A REPORT ON THE SEASONAL SUCCESSION OF THE BITING MIDGES, CERATOPOGONIDAE, IN THE TAIPEI AREA*#

by

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The biting midges, ceratopogonids, are very abundant and troublesome in Taiwan, nearly one hundred species in 13 genera recorded.[1] They bite noxiously and are reported elsewhere as vectors of viruses [2] [3] [4] and filaria [5] and leucocytozoa [6] among domestic animals. A one-year study of the seasonal succession of this group of insects was reported by the author in 1962. [7] This paper extends his observations to cover three years from Mar. 3, 1961 through Feb. 28, 1964. The seasonal succession of the ceratopogonids is examined in relation to temperature, relative humidity, rainfall and wind velocity.

MATERIALS AND METHODS

The midges were collected by using nine New Jersey light traps [8] in the Taipei area of Northern Taiwan. The traps, equipped with 20-watt bulbs, were operated four nights a week [9] from sunset to sunrise near pig or chicken shelters which provide a blood source to attract these blood-sucking insects. (Fig. 1). The specimens were brought back to the laboratory every morning for identification. Light traps were chosen because they tend to give a more uniform index than do most of the other collecting methods.

A total of 16 locations were sampled for varying periods of time except station No. 1 which was maintained continuously for the three year period as a control collecting spot. The altitude of the traps was uniform at about seven meters above sea level in the "Taipei Basin" except for four locations sampled on the nearby mountains at altitudes of about 150 M (No. 11), 200 M (No. 12 and 13), and 400 M (No. 15). (Fig. 2). Collections are expressed as numbers per trap-night (T N) converted to a four-week moving mean.

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RESULTS

The number of trap-nights was usually 36 per weekly period and yielded 4,230 TN samples during the 1961-64 period. The total number of ceratopogonids collected in the three years is 65,820. The data of collections in detail are presented in Table 1 and Figure 3.

DISCUSSION

Seasonal succession. In 1961, from March to mid-April the collections maintained a depression; collections then rose upward in early May to reach an eminence from late May until June. This is the first eminence, spring eminence, which lasts about three weeks. In mid-June it began to move downward to reach a depression, summer depression, in early July till early September. The second and more conspicuous eminence, autumn eminence, started in late September and reached its peak in early November, lasting about four weeks. From mid-December the curvature began to move down and reached a depression in late January till late February.

Table I. Weekly catches of ceratopogonids in the Taipei area from March 1961-February 1964

Week Ending	+TN	Specimen		*Moving Mean		Week Ending	TN	Specimen		Moving Mean	
		Male	Total	Male	Total			Male	Total	Male	Total
1961						14	36	3	129	0.34	4.82
Mar 3	36		40			21	36	2	189	0.21	4.18
10	36		201			28	36	1	55	0.04	3.51
17	36		60			Aug 4	36	4	135	0.07	3.52
24	36		72	0	2.59	11	27	3	133	0.08	3.86
31	16		67	0	3.05	18	36	1	87	0.07	3.15
Apr 7	36		66	0	2.17	25	36	0	115	0.06	3.57
14	36		75	0	2.27	Sep 1	36	10	237	0.11	4.28
21	36		130	0	2.67	8	27	9	163	0.16	4.56
28	36	#74	382	0	4.59	15	9	4	56	0.26	5.51
May 5	36	41	393	0	6.80	22	36	55	595	0.65	8.84
12	36	33	424	0	8.53	29	17	24	269	0.93	11.25
19	36	45	466	1.34	10.89	Oct 6	36	114	342	1.64	12.16
26	36	84	606	1.41	12.42	13	18	73	492	2.54	17.44
Jun 2	18	5	169	1.20	12.04	20	34	427	1,362	5.24	23.33
9	34	7	151	1.02	10.90	27	18	247	626	8.30	28.06
16	36	12	119	0.79	8.49	Nov 3	36	410	1,590	10.36	36.59
23	36	36	282	0.46	6.24	10	27	429	1,121	13.32	40.18
30	36	5	150	0.46	4.24	17	36	745	1,389	15.42	39.76
Jul 7	18	0	67	0.40	4.76	24	18	150	454	14.07	37.37

