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ECOLOGICAL STUDIES OF CTENOSCIARA HAWAIIENSIS (HARDY) (DIPTERA: SCIARIDAE)

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Abstract

The seasonal fluctuations of Ctenosciara hawaiiensis (Hardy) populations in two different ecosystems at the same elevation on Mauna Loa on the island of Hawaii are compared and correlated with fluctuations in rainfall, humidity, and temperature. Rainfall appears to be the most important extrinsic factor affecting seasonal changes in this species. There is a marked difference between the two populations which in part could be explained by differences in the ecosystems. Ctenosciara hawaiiensis is closely associated with Acacia koa. The larvae live under the bark of dead branches.

Ecological Studics of Ctenosciara hawaiiensis (Hardy) (Diptera: Sciaridae)

Introduction

The Sciaridac or dark-winged fungus gnats are a prominent element in many of Hawaii's ecosystems. The adults are small, usually dark flies commonly found around decaying plant and animal materials. The larvae are characterized by the shiny black head and the featurclcss, twelve-segmented, white, translucent body. Larvae generally feed on decaying plant and animal materials, animal excrement, molds and fungi; some feed on living plant tissues.

I am working on a revision of thcsc flies and recognize about 40 species in 11 genera. None of the genera are endemic; however, many of the species are, Since these flies are easily transported by man and his activities, ,determination of endemic versus introduced species is an arduous task, especially since Sciaridae in general arc poorly known and difficult to identify.

The life histories of 14 Hawaiian species have been studied under laboratory conditions where they were reared on Bacto-agar/corn meal agar slant cultures in constant temperature cabinets at 20°C. Gcncration time from oviposition to adult emergence ranged from 13 to 35 days; that of Ctenosciara hawaiiensis (Hardy) was from 23-34 days.

Ctenosciara hawaiiensis was selected as one of the species to be intensively investigated since it is relatively easy to identify, is common to all the sites being investigated and appears to be closely associated with one of the dominent elements of the plant community, Acacia koa. The larvae are commonly found under the bark of fallen koa branches and trees. They have also been reared from rotting Metrosideros, Freycinetia and several other rotting woods.

The seasonal fluctuations of C. hawaiiensis populations in two different ecosystems at the same elevation on Mauna Loa are compared and correlated with fluctuations in rainfall, humidity, and temperature.

Methods

A modified Malaise trap (Gressitt and Gressitt, 1962) is being used to sample the sciarid populations at several sites on the island of Hawaii. This is an interception trap designed to trap the insects as they fly. Presumably with this type of trap, it is easier to obtain indices of absolute population since it intercepts the insects more or less randomly. Julliet (1963) compared a Malaise trap with others and suggests that for larger Hymenoptera and some Diptera this trap is unbiased, but he found it unsatisfactory for Coleoptera and Hemiptera.

Malaise traps were set up at two sites on the island of Hawaii: one. in the Kilauea Forest Reserve (Transcct-Profile 2, segment 11) and the other near the IBP weather station on the Mauna Loa Transect (Transcct-Profile 1, segment 7). These two sites were selected because they arc being intensively studied by other researchers involved in The Islands Ecosystems stability and Evolution Subprogram of the U. S. International Biological Program. Both of the traps are near IBP weather stations and are at approximately the same altitude, 5400 feet. The ecosystems, however, are very different. Kilauea Forest Reserve is a montane rain forest composed primarily of Acacia koa, Metrosideros and Cibotium species (tree ferns). The Mauna Loa site is in a mountain parkland ecosystem formed by Acacia koa tree colonies, Styphelia-Dodonaea tall-shrub communities, both. in a matrix of subalpine grassland.

The first six months, samples were taken continuously and collected weekly. After July 5, 1971, the sites were sampled on alternate weeks only. The volume of material collected was too great to continue on a weekly basis.

Results

The numbers of adult Ctenosciara hawaiiensis collected in the Malaise trap at the Kilauea Forest Reserve site were relatively low throughout 1971 ranging from 0 to 26 per 7-day collection period (Pig. 1). The greatest adult activity occurred between January 25 and April 26 with two peak periods between January 25 - March 1 and March 8 - April 26. The numbers trapped subsequently were relatively low, increasing to a high of 20 during the week of August 30 - September 6. There was also a high of 13 during the week of September 27 - October '4 and again during the week of November 8-15.

