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Seasonal Changes of the Preimaginal Stages of Blackflies with Special Reference to the Overwintering in Nagasaki Area

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ABSTRACT

Seasonal changes of immature (preimaginal) stages of blackflies downstream of Yonoo River, Isahaya City, Nagasaki Prefecture were investigated in November, 1981 to January, 1983. Seven species, *Simulium (Simulium) quinquestriatum, S. (S.) arakawae, S. (Odagmia) bidentatum, S. (O.) aokii, S. (Eusimulium.) uchidai, S. (S.) japonicum*, and *Prosimulium* sp. were collected. *S. (S). quinquestriatum* was predominant species of 74% of the total specimens collected. Three species, *S. (S.) quinquestriatum, S. (S.) arakawae, S. (O.) bidentatum* were abundant in spring and autumn, but they were not collected in August and September. This is considered to have been mainly due to the high temperature and a great flood in July, 1982. The population was mainly composed of larvae in different developmental stages, throughout the year. Also in winter, from December to February, the larvae with different sized head capsules appeared and developed slowly during this period; they gradually pupated and emerged in March. This indicates that 3 species of *S. (S.) quinquestriatum, S. (S.) arakawae, and S. (O.) bidentatum* do not have such typical diapausing states in the larvae, as the larval diapausing states in *Armigeres subalbatus* mosquitoes.

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INTRODUCTION

In Japan, some species of blackflies suck human blood. Thus, they are nuisance insects. Many studies on taxonomy and biology of the blackflies have been conducted on materials in mainland, Japan. (OGATA *et al.*, 1956; ORII *et al.*, 1964; TOITA *et al.*, 1964; UEMOTO *et al.*, 1973; KONDO *et al.*, 1974). In southern Japan, Kyushu and Nansei Islands, only TAKAOKA (1972, 1973, 1974, 1976a, 1976b, 1977a and 1977b) reported the taxonomical studies. Few studies have been done on ecology, especially on overwintering in this insect. The present investigation was undertaken to elucidate the seasonal prevalence of immature (preimaginal) stages of blackflies in relation to the overwintering pattern in Nagasaki area.

STUDY AREA AND METHODS

The larvae and pupae of blackflies were collected in the downstream of Yonoo River, which flows from the northern part of Isahaya City into the main river of Honmyo River in the city, Nagasaki Prefecture (Fig, 1), in November, 1981 to January, 1983. The study