Week Ending	TN	Specimen		Moving Mean		Week Ending	TN	Specimen		Moving Mean	
		Male	Total	Male	Total			Male	Total	Male	Total
Dec 1	36	189	609	12.54	30.56	24	28	15	166	1.28	12.93
8	36	114	286	9.36	22.17	31	31	14	59	1.17	10.71
15	36	90	240	4.81	14.19	Sep 7	4	0	9	0.56	6.49
22	36	150	324	3.79	10.13	14	32	20	144	0.40	2.52
29	27	30	111	2.75	6.92	21	32	22	266	0.44	4.92
1962						28	24	13	57	0.46	4.93
Jan 5	18	10	52	2.10	5.41	Oct 5	28	20	120	0.64	5.44
12	36	21	89	1.62	4.61	12	14	10	262	0.65	8.32
19	27	16	100	0.71	3.29	19	28	49	459	0.93	10.34
26	27	6	68	0.49	2.97	26	14	10	111	0.97	11.83
Feb 2	8	3	9	0.44	2.53	Nov 2	28	26	274	1.02	13.21
9	4	3	13	0.49	2.73	9	32	34	381	1.15	11.53
16	8	1	23	0.57	2.52	16	24	104	857	1.79	16.34
23	4	4	14	0.57	2.69	23	16	16	202	1.87	17.33
Mar 2	24	128	892	1.82	11.70	30	32	38	278	1.93	17.17
9	24	76	207	2.41	10.89	Dec 7	32	51	305	2.42	16.51
16	24	130	840	3.73	21.07	14	32	45	373	1.30	10.49
23	24	101	540	4.53	25.82	21	32	64	313	1.55	9.89
30	12	64	427	4.53	25.43	28	16	7	100	1.36	9.27
Apr 6	24	1,380	3,132	18.13	55.89	1963					
13	24	431	2,389	21.25	72.03	Jan 4	8	6	24	1.16	7.64
20	24	118	948	21.43	76.28	11	32	72	483	1.36	8.51
27	24	248	1,143	22.68	79.29	18	32	36	142	1.14	7.19
May 4	24	953	4,193	18.23	90.34	25	24	22	138	1.26	7.07
11	23	239	1,596	16.34	82.81	Feb 1	32	17	112	1.21	7.19
18	23	353	1,614	18.95	90.47	8	32	46	223	1.00	6.79
25	24	287	1,720	19.35	96.51	15	26	14	110	0.86	5.11
Jun 1	12	60	561	10.72	54.49	22	24	12	78	0.75	4.48
8	24	104	1,568	9.14	63.48	Mar 1	32	64	334	1.12	6.62
15	23	23	266	5.57	45.94	8	32	178	1,230	2.15	14.08
22	24	13	277	2.72	33.79	15	32	113	527	2.89	17.15
29	24	30	152	1.78	23.69	22	32	104	558	3.58	20.69
Jul 6	12	7	72	0.85	8.86	29	24	71	334	3.82	21.56
13	24	24	532	0.85	11.51	Apr 5	32	69	520	2.97	16.02
20	26	26	437	0.96	12.95	12	32	40	442	2.40	15.35
27	32	24	236	0.84	13.09	19	32	35	809	1.86	17.31
Aug 3	32	29	345	0.92	14.29	26	32	40	879	1.44	20.70
10	32	78	613	1.28	13.52	May 3	32	79	915	1.52	23.79
17	28	35	446	1.34	13.27	10	32	221	1,295	2.93	30.46

