

Ecological Studies of *Drosophila* Populations in Korea

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초파리集團의 生態學的 研究

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摘 要

1. 1957年 8月 7일부터 18일까지 鷄龍山에서 高度差分布를 調査하기 爲하여 高度別 4地點에서 果物(복숭아, 도마도) trap를 使用하여 午前 6時와 午後 6시에 同時에 초파리를 採集하였다. 그리고 sweeping도 하여 總 33種을 採集하였는데 다음種들은 높은 地點에서 發見되었다. *Microdrosophila purpurata*, *Mycodrosophila basalis*, *Parascaptomyza disticha*, *Scaptomyza apicalis*, *Drosophila histrioides*, *D. difasciata*, *D. histrio*.

그리고 초파리의 性비가 高度에 따라 變動하였음을 觀察하였는데 특히 *D. suzukii*는 低地에서 雄이 顯著히 많았든것이 700米 高地에서는 거의 1:1의 性비를 보여주었다.

300米 높이의 (B)地點에서 *D. lacertosa*와 *D. coracina*의 日週期活動은 反對적이었는데 *D. lacertosa*는 濕도가 높은 아침에 주로 活動하고, *D. coracina*는 이와 反對로 주로 午後에 活動하고 있음을 알았다.

2. 초파리集團의 季節的 變動을 調査하기 爲하여 1958年 4월부터 11월까지 每月 中旬三日씩 公州蠶業試驗所溝內 桑田에서 그리고 同年 5월부터 11월까지는 每月 初旬三日씩 鷄龍山에서 各各 5개의 果物 trap를 設置하고 比較觀察하였다.

每月 초파리種들의 季節的 變動은 3表와 4表에 記載된바와 같다. 특히 *D. auraria*는 斗場所에서 優占種이었는데 公州蠶業試驗所溝內 桑田에서는 9월에 最高에 達했고, 鷄龍山에서는 8월에 最高에 達하는 unimodality를 表示했다.

3. 초파리의 日週期活動을 調査하기 爲하여 1959年 6월부터 10월까지 公州蠶業試驗所溝內 桑田에서 每月 2日間씩 2時間마다 採集을 하였다. 이地方에서 優占種인 *D. auraria*는 每月 日週期活動에 있어서 bimodality를 形成하였는데 9, 10월에는 두 peak는 서로 接近되었다. 그리고 6月 26日 2時間마다 sweeping法으로 採集한 *D. auraria*의 日週期活動도 比較研究하였는데 거의 같은 現象을 나타냈다.

Recently the ecological studies of *Drosophila* have attracted the attention of geneticists. Several papers have been contributed to this field by Patterson (1943), Dobzhansky and Pavan (1950), Ohba (1956), Wakahama (1956), Takada (1957), etc. In Korea, there were reports in this field by Paik (1958), and Kang *et al* (1960).

From September 1956, present author had been engaged in *Drosophila* survey in South Korea. The present article reports the results of survey of *Drosophila* populations in the Kongju region from 1957 to 1959.

The observational and experimental data bearing of the ecology of *Drosophila* are reported in the following

series of three items: altitudinal distribution, seasonal changes, and diurnal activity.

Here the author wishes to offer thanks cordially to Professor Sajiro Makino, and to Dr. Eizi Momma, Hokkaido University, for their valuable advices, and aslo to Dr. Haruo Takada, Otaru Fisheries High School in Japan, for his kind help and valuable suggestions. Cordial thanks should be also extended to Mr. On Sik Kim and to five students, Kongju Teachers College, for the collection of specimens which were made available for this study.

Localities and Method of Collection

From 7th to 18th August, 1957, the collections of *Drosophila* were made in Mt. Kyelyong ($36^{\circ} 21' N.$, $127^{\circ} 12' E.$, 827m high), about 10 miles south of Kongju. Following the Patterson's method(1943), large trap cans (30cm high by 28cm diam.) were used to collect flies. The traps baited with yeasted tomatoes, peaches and apples were set up at four spots: (A) 150m, (B) 300m (C) 550m and (D) 700m, as shown in Fig. 1, and collections were made simultaneously about 6 a. m. and 6 p. m. twice a day.

In 1958, the collections were made by use of five traps baited with fermenting fruits, which were set up at each spot at distant intervals of about 20m apart in the mulberry field (30m sea level) of the Kongju sericulture laboratory campus. Flies were collected twice a day in the

morning and evening, for three consecutive days in the middle of every month ranging from April to November. In the same year, collections were made in Mt. Kyelyong, for three days in the beginning of every month ranging from May to November, by the above-mentioned method.

