

OBSERVATIONS ON THE BIONOMICS OF THE BITING MIDGE
CULICOIDES ARAKAWAE (ARAKAWA) (DIPTRA: CERATOPOGONIDAE
IN TAIWAN††

by
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ABSTRACT

Culicoides arakawae (Arakawa) is widely distributed in Taiwan and its adjoining islands: the Pescadores, Small Liu Chiu Island and Orchid Island most abundantly at the plains from 200 m. elevation down to the sea coast. The yearly pattern of *C. arakawae* collected shows two eminences in spring and fall alternating with two depressions. The spring eminence is the dominant one. The nocturnal activity, sex ratio of the midge and the fed/unfed index of the females are also reported.

Culicoides arakawae (Arakawa) is widely distributed in East and Southeast Asia along the Pacific Coast. ⁽¹⁾ It bites mainly domestic fowl and occasionally man. It has been reported from Japan that *C. arakawae* is the vector in transmitting *Leucocytozoon caulleryi* among chickens. ⁽²⁾ At the U. S. Naval Medical Research Unit No. 2 (NAMRU-2) in Taipei, Taiwan isolations of virus have been made from *C. arakawae* since 1962. ⁽³⁾ A preliminary report on the seasonal succession of this biting midge in Taipei area has been published by the author in 1963. ⁽⁴⁾ The present paper covers three-year observations on the ecology of *C. arakawae* including geographical and seasonal distribution, nocturnal activity, sex ratio, and fed/unfed index among female midges.

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MATERIALS AND METHODS

The midges were collected chiefly by New Jersey light traps, equipped with 20 watt bulbs and operated four nights a week from sunset to sunrise near chicken or pig shelters which provide a blood source to attract these bloodsucking insects. ⁽⁵⁾ Collections were also made from animal baits, resting place and larval habitats.

The numbers of *C. arakawae* collected are listed in Table 1. And the climatic conditions in the Taipei area during the study period are listed in Table 2. Figure 1 correlates these two Tables.

RESULTS AND DISCUSSION

Geographical Distribution. After the first isolation of virus from *C. arakawae* in June, 1962 an extensive collection of this biting midge in Taiwan was made in order to study its geographical distribution both horizontally as well as vertically. During the years of 1962-64 the author travelled extensively throughout Taiwan including the following offshore islands; the Pescadores, Small Liu Chiu Island and Orchid Island. It has been found that *C. arakawae* is abundant everywhere in the plains from 200 m. elevation down to the sea coast. However, specimens were also collected in the mountains up to an elevation of 1,150 m. On six trips to higher altitudes in different seasons no *C. arakawae* were found. (Figur 2.)

C. arakawae breeds in mud commonly found in rice fields, shallow ponds and streams. The pH range of their breeding places is from pH 6-9 with pH $8\pm$ as the optimum.

Furthermore, *C. arakawae* appears as the most abundant ceratopogonid species in this area. Among 65,820 specimens of ten ceratopogonid species collected during the past three years in north Taiwan *C. arakawae* comprised approximately two thirds. ⁽⁶⁾

During this study the author observed that a number of chicken farms at Taipei, Taoyuan, and Pingtung were destroyed by chicken leucocytozoonosis known to be transmitted by *C. arakawae*. ^(2,7)

Seasonal Succession. In north Taiwan 16 locations were sampled for varying periods of time from 1962 till 1964. Station No. 1, however, was maintained continuously during this period as a control collecting spot. The altitude of the traps was uniform at about seven meters above sea level located in the "Taipei Basin" except for four locations sampled on the nearby mountains at altitudes of about 150 m., 200 m., and 400 m. respectively.

Station No. 1 was located in the Taipei Basin at 65 Hou-te-li, Sanchung, Taipei County along the Tamshui River. The light trap was set near a chicken shelter with adjoining pig shelter among dwellings surrounded by rice paddies.