Week Ending		TN	Specimen		Moving Mean		Week Ending		TN	Specimen		Moving Mean	
			Male	Total	Male	Total				Male	Total	Male	Total
	17	32	146	928	3.55	31.39		18	32	17	121	0.55	3.42
	24	32	503	1,695	7.42	37.76		25	24	79	101	1.03	2.42
	31	16	160	793	9.28	30.61	Nov	1	32	8	90	1.02	2.70
Jun	7	32	88	637	8.26	37.87		8	32	17	79	1.15	3.32
	14	32	107	722	7.95	36.29		15	16	0	0	1.02	2.37
	21	32	99	401	4.79	26.08		22	32	0	0	0.19	1.32
	28	32	87	392	2.97	16.82		29	8	1	13	0.16	1.03
Jul	5	16	32	213	2.78	15.16	Dec	6	32	17	82	0.16	1.05
	12	28	34	327	2.25	12.44		13	32	52	204	0.57	2.64
	19	14	36	139	2.04	11.79		20	32	50	186	0.96	4.09
	26	28	69	406	2.71	12.31		27	16	26	157	1.33	6.14
Aug	2	32	26	169	1.77	10.30	1964						
	9	32	45	405	1.72	10.55	Jan	3	8	24	181	1.95	11.16
	16	32	86	433	1.85	11.45		10	32	116	400	2.45	12.69
	23	27	24	275	1.45	10.42		17	32	42	180	2.39	12.64
	30	32	47	225	1.62	10.86		24	32	63	209	2.48	11.82
Sep	6	16	15	54	1.50	8.54		31	32	23	68	1.91	6.70
	13	3	1	4	0.91	5.49	Feb	7	32	33	134	1.26	4.61
	20	13	5	59	0.78	4.09		14	16	0	12	0.93	3.39
	27	29	40	238	0.76	4.38		21	24	33	274	0.76	4.62
Oct	4	32	9	54	0.59	3.96		28	32	108	328	1.42	6.65
	11	16	0	0	0.51	3.63	Total	157	4,230	12,821	65,820		

*TN=Number of trap-nights of the week.

#Number of males during the first 8-weeks not recorded.

*The average number of weeks used here is by a moving mean which includes the four previous weeks. For example, the value of Mar 24, 1961 in the table represents an average of the weeks of Mar 3, 10, 17 and 24.

In 1962, the seasonal pattern also showed two eminences alternating with two depressions but the spring eminence was dominent over the autumn one. The spring eminence started from late March moving sharply upward to reach its peak in late April until May, lasting for about five weeks. In late June collections turned down to a low in early July and then showed a small crest before reaching its summer depression in late August till early October. From mid-October the collections rose again and reached a peak in mid-December. This second eminence is smaller and inconspicuous lasting about three weeks. The collections then began to move downward in mid-December and reached a blunt winter depression in late December 1962 until late February 1963.

The curvature of the collections in the year 1963-64 is similar to that of the year 1962-63 with a dominant eminence in spring and a smaller one in fall. However, the spring eminence in 1963 is rather blunt compared with those of the previous years. It possesses

a peak in mid-May till mid-June lasting about four weeks and gradually moving downward in late June. The second eminence started from late December and reached its peak in early January lasting about three weeks. It was four weeks later than during the previous year. The depression between the two eminences was also about five weeks late, which appeared in mid-September till early December.

Correlation of midge succession with climatic factors. The climatic factors of the three years 1961-64 in the Taipei area including temperature, relative humidity, rainfall

Table II. Weekly records (Four-week moving mean) of the climatic factors in the Taipei area