In 1959, two traps equipped with fermenting fruit were placed in the mulberry field of the Kongju sericulture laboratory campus. And the collections were made every other hour, for two consecutive days, ranging from June to October.

The temperature, humidity, illumination, rainfall and the condition of the wind were noted at every observation in the field.

Altitudinal Distribution

From 7th to 18th August, 1957, our collections at the four elevational spots in Mt. Kyelyong were totalled to 11,587 specimens including twenty-nine species. Table 1 gives numerical data of *Drosophila* species obtained, which shows the elevational distribution of flies by use of four traps baited.

The predominant species are *D. coracina*, *D. auraria*, *D. suzukii*, *D. brachynephros*, *D. angularis*, *D. unispina*, *D. testacea*, *D. bizonata* and *D. lacertosa*. Particularly the *quinaria* group was dominant among these, except *D. nigromaculata*. *D. histrioides*, *D. difasciata* and *D. histrio* were found at the high altitudes, and were absent or rare at the low altitudes. *D. busckii*, *D. melanogaster* and *D. virilis* which are domestic species were found at the (D) spot near the temple. It seems that these species associated themselves with people in the temple. It should be noted that the *robusta* group (*D. sordidula*, *D. cheda* and *D. lacertosa*) was abundant at the (B) spot near the mountain-stream. Furthermore, a few species collected by net sweeping in various sorts of vegetation: *Microdrosophila purpurata*

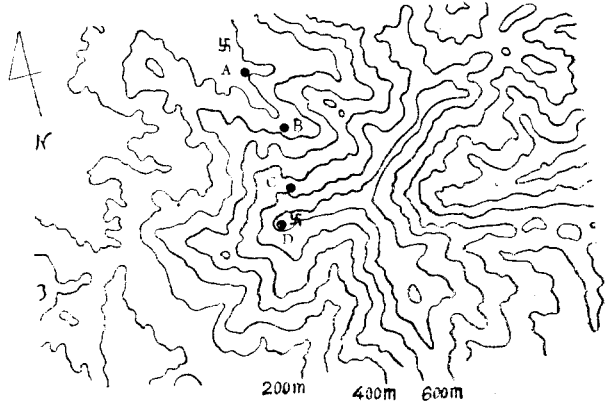


Fig 1. Bird's eye view of Mt. Kyelyong (827m high).
Map showing four elevational spots of collections.

Table 1. Numerical data of *Drosophila* species obtained in Mt. Kyelyong (Aug. 1957), showing an elevational distribution of flies.

Altitude (m)	(A)	(B)	(C)	(D)	Total
Species	150	300	550	700	
<i>Amiota variegata</i>	32	28	11	14	85
<i>Leucophenga argentosa</i>	1	3	—	—	4
<i>L. concilia</i>	4	3	—	—	7
<i>L. maculata</i>	3	2	—	—	5
<i>L. quinquemaculata</i>	2	1	1	—	4
<i>Parasaptomyza disticha</i>	5	2	4	1	12
<i>D. histrioides</i>	—	1	8	19	28
<i>D. busckii</i>	2	6	64	169	241
<i>D. coracina</i>	163	171	52	213	599
<i>D. rufifrons</i>	1	3	—	—	4
<i>D. bifasciata</i>	—	2	17	81	100
<i>D. suzukii</i>	137	54	71	101	363
<i>D. lutea</i>	12	1	—	—	13
<i>D. melanogaster</i>	—	2	4	7	13
<i>D. auraria</i>	309	280	110	317	1016
<i>D. nigromaculata</i>	2	4	1	2	9
<i>D. brachynephros</i>					
<i>D. angularis</i>	1398	210	1110	2658	5376
<i>D. unispina</i>					
<i>D. sternopleuralis</i>	6	4	2	—	12
<i>D. testacea</i>	93	32	65	109	299
<i>D. bizonata</i>	610	135	318	1190	2253
<i>D. histrio</i>	2	1	42	110	155
<i>D. immigrans</i>	2	1	—	—	3
<i>D. melanissima</i>	5	3	—	—	8
<i>D. virilis</i>	—	—	—	3	3
<i>D. sordidula</i>	3	25	3	16	47
<i>D. cheda</i>	5	50	6	15	76
<i>D. lacertosa</i>	55	417	119	261	852
Total	2852	1441	2008	5286	11587

(5 specimens), *Parasaptomyza disticha* (35 specimens) and *Saptomyza apicalis* (3 specimens) were found on the grass at 800m altitude. And *Mycodrosophila basalis* (26 specimens) was found in the mushrooms at 500m altitude.