The seasonal succession of *C. arakawae* from Station No. 1 correlated with the climatic factors for the year June 1962 till May 1963 in the Taipei area shows a similar pattern to the ceratopogonid curve of the total collections from all 16 stations with

two eminences occurring in the spring and fall alternated with two depressions. The spring eminence is the dominant one. (Figure 1) ⁽⁵⁾

Kitaoka *et al.* reported the seasonal appearance of adult *C. arakawae* from their 10-month collection in Japan from March to December, 1962. The midges maintained a continuous peak from April till October. ⁽⁸⁾ This divergence is probably due to the different climatic conditions.

Nocturnal Activity. *C. arakawae* is one of the night-biters. A study of the time at which *C. arakawae* began its nocturnal activity was made from July 30-August 8, 1964 at Station No. 10, Hsinchung, Taipei County. The midges were collected by light trap on a chicken farm at 30 minute intervals. Collecting was started at 6:30 PM just before sunset and continued for the whole night until 5:30 AM the next morning. The results are shown graphically in Figure 3. It was found that *C. arakawae* started biting at about the time of sunset. By far the greatest number of midges were collected during the two hours after sunset from 6:30 till 8:30 PM.

Sex Ratio. The sex ratio (Male/Female) of *C. arakawae* was highest with an average of 70% for September and October and much lower (0—18.8%) during the remaining months (Table 1). Males were missing from collection only for the month of January. The yearly average sex ratio of *C. arakawae* collected is 10.1% which is higher than those of the mosquitoes except *Culex quinquefasciatus* collected during the same period of time in the Taipei area. ⁽⁹⁾

Kitaoka *et al.* reported the sex ratio of *C. arakawae* from their light trap collections at Yokohama and Omiya in Japan during 1962. The sex ratio greatly fluctuated according to the locality from the highest 1.71 at Omiya to the lowest 0.28 at Yokohama. ⁽¹⁰⁾ These observations from Taiwan and Japan clearly demonstrate that males of *C. arakawae* are attracted to light traps.

Copulating midges are often collected in the light traps. Out of approximately 1,000 copulating pairs several cases of interspecific matings were noted. In each case the male was *C. arakawae*. In a number of cases the females were *C. schultzei*; in one case the female was *C. duodenarius*. In another most interesting case the female was a gall-gnat (Cecidomyiidae, Diptera). This aberrant mating behavior will be published in a separate paper. (Figure 4)

Fed/unfed Index. The female *C. arakawae* collected from Station No. 1 were divided into two groups: fed females engorged with blood and unfed females without blood (Table 1). Fed females appeared in collections from April through August, with the highest fed/unfed (f/u) index of 51.8% occurring in August. The second highest f/u index, however, was only 9.2% for April. The f/u index was zero for the months of September through March even though in November, December, and March 131, 191, and 156 female midges, respectively, were collected.

SUMMARY

1. An extensive collection of *C. arakawae* in Taiwan was made during 1962~64 by

using light traps, animal baits, resting place collections and larval collections.

2. *C. arakawae* is widely distributed in Taiwan and its adjoining islands (the Pescadores, Small Liu Chiu Island and Orchid Island)* and is abundant in the plains from 200 m. elevation down to the sea coast.

3. The yearly pattern of *C. arakawae* collected shows two eminences in spring and fall alternating with two depressions. The spring eminence is the dominant one.

4. The nocturnal activity, the sex ratio and the fed/unfed index of the female *C. arakawae* are reported.

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* New Records

Table 1.

Monthly Catches of *Culicoides arakawae*
from Station No. 1 June 1962-May 1963

(Analyzed for average trap-night yield, sex ratio, and ratio of fed to unfed females.)