At the Mauna Loa Transect Climatic Station, the numbers of adults collected showed very pronounced fluctuations (Fig. 2). The first and greatest increase began during the week of January 25 - February 1 climbing from 13 to 131, The following week 258 adults were captured. After a decrease to 219 during the week of February 1, the catch rose to 281, the highest of the year. During the next four weeks the numbers of adults collected dropped to 4.6. Two similar cycles accurred in mid-April and early June but to a lesser magnitude.

During the summer dry season the catch dropped to a weekly low of 7. After July 5 the collections wcre made on alternate weeks anly and this undoubtedly has affected the results, Three additional cycles were observed in early September, mid-October and late December.

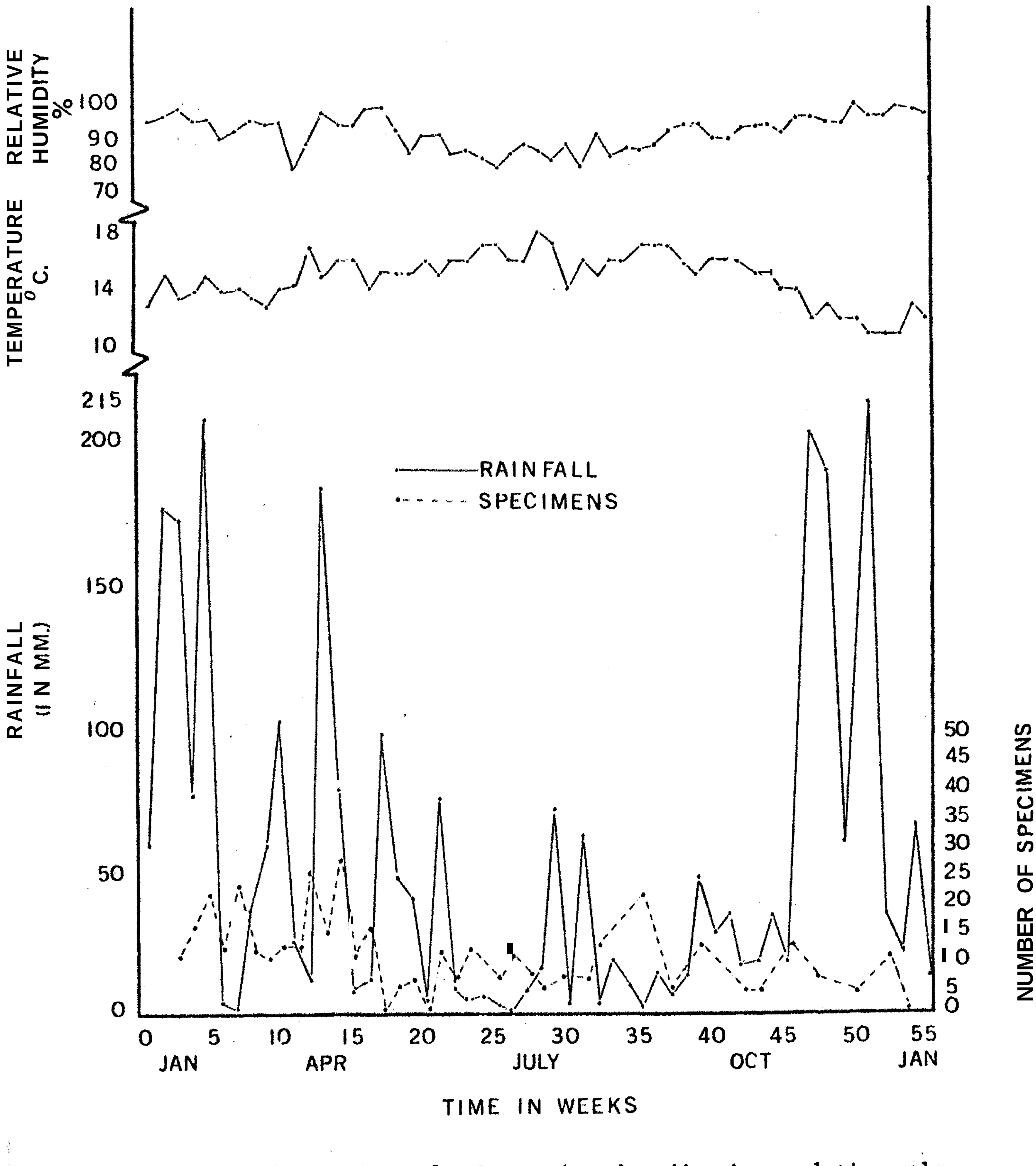

Fig. 1. Fluctuations of a Ctenosciara hawaiiensis population relative to rainfall, temperature and relative humidity, Kilauea Forest Reserve