The records on the elevational variations of sex ratio in *Drosophila* species selected are as shown in Table 2. *D. auraria* was preponderant of males, while *D. lacertosa* and *D. busckii* were preponderant of females in 700m altitude. *D. coracina*, *D. bifasciata*, *D. testacea* and the *quinaria* group were excessive of males in all spots without any definite relations to the altitude. *D. suzukii* was an interesting species: the sex ratio in natural populations was observed by Takada (1957) in Japan and by Paik (1958) in Mt. Mootung.

They observed that considerably more males were contained. As they observed, our data also indicated a similar phenomenon in the low altitude, but the author observed that, as shown in Table 2, the sex ratio was approximately 1:1 at 700m high. It was found that the males of *D. suzukii* were abundant around the places of low altitude, and tended to increase in females at high altitude, while an inverse relation occurred for males. Judging from the fact, it seems that sex ratio of *Drosophila* in its natural populations

Table 2. Elevational variations of sex ratio in *Drosophila* species selected.

Species	Altitude (m)	Collected numbers	Female (%)	Male (%)	X ² for 1:1 ratio	Probability:∴
<i>D. suzukii</i>	(A) 150	137	12.4	87.6	77.44	—
	(B) 300	54	22.2	77.8	16.67	—
	(C) 550	71	39.4	60.6	3.17	0.10-0.05
	(D) 700	101	50.5	49.5	0.01	0.95-0.90
<i>D. auraria</i>	(A) 150	309	46.3	53.7	1.71	0.20-0.19
	(B) 300	280	56.8	43.2	4.94	0.05-0.02
	(C) 550	110	46.9	53.1	3.64	0.10-0.05
	(D) 700	317	35.0	65.0	28.47	—
<i>D. bizonata</i>	(A) 150	610	41.1	58.9	19.12	—
	(B) 300	135	43.0	57.0	2.67	0.20-0.10
	(C) 550	318	52.8	47.2	1.02	0.50-0.30
	(D) 700	1190	49.2	50.8	0.27	0.70-0.50
<i>D. lacertosa</i>	(A) 150	55	58.2	41.8	1.47	0.30-0.20
	(B) 300	417	54.9	45.1	4.03	0.05-0.02
	(C) 550	119	67.2	32.8	14.13	—
	(D) 700	261	60.5	39.5	11.59	—

∴ Indicates the probability much less than 0.01.

changes with altitude.

In addition, the author observed the constitutions of *Drosophila* populations in the morning and afternoon respectively at each spot. It makes no difference of the frequencies of collected *Drosophila* species in the morning and afternoon at all spots, except the *robusta* group (*D. sordidula*, *D. cheda* and *D. lacertosa*) and *D. coracina*. Fig. 2 shows the diurnal activities of *D. lacertosa* and *D. coracina* at the (B) spot in 300m high. It was based on collections in the morning and afternoon twice a day. As a rule, *D. lacertosa* was collected chiefly in the morning, while *D. coracina* was collected chiefly in the afternoon. The weather on 11th August was cloudy, windy and dry, it should be noted that *D. coracina* was attracted in large numbers even in the morning. Furthermore, it was rainy the next day; much less other species were collected in the morning and afternoon than the *robusta* group and *D. coracina*.

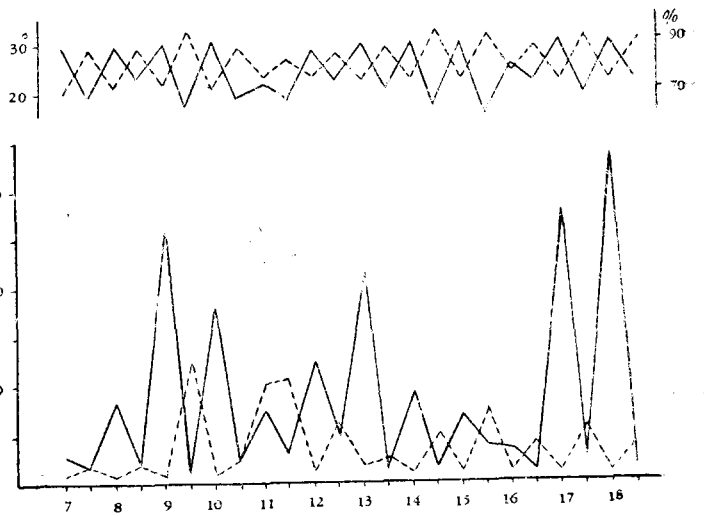


Fig. 2. Illustrating the diurnal activity of *D. coracina* and *D. lacertosa* in Mt. Kyelyong (August, 1957). Based on morning and evening collections. Solid lines (upper): humidity, dotted lines (upper): temperature. Solid lines (below): *D. lacertosa*, dotted lines (below): *D. coracina*. Abscissa: date. Ordinate: collected number.