from March 1961-February 1964

Week Ending	Temperature		Relative Humidity	Rainfall	Wind Velocity	Week Ending	Temperature		Relative Humidity	Rainfall	Wind Velocity
	Max	Min					Max	Min			
1961						8	34.28	25.14	72.50	32.73	3.44
Mar 3	20.10	13.19	84.11	36.68	2.92	15	33.90	25.12	72.74	70.55	3.90
10	19.44	13.37	83.71	43.58	3.34	22	32.80	24.45	72.63	72.45	3.75
17	20.55	13.97	82.29	55.25	3.26	29	32.24	24.10	72.38	85.88	4.09
24	22.08	14.55	80.18	41.38	3.14	Oct 6	31.04	23.48	73.77	77.98	4.01
31	21.63	14.64	80.29	62.55	3.32	13	30.15	22.34	71.96	40.85	3.88
Apr 7	24.10	14.64	75.44	53.00	3.00	20	30.44	22.09	70.54	29.58	3.96
14	25.43	16.49	72.00	42.93	2.98	27	29.11	21.30	72.47	22.35	3.76
21	26.01	17.15	69.01	40.48	3.11	Nov 3	28.27	19.97	71.97	20.65	3.75
28	26.56	18.25	72,79	27.40	2.88	10	27.44	19.85	74.18	18.45	3.91
May 5	26.46	18.47	73.57	26.75	3.02	17	26.58	19.24	75.75	20.20	3.87
12	27.25	19.18	73.68	21.22	2.81	24	25.88	18.52	75.72	12.73	4.02
19	28.51	20.10	74.43	23.45	2.74	Dec 1	25.77	18.82	76.32	7.28	4.39
26	28.97	20.58	75.61	41.63	3.37	8	23.53	17.37	76.32	8.30	4.35
Jun 2	29.67	21.96	78.25	47.00	3.13	15	23.35	15.55	75.61	6.15	4.83
9	30.21	22.59	79.14	53.55	3.13	22	23.31	16.38	75.50	3.93	4.61
16	31.37	23.14	72.61	42.75	3.01	29	22.04	15.42	75.11	3.93	4.57
23	33.43	24.11	76.61	21.58	2.44	1962					
30	34.19	24.56	70.57	15.90	2.74	Jan 5	21.10	14.62	77.21	31.78	4.29
Jul 7	34.49	24.90	69.68	15.90	2.56	12	20.00	13.60	79.36	44.68	3.62
14	34.15	24.88	70.50	64.30	2.81	19	18.54	12.30	80.32	47.13	3.67
21	33.98	25.13	70.46	60.63	3.12	26	16.81	10.24	78.82	46.50	3.26
28	34.15	25.24	70.43	101.00	2.90	Feb 2	16.99	9.75	75.50	19.20	3.54
Aug 4	34.21	25.06	70.29	92.40	3.14	9	17.56	9.36	72.82	5.83	3.48
11	34.50	25.19	70.00	53.58	3.30	16	17.84	9.30	72.54	9.78	3.42
18	34.32	24.74	71.07	54.45	2.98	23	20.35	10.56	72.97	9.78	3.56
25	34.33	24.82	71.86	21.28	3.41	Mar 2	20.78	11.89	77.22	21.43	3.54
Sep 1	34.46	25.16	71.86	23.25	3.62	9	21.12	12.82	79.14	21.23	3.69