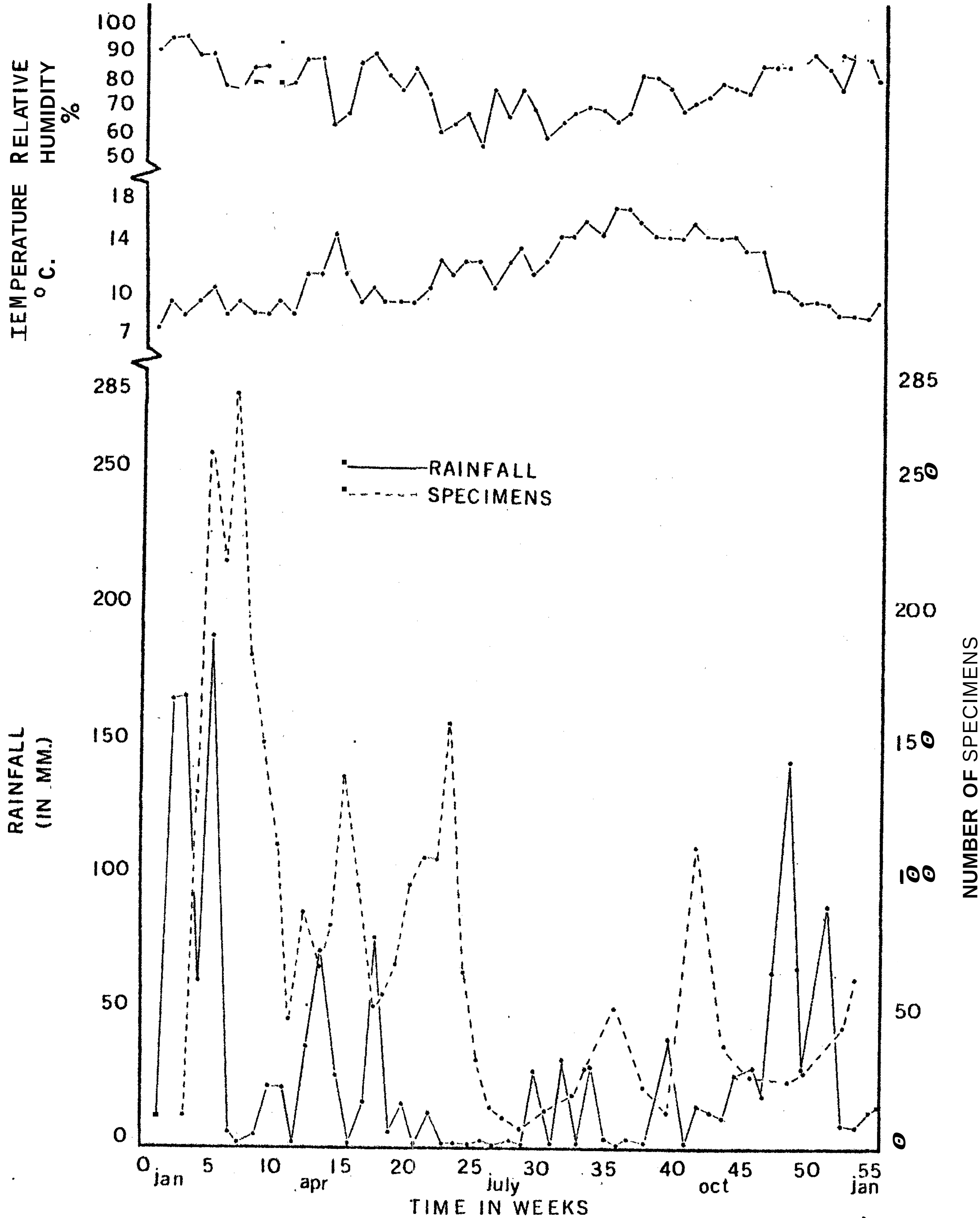

Fig. 2. Fluctuations of a Ctenosciara hawaiiensis population relative to rainfall, temperature and relative humidity, Mauna Loa Strip Road.

Discussion

Comparison of available climatic data -- rainfall, mean weekly temperatures, and mean weekly relative humidity -- with seasonal population fluctuations of C. hawaiiensis adults indicates that at the Mauna Loa site rainfall appears to be the most important extrinsic factor affecting seasonal changes in S. hawaiiensis populations. The first half of the year there were three cycles of adult activity, as reflected in the number of adults captured in the Malaise trap.