Seasonal Changes

From April to November 1958, our collections in the mulberry field of the Kongju sericulture laboratory campus were totalled to 3,313 specimens including fourteen species. Table 3 shows the seasonal changes-

in the relative frequencies of different species of *Drosophila*. The baits did not attract them on account of low temperature from December to March in the Kongju region. *D. auraria* was found to be most predominant in this field through the year; they occurred in spring in small numbers, and showed the maximum occurrence with 586 specimens in September and decreased in October. On the other hand, *D. nigromaculata* occurred in small numbers until August, but showed the maximum occurrence in October with 166 specimens, and they showed a high frequency in November. Paik (1958) observed that *D. nigromaculata* showed two peaks in April and October at Mt. Mootung. In the Kongju region, however, it was noted that the flies showed unimodality in activity. *D. coracina* was abundant in spring and summer, and *D. brachynephros* and *D. angularis* were abundant in September.

In addition, it had to be noted that some drosophilid species such as *Mycodrosophila koreana*, *Parascaptomyza disticha*, *D. clarofinis* (described by author, 1959) and *D. nipponica* were attracted in small numbers by apple baits.

In the same year, from May to November, our collections at the altitude of 150m in Mt. Kyelyong were totalled to 4,639 specimens including fifteen species. The seasonal changes in the relative frequencies of different species of *Drosophila* are shown in Table 4. *D. auraria* was found to be predominant in Mt. Kyelyong, too. They showed the maximum occurrence in August with frequency 56.0 per cent (864 specimens).

Table 3. Seasonal changes in the relative frequencies of different species of *Drosophila* in the mulberry field of the Kongju sericulture laboratory campus (1958).

Species	Apr. (%)	May (%)	June (%)	July (%)	Aug. (%)	Sept. (%)	Oct. (%)	Nov. (%)
<i>Amiota variegata</i>	—	—	0.1	—	0.2	—	—	—
<i>Mycodrosophila koreana</i>	—	—	—	—	—	0.3	—	—
<i>Parascaptomyza disticha</i>	1.2	0.8	1.7	0.8	0.5	0.7	1.0	2.4
<i>Drosophila bisckii</i>	—	—	1.3	—	—	0.2	0.2	—
<i>D. coracina</i>	21.7	23.8	21.2	9.7	11.5	3.4	2.0	1.6
<i>D. sukui</i>	—	—	1.3	2.1	2.9	1.1	1.0	1.6
<i>D. melanogaster</i>	—	—	2.2	1.2	1.4	0.7	2.2	2.4
<i>D. clarofinis</i>	—	—	0.1	—	—	0.3	0.2	—
<i>D. nipponica</i>	2.4	—	—	1.2	1.3	1.0	1.8	3.2
<i>D. auraria</i>	72.3	71.0	62.8	73.7	59.5	55.0	35.8	39.4
<i>D. nigromaculata</i>	—	2.0	2.6	3.9	4.9	19.1	33.9	48.8
<i>D. brachynephros</i>	—	—	—	—	—	—	—	—
<i>D. angularis</i>	2.4	2.4	4.3	4.9	14.4	15.7	16.8	6.4
<i>D. bizonata</i>	—	—	1.7	2.3	3.4	2.6	4.9	3.2
Total specimens collected	83	252	231	513	555	1065	489	125
Mean temperature (°C)	13.4	17.6	23.4	26.3	23.8	20.9	15.0	8.8
Mean humidity (%)	69.0	70.0	67.0	81.0	89.0	85.0	79.0	76.0
Mean rainfall (mm)	180.9	151.4	61.2	559.1	200.3	319.7	141.2	66.4

D. coracina was common species, which showed the maximum occurrence in July with 143 specimens, and *robusta* group (*D. sordidula*, *D. cheda* and *D. lacertosa*) showed frequent occurrence chiefly in summer. It should be noted that *D. nigromaculata* was found in less numbers through the year, compared with the collections in the mulberry field of the Kongju sericulture laboratory campus, and *D. brachynephros*, *D. angularis* and *D. unispina* were decreased compared with the collections at the same place in August 1957.