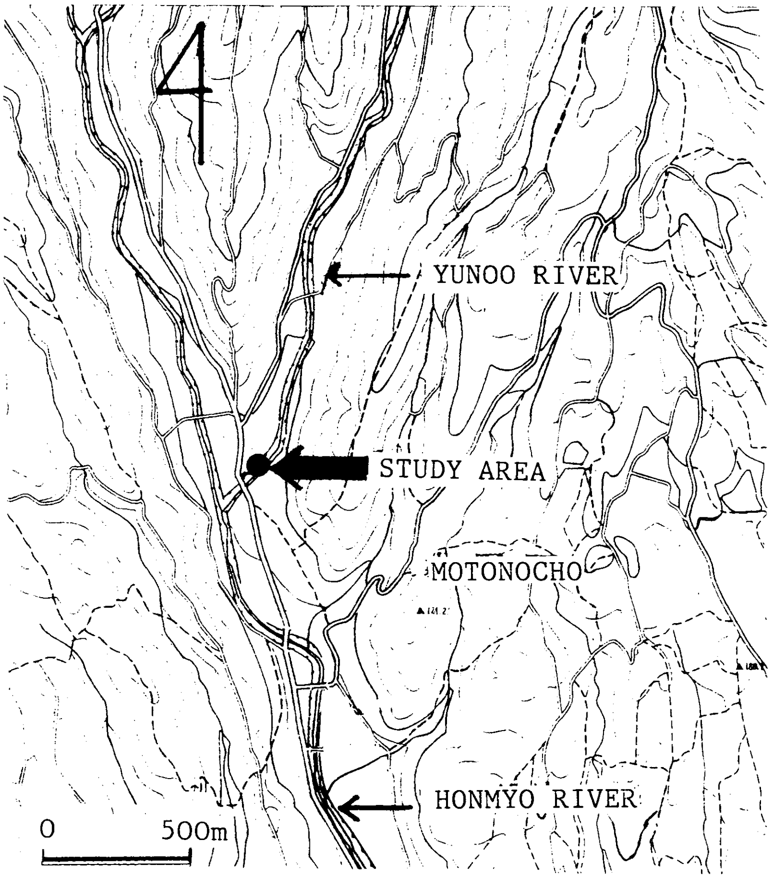

Fig. 1. Map of study area in Isahaya City.

area was surrounded by an open vegetable field. In spring and autumn, the width and depth of the river in the study area were about 20m and 0.5m, respectively. The rainy season was in early June to late July, when the depth of the river was about 1m. The river bed consisted of gravel and stones, where some kinds of grasses grew abundantly from spring to autumn. The water flow at the collection site was relatively rapid throughout the season. Water temperature was usually 2−5℃ lower than the air temperature. Three sampling sites were chosen in the study area. The distance between the sites was about 30m. For investigation of the seasonal changes, 10 strips of semitransparent polyethylene tapes (5×30cm) were used as traps to catch the immature stages (larvae and pupae) in water in three points. These traps were fixed to stones and grasses, and changed at each time of collection. After collection, larvae and pupae were kept in 70% ethanol. One of us, L. M., identified these blackflies according to the descreptions reported by ORII *et al.* (1964) and TAKAOKA (1976 a,b 1977 a,b) under a binocular microscope and stereomicroscope. After identification, the head width was measured with all young larvae (without respiratory filament) in *S. (S.) quinquestriatum, S. (S.) arakawae, and S. (O.) bidentatum* which were collected from December, 1981 to April, 1982. Fifty pupae of *S. (S.) quinquestriatum, S. (S.) arakawae, and S. (O.) bidentatum* collected in December and January, 1983, were individually allowed to emerge in small glass tubes (3cm high × 1cm in diameter) at 20℃.

RESULTS

Table 1 shows the species and number of insects collected between November, 1981 and January, 1983. Seven species belonging to 2 genera were collected. *Simulium (S.) quinquestriatum* was most abundant, followed by *S(S.) arakawae, S. (O.) bidentatum, S. (O.) aokii, S. (E.) uchidai, S. (S.) japonicum, and Prosimulium* sp. in descending order.

Table 1. Total number of blackfly immature stage collected in Yonoo River, Isahaya, between November, 1981 and January, 1983.

Species	Total No.* immature stages
Simulium (Simulium) quinquestriatum (Shiraki)	31,215
*Simulium (Simulium) arkawae*Matsumura	6,415
Simulium (Odagmia) bidentatum (Shiraki)	3,974
Simulium (Odagmia) aokii (Takahashi)	420
Simulium (Eusimulium) uchidai Takahashi	53
Simulium (Simulium) japonicum Matsumura	34
Prosimulium sp.	1
Total No.	42,112

*Total No. attached at 10 traps (polyethelene tapes).

The order of species varied with the season (Fig. 2). *S. (S.) quinquestriatum* was the most abundant from November, 1981 to October, 1982, but in November and December, 1982, *S. (S.) arakawae* became predominant. In January, 1983, *S. (S.) quinquestriatum* became the most abundant species again.

Fig. 3 shows the seasonal changes in number of immature stages of 3 species *S. (S.) quinquestriatum, S. (S.) arakawae* and *S. (O.) bidentatum* togather with climatie date of rainfall and air temperatuers. The number of insects at each collection time is expressed by the formula log (x+1), where x is the number of immature stages attached to 10 strips of tapes. In 3 species, immature stages were abundant from November 1981 to May 1982, but they began to decrease gradually in late june when the air temperature began to raise to 25℃ (maximum temperature). On July 23, 1982, a great flood occurred. No immature stages were collected in August and September, but the population of these 3 species were collected again in Octover and then increased.