The first cycle, January 25 - March 15, began about three weeks after a period of high rainfall in January. The following week the population dropped slightly, corresponding to a dccreasc in rainfall three weeks earlier. The population reached a high during the week of February 12-22 when the catch rose to 281, the greatest of the year. Again this can be correlated to the highest rainfall of the year which occurred three weeks earlier. The rapid decrease in adult activity the following week was preceeded three weeks earlier by a similar but greater decrease in rainfall.

The next two cycles in mid April and early June were almost identical but about half the magnitude. Again the fluctuations could be correlated with fluctuations in rainfall three weeks earlier, the only discrepency being in the last cycle. The first peak occurred about 4 weeks after the week of peak rainfall. Rainfall then decreased sharply and remained at a relatively low level. However, the activity of the adult C. hawaiiensis after dropping only slightly, increased sharply. The only explanation I can offer is that since the population of C. hawaiiensis was still fairly high, the relatively low level of rainfall was sufficient to provide another period of favorable growth.

It would appear that this species is very sensitive to fluctuations in rainfall. The usual three-week delay in response, i.e. activity of adults as expressed in Malaise trap captures, possibly represent the generation time of S, hawaiiensis in nature. This is about one week shorter than its generation time in the laboratory, but since we have considerable difficulty colonizing this species, our laboratory cvnditions are undoubtedly below the minimum required to sustain these populations.

During the second half of the year, the Malaise traps were used on alternate weeks only. This was necessary since we did not have the technical staff to process the samples, but unfortunate in that the samples were not taken frequently enough to detect the rapid changes that seem to occur in C. hawaiiensis populations.

There were again three cycles of adult activity during the second half of the year. The first and second were responses to increases in rainfall three weeks prior to each peak. The initiation and magnitude of the final cycle was much less than expected. To some extent the fluctuations may have been dampened by the alternate week sampling method, but even taking that into consideration, the numbers of adult C. hawaiiensis were lower than expected.

The fluctuations of C. hawaiiensis populations at the Kilauea site were about 1/10 the magnitude of those at the Mauna Loa site; however, they did reflect similar responses. Rainfall and relative humidity were generally greater at the Kilauea site, but the mean weekly temperatures were lower.

It therefore appears that some factor or factors were suppressing the population of C. hawaiiensis at Kilauea. The differences in the magnitude of the fluctuations are shown in Figure 3.