Month	Specimens			Total	TN	ATN		Index %	
	Male	Female				Male	Total	Male/Female	f/u
		Fed	Unfed						
1962									
Jun	11	7	167	185	18	0.61	10.28	6.32	4.19
Jul	9	15	115	139	14	0.64	9.93	6.92	1.30
Aug	32	87	168	287	19	1.68	15.11	12.55	51.79
Sept	7	0	6	13	11	0.64	1.18	116.67	0.00
Oct	7	0	13	20	12	0.58	1.73	53.85	0.00
Nov	16	0	131	147	17	0.94	8.65	12.21	0.00
Dec	30	0	191	221	14	2.14	15.79	15.31	0.00
1963									
Jan	0	0	8	8	12	0.00	0.67	0.00	0.00
Feb	3	0	16	19	15	0.20	1.27	18.75	0.00
Mar	20	0	156	176	19	1.05	9.62	12.82	0.00
Apr	7	20	218	245	16	0.44	15.31	2.94	9.16
May	23	2	311	336	18	1.28	18.67	7.35	0.64
Total	165	131	1,500	1,796	185	0.89	9.71	10.12	8.73

TN-Trap nights.

ATN-Average yield per trap-night.

f/u-Fed/unfed females.

Table 2
Climatic Records (Monthly Average*)
in the Taipei Area June 1962-May 1963

Month	Temperature °C		Relative Humidity %	Rainfall* mm	Wind Velocity m/s
	Maximum	Minimum			
1962					
Jun	32.3	23.9	83	212.8	2.2
Jul	34.5	25.1	79	175.8	2.1
Aug	33.7	24.7	80	338.9	2.9
Sept	32.4	24.0	80	306.3	3.2
Oct	28.1	20.6	78	104.3	3.7
Nov	24.1	17.5	81	99.1	3.9
Dec	21.9	13.3	80	38.3	2.8
1963					
Jan	17.3	6.1	75	26.3	2.6
Feb	18.1	10.5	77	44.5	3.8
Mar	22.6	13.4	81	87.4	3.3
Apr	27.6	18.4	78	45.5	3.1
May	32.4	22.8	79	108.9	2.5

* Rainfall in monthly total amount.