Week Ending	Temperature Max	Temperature Min	Relative Humidity	Rainfall	Wind Velocity	Week Ending	Temperature Max	Temperature Min	Relative Humidity	Rainfall	Wind Velocity
16	22.63	13.70	79.43	15.08	3.49	14	21.23	14.80	81.82	15.55	3.37
23	21.72	14.46	84.15	64.33	3.61	21	19.60	13.93	83.57	15.83	3.27
30	22.20	13.90	81.43	65.08	3.41	28	20.48	13.40	80.00	3.65	2.79
Apr 6	22.63	13.85	80.65	76.35	3.36	1963					
13	22.58	14.54	81.22	77.03	3.52	Jan 4	19.80	13.08	82.57	6.98	2.62
20	23.73	15.55	78.14	37.03	3.55	11	17.50	10.78	75.29	7.63	2.74
27	25.74	15.99	78.61	29.03	3.45	18	17.03	8.33	76.43	5.85	2.42
May 4	26.29	17.39	80.22	19.58	3.42	25	15.68	6.88	72.71	5.78	2.83
11	26.88	18.10	81.32	27.28	3.25	Feb 1	16.15	5.23	69.57	2.20	2.70
18	28.65	19.88	82.61	22.60	3.01	8	16.95	6.18	74.00	1.75	2.91
25	28.83	20.80	83.25	18.20	3.08	15	17.43	7.93	82.43	5.10	3.15
Jun 1	29.80	21.49	84.50	43.25	3.02	22	16.98	9.18	80.86	9.30	3.56
8	30.45	22.21	83.32	37.53	3.08	Mar 1	17.60	10.38	77.15	9.30	3.70
15	29.92	22.33	85.18	68.88	2.84	8	19.08	11.68	78.93	7.93	3.73
22	30.91	23.19	85.18	69.30	2.47	15	19.45	12.20	80.11	14.55	3.87
29	31.34	23.45	83.00	46.80	2.27	22	21.25	12.88	80.43	13.78	3.13
Jul 6	32.08	23.48	83.11	49.15	1.80	29	21.93	14.18	82.50	19.40	3.46
13	33.30	24.10	79.04	13.23	1.95	Apr 5	22.55	14.03	80.93	19.28	3.14
20	33.88	24.30	77.90	29.98	1.87	12	24.98	14.48	76.79	9.05	3.34
27	33.60	24.38	79.61	37.90	1.78	19	24.28	15.73	76.75	12.83	3.35
Aug 3	33.63	24.88	78.57	38.85	2.36	26	26.28	17.30	77.47	10.78	3.20
10	33.13	24.78	81.11	82.70	2.64	May 3	27.18	18.80	78.86	10.78	3.31
17	32.80	24.53	81.12	65.53	2.65	10	29.20	20.40	81.57	11.10	2.65
24	33.10	24.43	79.39	62.23	2.69	17	30.00	20.98	81.57	37.63	2.70
31	32.83	24.15	79.86	85.73	2.90	24	31.05	21.55	80.39	35.65	2.43
Sep 7	32.38	24.08	80.14	119.15	3.28	31	31.78	21.18	79.32	35.85	2.31
14	32.03	23.80	81.61	123.08	3.36	Jun 7	31.55	22.30	78.93	70.48	2.95
21	31.83	23.53	81.68	114.08	3.36	14	30.80	22.28	77.86	41.68	3.40
28	31.50	23.25	79.89	86.33	3.15	21	30.56	22.60	79.79	48.90	3.70
Oct 5	30.95	23.00	79.43	38.18	3.08	28	30.71	22.81	81.11	65.13	3.65
12	29.68	22.98	79.00	34.25	3.38	Jul 5	31.16	23.43	81.57	38.15	3.14
19	28.28	22.40	79.50	39.35	3.90	12	32.41	24.17	83.57	47.73	2.57
26	26.48	21.20	79.25	34.93	3.96	19	32.58	24.31	83.04	59.48	2.72
Nov 2	25.68	19.55	76.75	7.43	3.40	26	32.90	24.42	81.32	43.05	2.95
9	24.85	18.28	76.11	19.15	3.72	Aug 2	33.43	24.27	80.25	38.90	2.91
16	24.35	18.10	76.61	15.05	3.65	9	33.58	24.06	78.14	34.08	3.05
23	24.23	17.78	78.50	16.10	3.72	16	35.02	24.30	77.47	15.85	2.56
30	22.90	17.30	82.04	26.73	4.04	23	34.03	24.25	79.57	39.83	2.28
Dec 7	21.65	15.85	80.75	15.25	3.75	30	34.10	24.56	79.86	36.23	2.26

Week Ending	Temperature Max	Temperature Min	Relative Humidity	Rainfall	Wind Velocity	Week Ending	Temperature Max	Temperature Min	Relative Humidity	Rainfall	Wind Velocity
Sep 6	34.54	25.13	79.32	28.65	2.79	13	22.47	15.71	84.18	35.37	4.07
13	33.67	25.09	80.89	151.50	3.63	20	21.40	14.97	84.50	35.15	4.17
20	33.31	25.00	82.14	153.90	3.63	27	21.13	13.65	82.96	27.48	3.78
27	32.89	24.75	82.00	154.48	4.41	1964					
Oct 4	31.77	23.78	83.75	157.53	4.29	Jan 3	21.55	13.40	82.36	16.85	3.68
11	30.85	22.65	80.93	34.33	3.88	10	21.93	13.58	81.43	8.65	3.74
18	30.06	21.82	76.72	8.45	4.48	17	22.65	13.15	82.00	23.30	3.51
25	28.64	20.30	75.07	7.73	4.20	24	21.63	12.99	83.82	37.90	3.40
Nov 1	27.82	19.43	73.75	5.73	4.21	31	19.48	12.71	86.89	54.80	3.27
8	28.18	19.11	73.61	3.73	4.10	Feb 7	18.34	11.64	86.36	54.75	3.23
15	27.65	18.89	76.65	7.60	3.97	14	17.60	11.29	86.32	37.90	3.69
22	27.37	19.28	79.00	10.30	3.83	21	18.42	11.91	87.28	33.78	4.17
29	26.24	18.57	80.33	15.45	3.97	28	18.78	12.27	86.68	25.63	4.56
Dec 6	24.07	16.99	82.90	31.13	3.92						