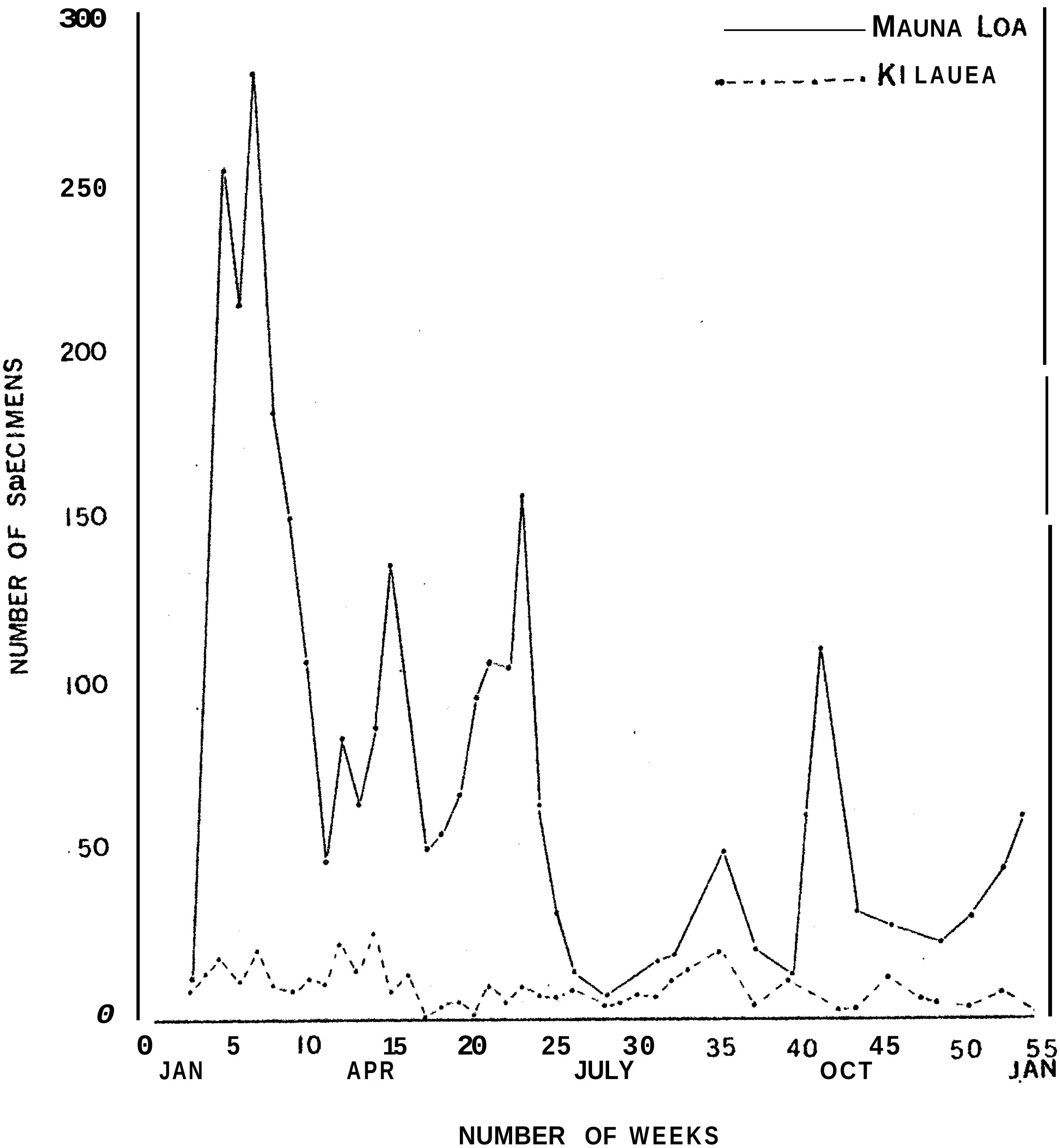

Fig. 3. Comparison of Ctenosciara hawaiiensis population fluctuations, Mauna Loa Strip Road and Kilauea Forest Reserve.

As explained earlier, the two sites, although at the same elevation and only a short distance apart, are very different ecologically, Kilauea is a rain forest and usually wet. Sciaridae reared in the laboratory are very susceptible to excess moisture although this aspect has not been investigated quantitatively. The larvae are highly susceptible to drowning. Excess moisture also seems to make them more susceptible to pathogenic organisms. These are a few of the factors, both extrinsic and intrinsic, which might be suppressing the population at Kilauea.

Another factor which may bc involved is availability of food and shelter. C. hawaiicnsis larvae are usually found under the bark of fallen koa trees and branches and seem to prefer branches where the bark is still tightly against the wood. This probably provides them some protection from predators and parasites and provides a more suitable microclimatic niche, Fallen koa trees with a tremendous number of dead branches are very typical of the Mauna Loa site, whereas they are not as prominent at the site on Kilauea.

Literature Cited

Gressitt, J. L. and M. K. Gressitt. 1962. An improved Malaise trap. Pacific Insects *4:* 87-90.

Julliet, J. A. 1963. A comparison of four types of traps used for capturing flying insects. Canadian J. Zool. 41: 219-223.

Table 1. Numbers of <u>Ctenosciara hawaiiensis</u> adults collected in Malaise traps at Kilauea Forest Reserve (Trap 2) and Mauna Loa Strip Road (Trap 3) from January 18, 1971 to January 10, 1972.*

Collection Period	Trap 2	Trap 3	Collection Period	Trap 2	Trap 3	Collection Period	Trap 2	Trap 3
Jan. 18–25	9	13	Apr. 12–19	9	139	July 12–19	4	7
25–Feb. 1	14	131	19–26	13	96	Aug. 2–9	6	18
Feb. 1–8	20	258	26–May 3	0	51	16–23	11	20
8–15	11	219	May 3–10	4	57	30–Sept. 6	20	52
15–22	23	281	10–17	5	69	Sept. 13–20	4	22
22–Mar. 1	10	181	17–24	1	99	27–Oct. 4	13	20
Mar. 1–8	9	152	24–31	10	108	Oct. 11–18	2	111
8–15	12	109	31–June 7	5	107	25–Nov. 1	2	39
15–22	11	46	June 7–14	10	159	Nov. 8–15	13	28
22–29	24	93	14–21	a	65	22–29	6	25
29–Apr. 5	14	66	21–28	6	33	Dec. 6–13	1	33
Apr. 5–12	26	84	28–July 5	8	15	20–27	a	41
						Jan. 3–10	1	62

* After July 5, 1971, collections were made on alternate weeks only.