S. (O.) aokii appeared from February to May, 1982 and in December and January, 1983. Small number of *S. (E.) uchidai* and *S. (S.) japonicum* were also collected in December or January to May or April, 1982 and in January, 1983. Also only one larva of *Prosimulium* sp. was found in January, 1983 (Table 2).

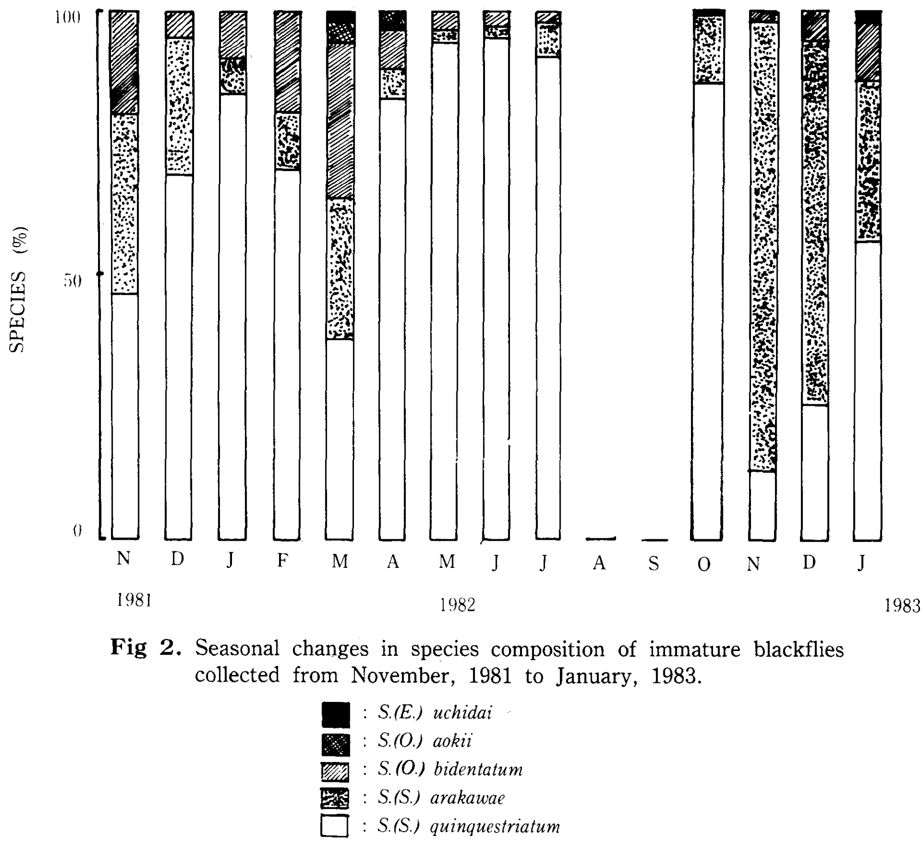

Fig 2. Seasonal changes in species composition of immature blackflies collected from November, 1981 to January, 1983.