and wind velocity were calculated by the use of four-week moving means and presented in Table 2 and Figure. 4.

The seasonal changes of the temperature from 1961 till 1964 in the Taipei area show a quite regular pattern. The cold season of each year is January-February with an average maximum of around 17°C and an average minimum temperature of about 9°C. It lasts from late January until mid-February. On the other hand, the hot season of the year in the Taipei area is July-August-September. A high temperature plateau is maintained for about 11 weeks with an average maximum temperature of about 33°C and an average minimum temperature of about 25°C.

The number of the ceratopogonids collected during either the hot or cold season was equally poor and was abundant during spring and autumn. An exception occurred in the fall of 1963; the second eminence for the year did not appear until mid-December.

The wind velocity is strong during the winter from October till January with the average speed of 3.5-4.8 meters per second (m/s). The average of the wind velocity of the remaining months is below 3 m/s especially during the summer when it is only about 2 m/s.

The rainfall of the Taipei area during the winter from December till January is very low; the wettest season is from March till June although the summer months, July till September yield large amounts of rainfall with occasional heavy storms, typhoons.

It is of interest to note that during the winter the low temperature depression is accompanied by high wind velocity and low rainfall. This combination probably yields an unfavorable ecological condition, cold and dry with strong wind, which immobilizes the midges. On the other hand, during the summer the climatic factors, especially the high

temperature plateau, are also unfavorable to the midges. This may explain why the collections of ceratopogonids shows a reduction in either cold or hot weather.

The relative humidity of the years 1961-64 in the Taipei area shows a quite variable figure. In 1961 a high relative humidity with the weekly average of RH 80-84% occurred in March and a depression (RH 70-71%) from July till September. In 1962 the high RH (82-85%) appeared in the months of May till June and the low RH (76-76%) in the months of September till November. In 1963 a low RH (73-79%) appeared from mid-January till early March, a high RH (80-83%) from June till August, then another low RH (73-76%) in October-November. From early December 1963 till late February 1964 there extended a long high RH (82-87%) for about 12 weeks. The absence of correlation between the changes in relative humidity and the seasonal succession of the midges may be due to the rather narrow range of variation RH (70-87%) which is adequate for midge activity.

SUMMARY

1. A collection of ceratopogonids was made in the Taipei area from March 1961 through February 1964 by using New Jersey light traps. The light traps were operated four nights a week and yielded a sample of 4,230 collections for the three year period.

2. The records of ceratopogonid collections and the climatic factors including temperature, relative humidity, rainfall and wind velocity of the Taipei area for 1961-64 were correlated and analyzed by the use of four-week moving means.

3. The yearly pattern of the ceratopogonids collected shows two eminences in spring and autumn alternating with two depressions in cold and hot seasons respectively.

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Fig. 1. Collecting Station
"↑" indicates the New Jersey trap located by a pig shelter.

