is likely to be characteristic of many animals on bare lava flows in the tropics, where daytime surface temperature may be very high: Howarth noted a diurnal temperature range of 25–50 °C, and a surface soil temperature of 66 °C has been recorded on Anak Krakatau (Barker & Richards 1982).

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This study has confirmed the presence of an aeolian ecosystem (*sensu* Swan 1963) on Anak Krakatau, with one species of scavenging arthropod far outnumbering any other consumer present. Trapping in 1985 (Thornton *et al.* 1988) and 1986 (a malaise trap was also operated at the western site and 348 arthropods were taken in 12 days), clearly demonstrate that numerous windborne animals are available as an allochthonous nutrient source. As Howarth (1979) pointed out, the lava flow 'system' shows parallels with cave habitats relying on imported foods. Although such tropical lava flow communities have been documented earlier only in Hawaii, it is possible that they may also be widespread in other areas of intense volcanic activity in which vegetation may take a considerable period to establish. Whereas alpine aeolian ecosystems are now relatively well known (Edwards 1987), such low-altitude communities as that on Anak Krakatau appear to have been very poorly documented.

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