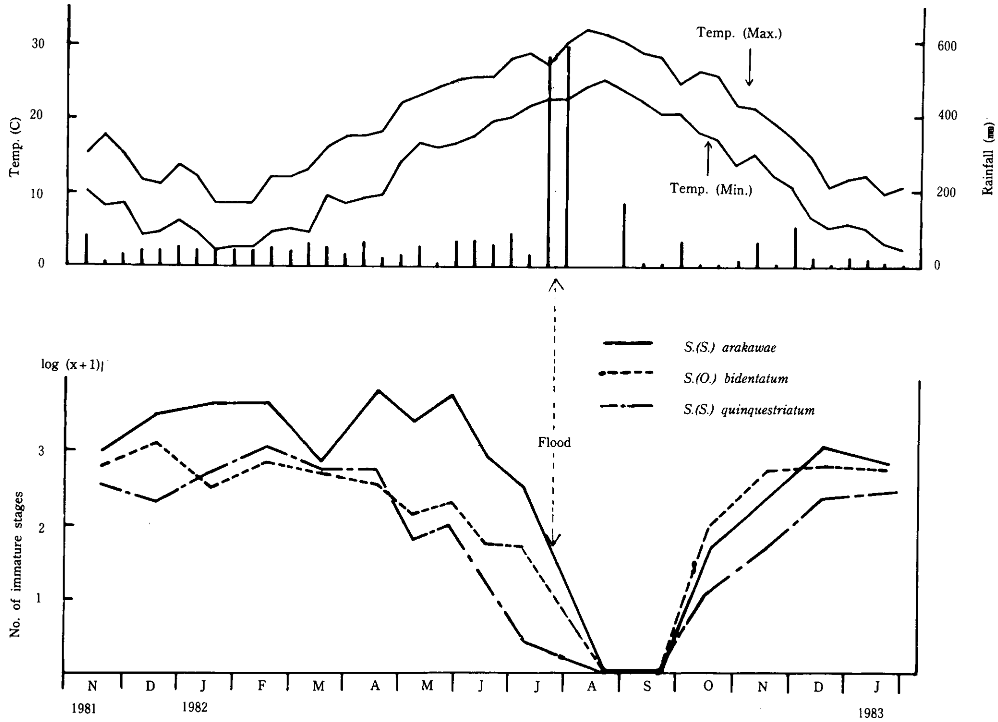

Fig. 3 Seaconal changes in number of immature blacflies of 3 species from November, 1981 to January, 1983.

Table 2. Seasonal changes in number* of immature stages of blackflies collected between November, 1981 and January, 1983.

Date of collection	Species and No. collected			
	S.(O.) aokii	*S.(E.) uchidai*	*S.(S.) japonicum*	*Prosimulium sp.*
1981, Nov. 16	0	0	0	0
Dec. 15	0	1	0	0
1982, Jan. 11	0	4	8	0
Feb. 16	3	13	16	0
Mar. 16	78	20	7	0
Apr. 15	249	12	0	0
May 7	34	0	0	0
May 27	7	0	0	0
Jun. 16	0	0	0	0
Jul. 7	0	0	0	0
Aug. 26	0	0	0	0
Sep. 21	0	0	0	0
Oct. 16	0	0	0	0
Nov. 12	0	0	0	0
Dec. 6	44	0	0	0
1983, Jan. 25	6	3	3	1
Total No.	420	53	34	1

*Total number of larvae and pupae which were collected in 10 traps on each collection date.

Table 3 shows the seasonal changes in age-structure as the percentage of the total number of immature stages of the species at each collection time.

Generally, the population was composed of a small number of pupae and many larvae containing young or mature ones regardless of the season. In January and February, 1982 mature larbvae and pupae were collected in a low rate in *S. (S.) quinquestriatum, S(S.) arakawae* and *S. (O.) bidentatum.* In March, they increased and decreased again in April in S. (S.) quinquestriatum and *S(S.) arakawae.* A similar pattern was seen for *S. (O.) bidentatum.* This means that larvae develop even in winter. This phenomenon was not confirmed in the other 4 species because only a small number of them could be collected.

Fig. 4 shows the changes in the head width of young larvae of *S. (S.) quinquestriatum* in winter. Young larval head width varied greatly. In December, most of the young larvae had a head width of 100 to 200μ, and then the head size increased gradually from January to March. This change in head size was similar to that in mature larvae. Small larvae less than 150μ increased in number again in April. This means that the females emerging from the overwintering larvae laid eggs in April. This change in head width is roughly similar to that of *S(S.) arakawae* and *S. (O.) bidentatum* (Figs. 5 and 6).

Table 4 shows that a small percentage of the pupae collected in winter emerged

Table 3. Seasonal changes in age-structure of immature stages of blackflies from November, 1981 to January, 1983.