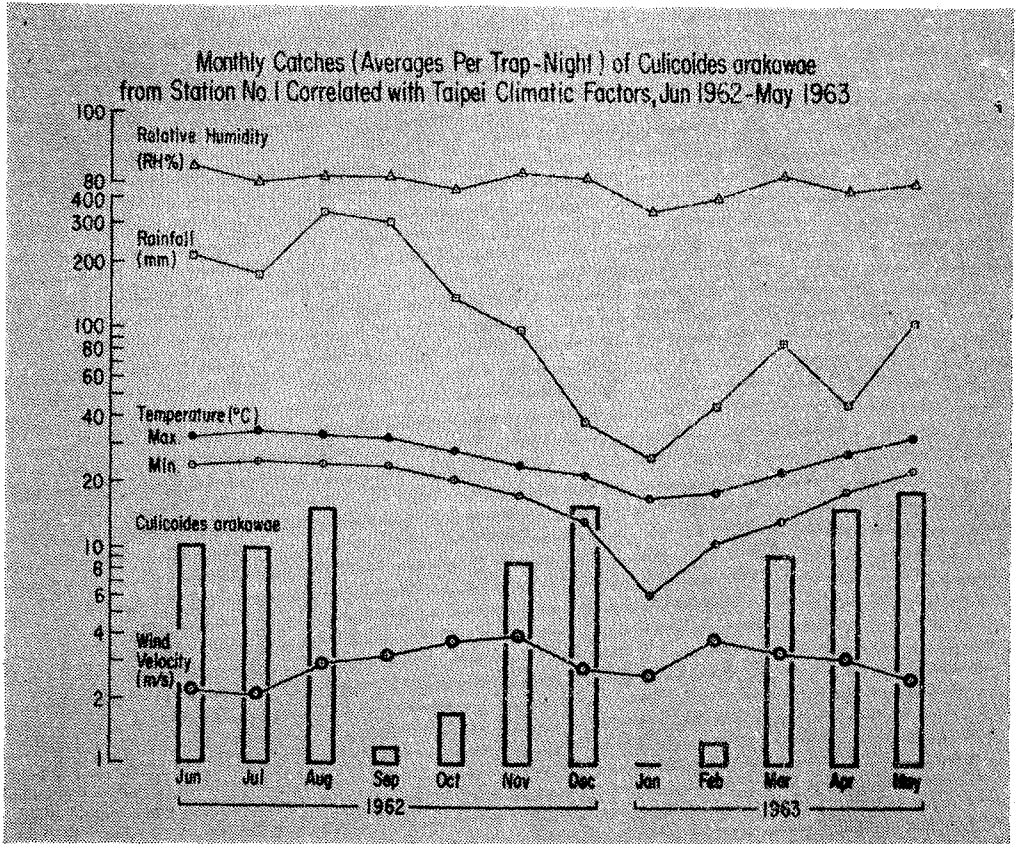


Fig. 1. Collection of *Culicoides arakawae* from Station No. 1.