Table 4. Seasonal changes in the relative frequencies of different species of *Drosophila* in Mt. Kyelyong (1958).

Species	May (%)	June (%)	July (%)	Aug. (%)	Sept. (%)	Oct. (%)	Nov. (%)
<i>Amiota variegata</i>	3.2	3.8	1.5	0.6	1.8	—	—
<i>Drosophila coracina</i>	29.4	20.1	15.2	5.3	6.5	1.8	2.7
<i>D. suzuki</i>	2.7	4.7	9.0	6.2	4.5	2.1	2.7
<i>D. lutea</i>	—	—	—	0.5	1.0	1.8	—
<i>D. melanogaster</i>	—	—	—	1.2	1.9	2.1	—
<i>D. auraria</i>	62.4	54.4	51.2	56.0	36.6	29.4	33.3
<i>D. nigromaculata</i>	—	—	0.2	0.5	1.8	6.4	6.7
<i>D. brachynephros</i>	—	—	—	—	—	—	—
<i>D. angularis</i>	—	7.4	9.7	16.9	32.7	48.2	48.0
<i>D. unispina</i>	—	—	—	—	—	—	—
<i>D. testacea</i>	—	1.6	1.7	1.5	1.1	—	—
<i>D. bizonata</i>	2.3	3.6	8.4	8.5	10.6	7.1	6.7
<i>D. sordidula</i>	—	0.7	0.1	0.1	—	—	—
<i>D. cheda</i>	—	1.1	0.2	0.2	0.3	—	—
<i>D. lacertosa</i>	—	2.7	2.8	2.5	1.2	—	—
Total specimens collected	221	447	938	1542	1136	280	75

Diurnal Activity

The diurnal activities and the seasonal variations of *Drosophila* were observed in the mulberry field of the Kongju sericulture laboratory campus. Collections were made by two fermenting fruit traps for two consecutive days at the end of each month, ranging from June to October in 1959.

A total of 1,725 specimens was obtained, they comprised the following species: *Amiota variegata*, *Parascaptomyza disticha*, *Drosophila busckii*, *D. coracina*, *D. suzuki*, *D. melanogaster*, *D. clarofinis*, *D. nipponica*, *D. auraria*, *D. brachynephros*, *D. angularis*, *D. nigromaculata*, *D. bizonata* and *D. melanissima*. Among them 932 specimens were represented by *D. auraria* (type A) which was predominant in this field. All flies showed a clear bimodality in diurnal activity, as shown in Fig. 3. Particularly, the diurnal activity and the seasonal variations of *D. auraria* showed a bimodal feature in each month, as shown in Fig. 4. The data showed a clear bimodality in their activities; visiting the bait chiefly in the morning and again in the evening, and mostly quiescent during the middle of daytime and whole night. The time of activity is correlated with the time of sunrise and sunset: in summer the morning and the evening maxima are far apart, while in autumn they approximate each other. And the variety of diurnal behaviors correlated with illumination, temperature, and humidity.

In addition, on 26th June, we collected the flies at the garden of Chinese milk-vetch (*Astragalus sinicus*), about 20m², by net sweeping. And we collected for three minutes every two hours in the same way. A total of 335 specimens was obtained, they comprised the following species: *Parascaptomyza disticha*, *Scaptomyza graninum*, *D. nipponica*, *D. auraria*, *D. brachynephros* and *D. nigromaculata*.

Among them 241 specimens were represented by *Parascaptomyza disticha*, which was most predominant in the collections. The collecting data of *Parascaptomyza disticha* and *D. auraria* were as shown in Fig. 3. They showed mostly a bimodal activity, particularly, it has to be noted that *D. auraria* was collected rarely by net sweeping during the night, even on the grass. The author supposes that *Drosophila* removed from the garden to the tall trees near the campus.