Species	*S.(S.) quinquestriatum*			*S.(S.)arakawae*			*S.(O.)bidentatum*			*S.(O.)aokii*			*S.(E.)uchidai*			*S.(S.)japonicum*		
Stage / bate	Y	M	P	Y	M	P	Y	M	P	Y	M	P	Y	M	P	Y	M	P
1981, Nov. 16	85.3	6.8	7.9	65.8	22.0	12.2	81.2	11.3	7.5									
Dec. 15	99.0	0.7	0.3	80.5	11.4	8.2	83.7	13.0	3.4				0	100.0	0			
1982, Jan. 11	94.3	4.1	1.6	80.5	10.4	9.1	81.5	11.6	6.9				50.0	25.0	25.0	100.0	0	0
Feb. 16	81.4	12.2	6.5	86.5	6.3	7.2	86.7	10.6	2.8	66.7	33.3	0	84.6	7.7	7.7	81.3	18.8	0
Mar. 16	51.7	27.4	20.9	50.5	32.2	17.3	49.8	28.8	21.6	46.2	53.8	0	41.7	33.3	25.0	100.0		
Apr. 15	97.9	11.7	0.4	78.4	11.7	9.9	78.7	9.4	11.8	83.9	11.6	4.4	100.0	0	0			
May 7	84.1	8.0	7.9	75.4	11.9	12.7	83.3	11.7	5.0	88.2	11.8	0						
May 27	97.9	0.7	1.5	89.1	3.1	7.8	97.1	1.0	1.9	28.6	0	71.3						
Jun. 16	83.4	5.8	6.8	44.6	39.3	16.1	87.5	6.3	6.3									
Jul. 7	78.7	6.7	14.7	85.4	8.3	6.3	50.0	0	50.0									
Aug. 26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep. 21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct. 16	93.6	0	6.4	96.2	1.9	1.9	100.0											
Nov. 12	96.3	0.9	2.8	72.6	8.3	19.0	70.8	8.3	20.8									
Dec. 16	98.8	0.1	1.1	87.5	4.1	8.4	82.9	4.2	13.0	81.8	16.6	4.5	100.0					
1983, Jan. 25	97.1	1.1	1.8	93.0	2.1	4.8	78.7	5.6	15.7	100.0			75.0	25.0		100.0		

Y: Young larvae without respiratory filament
M: Mature larave with respiratory filament
P: Pupae

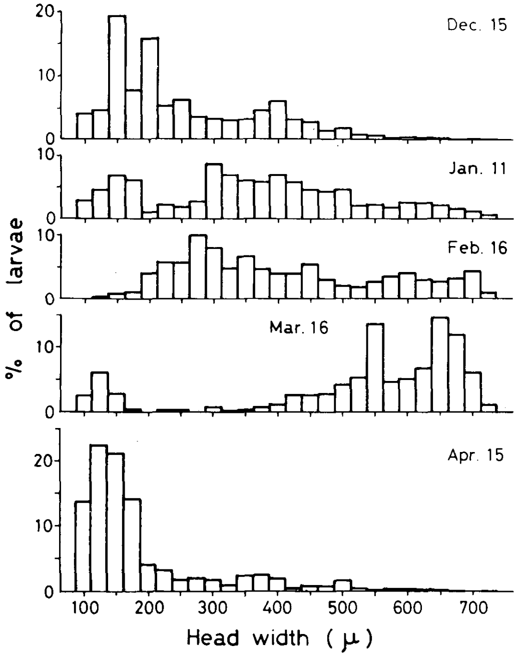

Fig. 4. Changes in head width of young larvae of *S. (S.) quinquestriatum* in winter.