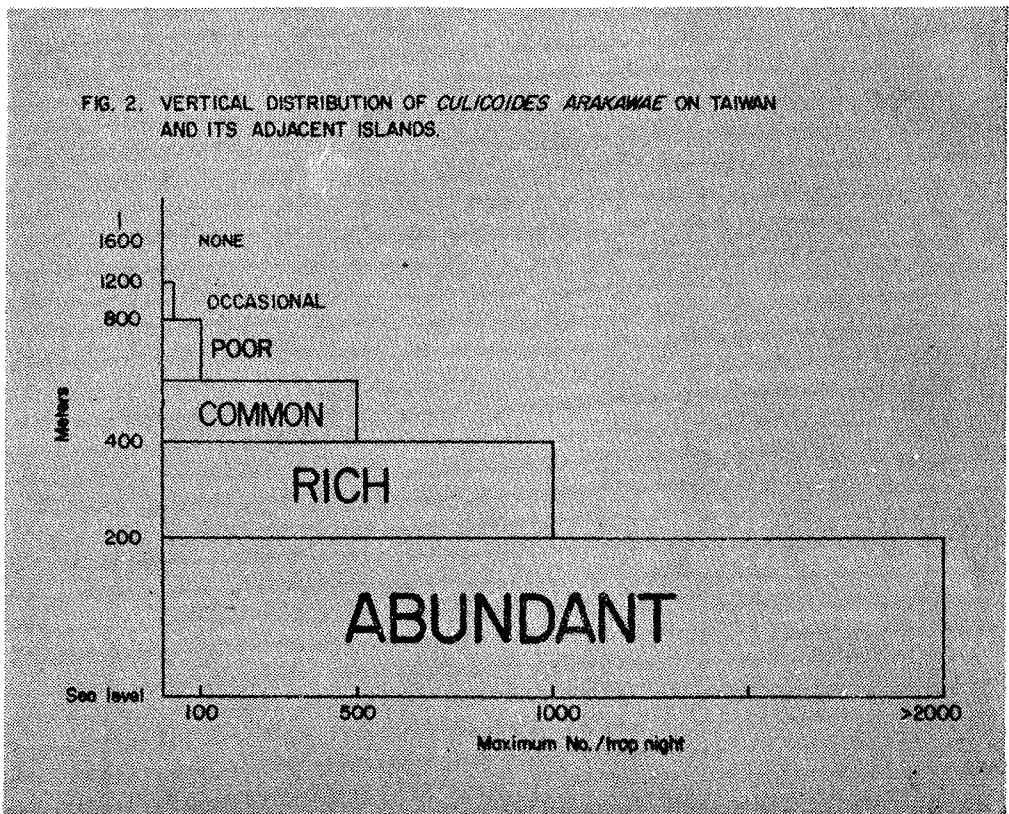


Fig. 2. Vertical Distribution of *Culicoides arakawae* in Taiwan

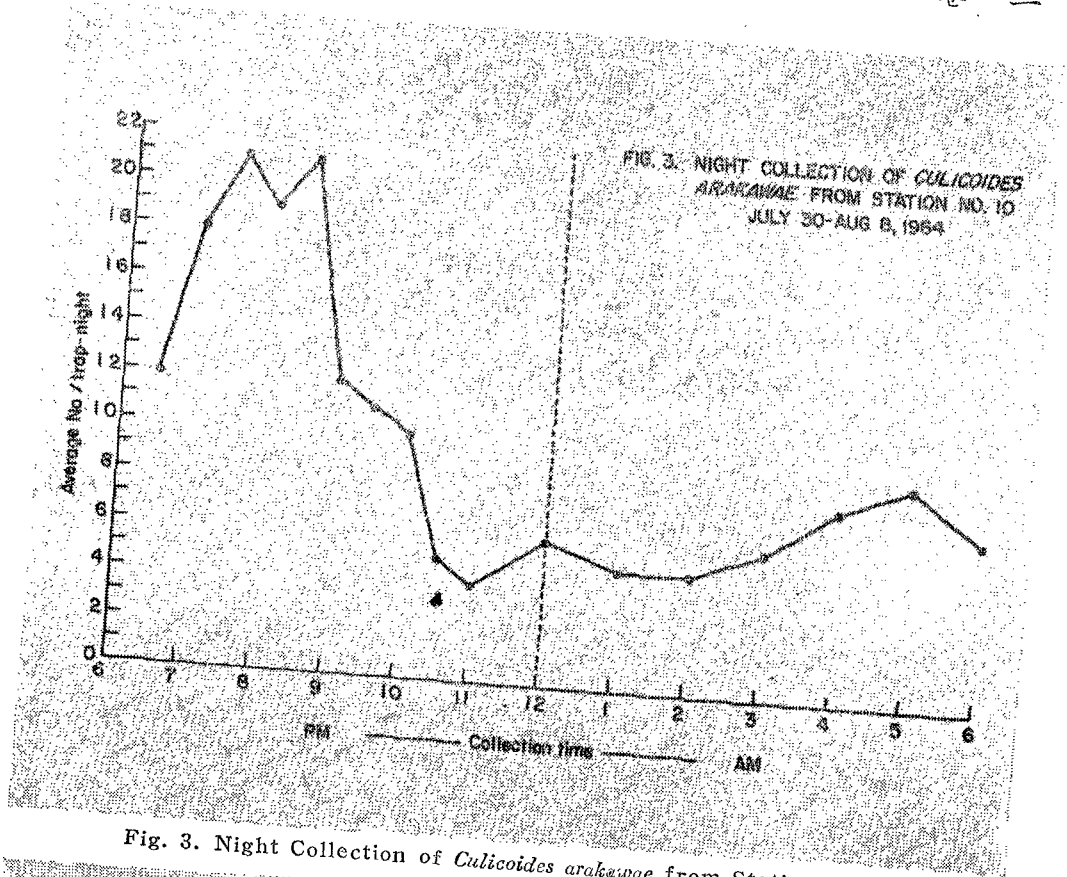


Fig. 3. Night Collection of *Culicoides arakawae* from Station No. 10.