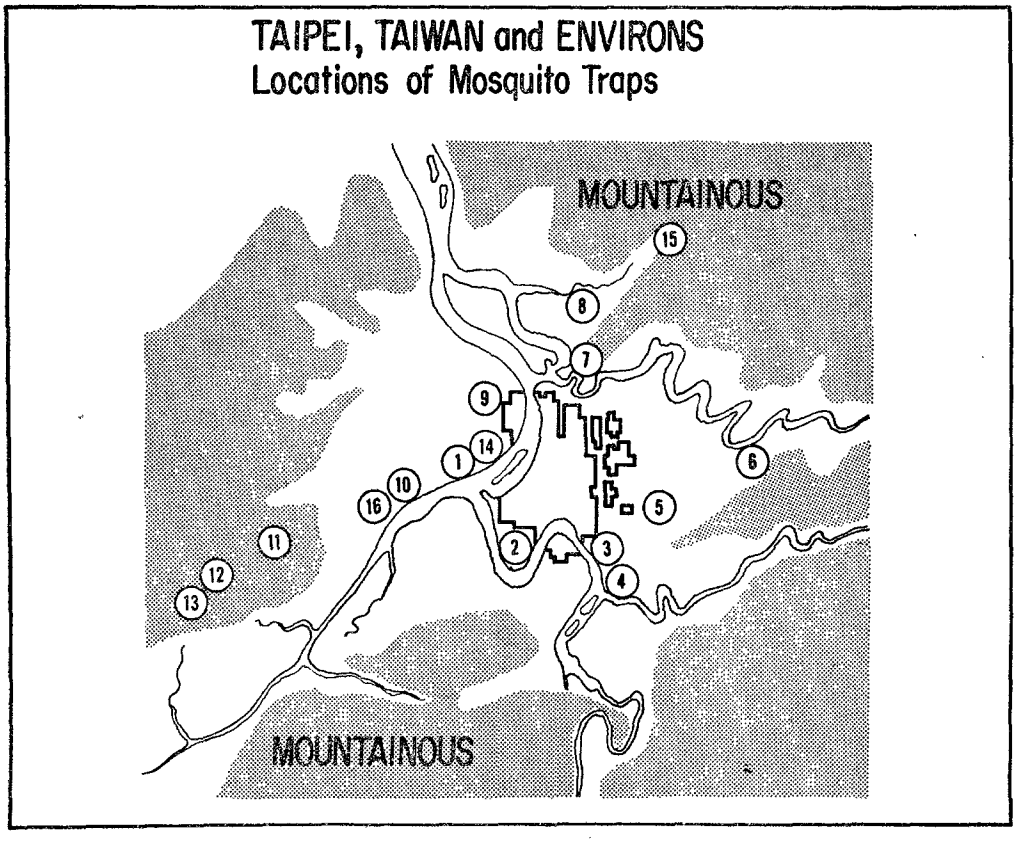

Fig. 2. Taipei, Taiwan and Environs Locations of Collecting Traps

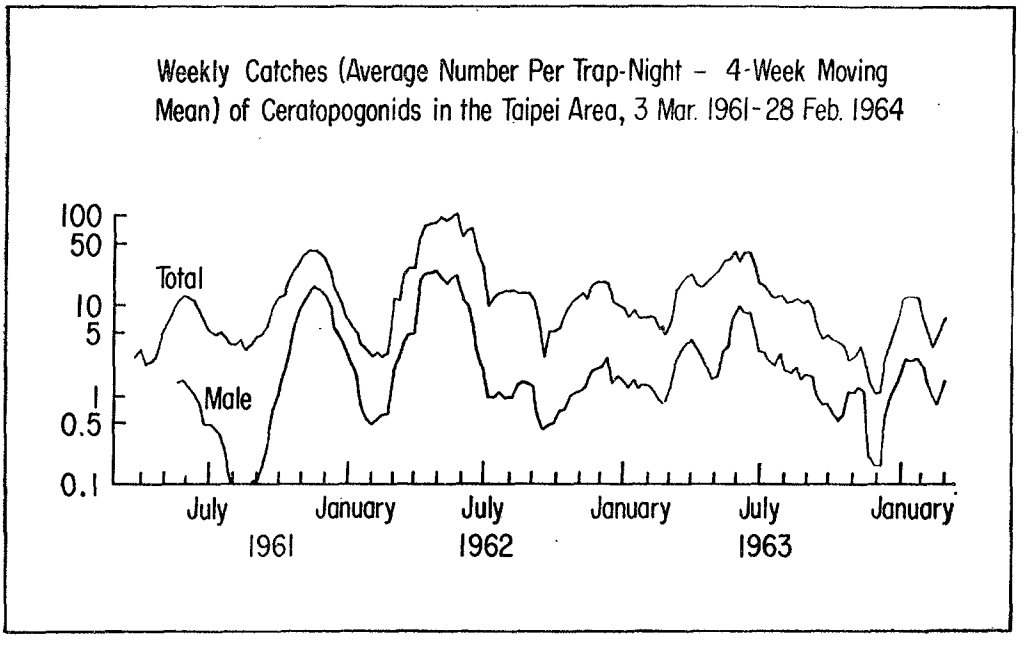

Fig. 3. Weekly Catches of Ceratopogonids

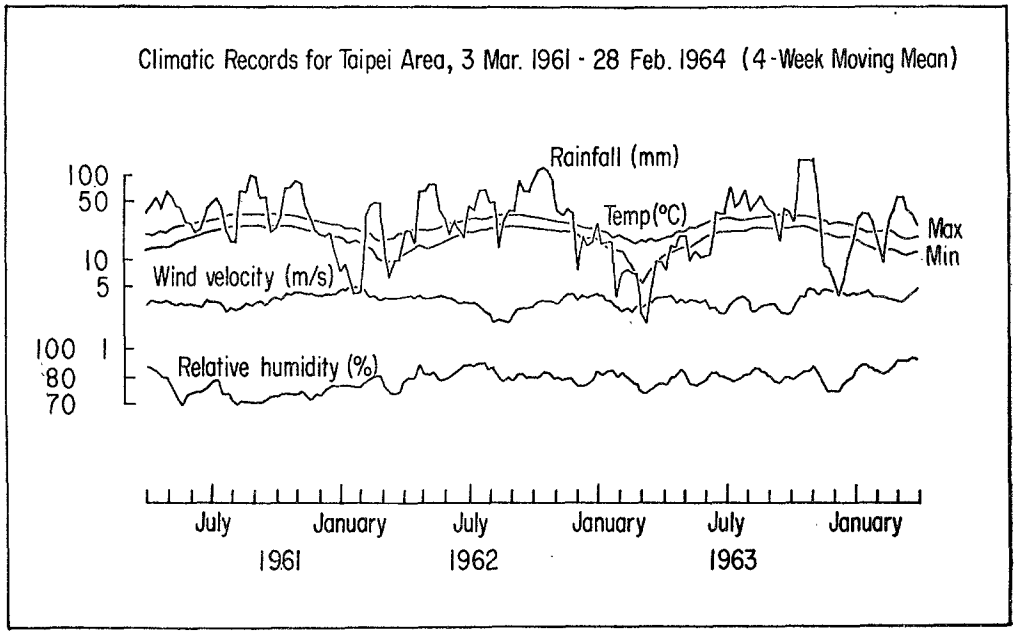

Fig. 4. Climatic Records for Taipei Area

臺北市附近糠蚊類季節消長之三年觀察報告

一、本文係就五十年三月至五十三年二月間在臺北市附近由新澤西式誘蟲燈所捕獲之糠蚊，作一分析之研究，以比較研究其季節消長模樣及其與溫度、相對濕度、雨量、風速等氣候因子之關係。

二、誘蟲燈分設於臺北市附近地區，北起陽明山、北投，南迄桃園、龜山，共有十六採集站，每週採樣四次，三年取樣總數 4,230，採得標本共 65,820 本，其中雄者 12.821，雌者 52,999。

三、本文所用之材料及方法，概依照著者五十一年「臺北市附近蚊類糠蚊類季節消長之研究。」（見"東海學報"四卷二期）一文中所載者。

四、糠蚊年消長之曲線，在春季和秋季各有一高峯，而在夏季和冬季則各爲一低谷。