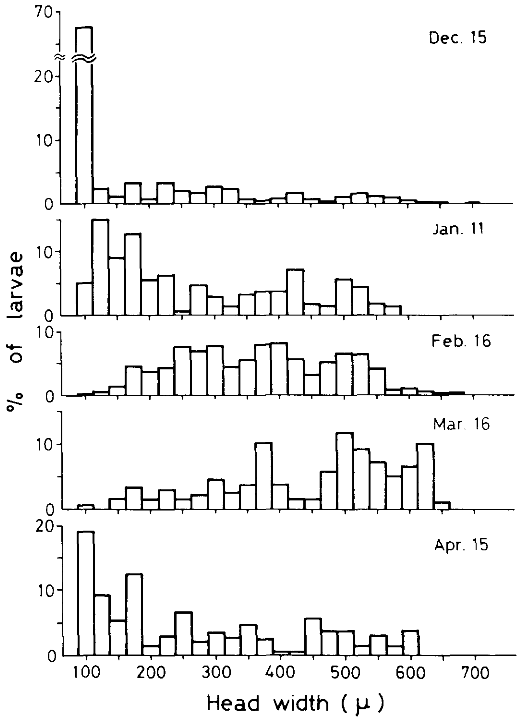

Fig. 5. Changes in head width of young larvae of *S. (S.) arakawae* in winter.

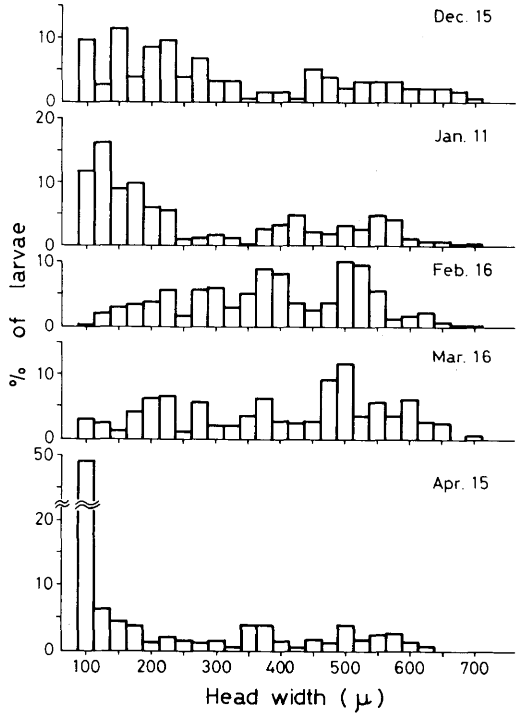

Fig. 6. Changes in head width of young larvae of *S. (O.) bidentatum* in winter.

Table 4. Percentages of blackfly adults having emerged from pupae within 10 days after collection in November, 1982 and January, 1983.

Date \ species	*S. (S.) quinqestriatum*	*S. (S.) arakawae*	*S. (O.) bidentatum*
1982, Nov. 22	28.0	76.0	8.0
1983, Jan. 18	8.0	10.0	2.0

*Fifty pupae of each species were kept separately before emergence.

when the air temperature was a little high. From these results it is concluded that the oviposition activity continues until winter and most of the overwintering population is composed of especially young larvae that develop gradually even during winter and emerge in March.

DISCUSSION

The present study shows that the immature population of *S. (S.) quinquestriatum, S. (S.) arakawae* and *S. (O.) bidentatum* begin to decline in June when the air temperature becomes about 25℃ of maximum temperature. This suggests that a high temperature is an important factor inhibiting the population, though many factors are considered to be related. The immature stages of 3 species were not collected in August and September when the maximum temperature was 28 to 30℃. In addition to the high temperature, the flood was also considered to have been an important factor reducing the population in August and September. The size of the population in Octover when the temperature was around 25℃ was considered to be similar to that in July.

Even in winter larvae were found to develop gradually and pupae also appeared. This means that in *S. (S.) quinquestriatum, S. (S.) arakawae* and *S. (O.) bidentatum* they are not in the typical diapausing states as the larval diapausing conditions of *Armigeres subalbatus* mosquitoes (ODA *et al.,* 1979).

The order of species changed in October, 1982. *S. (S.) arakawae* became the predominant species insted of *S. (S.) quinquestriatum.* The reason for this change in order is not clear, but the *S. (S.) quinquestriatum* population may have been damaged greatly by the flood because the phenomenon was noted after the flood.

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