SUMMARY

1. Collections of drosophilid flies were undertaken at the elevational spots in Mt. Kyelyong, from 7 th to

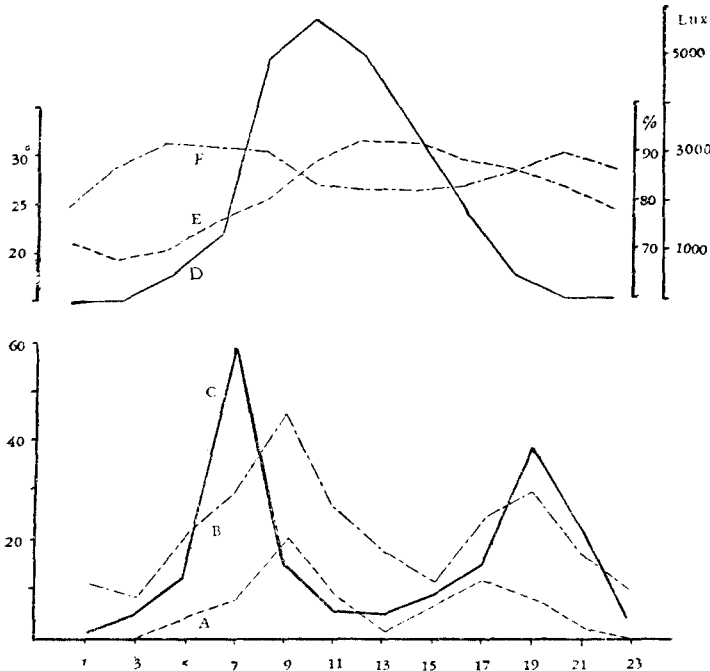


Fig. 3. Illustrating the diurnal activity of *Drosophila* in the mulberry field of the Kongju sericulture laboratory campus (June 26, 1959.) Abscissa; hours. Ordinate: collected number. a, *D. auraria* by net sweeping. b, *Parascaptomyza disticha* by net sweeping. c, all flies by use of traps baited. d, illuminatin intensity in lux. e, temperature. f, humidity.

2. Seasonal changes in *Drosophila* populations were observed comparatively at the two adjacent localities in the Kongju region. From April to November 1958, collections of drosophilid flies were made in the mulberry field of the Kongju sericulture laboratory campus. Also, in the same year, from May to November, collections of drosophilid flies were made in Mt. Kyelyong. The seasonal changes in the relative frequencies of different species of *Drosophila* at the two localities were presented in Table 3 and 4 in this paper. *D. auraria* was found to be most predominant in the Kongju region, and the flies showed unimodality in seasonal activity in both the mulberry field and Mt. Kyelyong.

3. The diurnal activities and the seasonal variations of *Drosophila* were observed by trapping method in the mulberry field of the Kongju sericulture laboratory campus, ranging from June to October in 1959. Particularly, the diurnal activity and the seasonal variations of *D. auraria* showed a bimodal feature each month, and the flies were compared with the collections by net sweeping on the grass.

18th August, 1957, by trapping and sweeping methods. They were classified in 33 species of Drosophilidae. Among them the following species were found at the high altitudes; *Microdrosophila purpurata*, *Mycodrosophila basalis*, *Parascaptomyza disticha*, *Scaptomyza apicalis*, *Drosophila histrioides*, *D. bifasciata* and *D. histio*.

The elevational variations of sex ratio in *Drosophila* species were observed at the all spots. Particularly, the males of *D. suzukii* were abundant around the places of low altitude, and tended to increase in females at high altitude, while an inverse relation occurred for males.

The diurnal activities of *D. lacertosa* and *D. coracina* were observed in the morning and afternoon twice a day at the (B) spot in 300 meters high. *D. lacertosa* was collected chiefly in the morning, while *D. coracina* was collected chiefly in the afternoon.

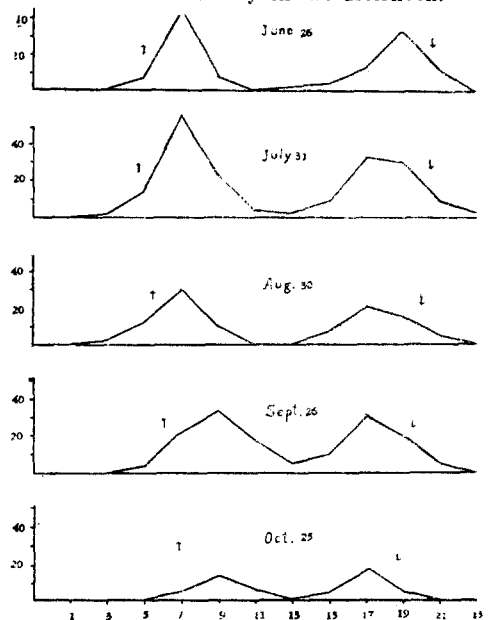


Fig. 4. Graphs showing the diurnal activity of *Drosophila auraria* each month, ranging from June to October, 1959. Abscissa; hours. Ordinate; collected number. ↑, sunrise ↓, sunset.

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