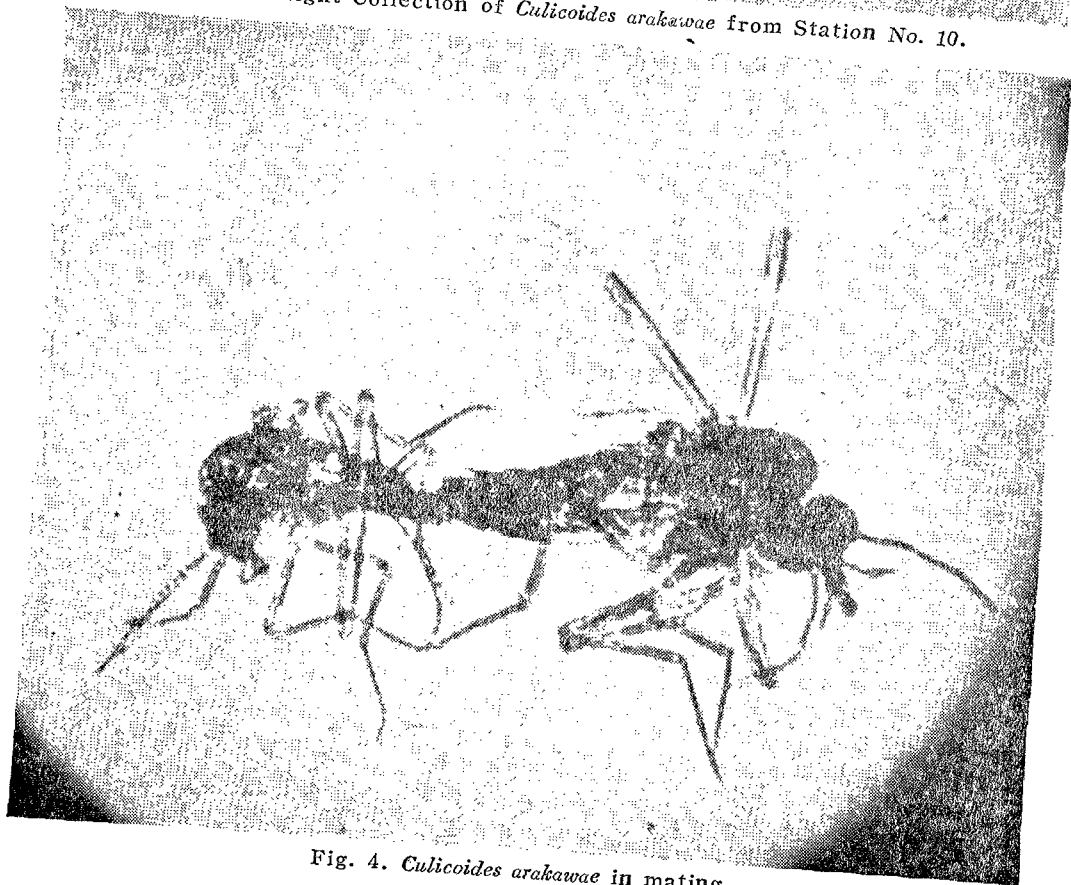


Fig. 4. *Culicoides arakawae* in mating

臺灣荒川氏糠蚊的生態研究

孫 克 勤

- 一、著者於五十一年迄五十三年間曾在臺灣及其隣島從事荒川氏糠蚊之生態研究，研究之方法：利用誘蟲燈（新澤西式）、動物餌以捕取成蟲，同時並作憩息場所以及幼蟲棲所之調查。
- 二、荒川氏糠蚊在本區域之分布甚為廣泛，遍及本島，澎湖列島，蘭嶼以及小琉球（後三處為新記錄）等地。
- 三、荒川氏糠蚊繁生於海拔 200 公尺以下之平地區域，幼蟲棲居於水田、池沼及小溪，成蟲活動於雞埕、豬舍中，侵襲雞、鴨、火雞、以及豬、牛等禽畜，偶亦襲擊人體。
- 四、荒川氏糠蚊的活動在夜晚，以傍晚 6:30—8:30 即日沒後二小時間最為活躍。
- 五、荒川氏糠蚊的季節消長，顯示每年有二高峯，而以春季高峯為顯著。
- 六、荒川氏糠蚊之性別比例，錯配現象，以及雌蚊之吸血者與無吸血者之比例，文中曾有報告。
- 七、臺北、桃園、屏東各地之雞白血病（Leucocytozoonosis）與荒川糠蚊之關係，本文亦有論及。