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The Life Cycle of *Blattella nipponica* ASAHINA in Kyoto

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Abstract The life cycle of *Blattella nipponica* was studied in the field as well as under indoor conditions in Kyoto. Adults emerged early in June and seemed to begin to deposit their first oothecae late in July, the second early in September, and no or few further oothecae in the field. Nymphs hatched upon the deposition of oothecae. The new nymphs did not become adults before the end of the year in the field. Most of them seemed to overwinter at their penultimate (6th) instar stage. The greatest number of fertile oothecae deposited per adult female was 5 and that of nymphs hatching per ootheca was 43 under the room conditions. Second-generation adults emerged, copulated, and deposited oothecae under the room conditions, but they hardly produced fertile oothecae. The results suggest that *B. nipponica* normally has 1 generation a year, entering diapause at the penultimate nymphal instar stage in the field.

Introduction

Although the occurrence of *Blatella nipponica*, a field cockroach extremely allied to house-dwelling *B. germanica*, is not uncommon in southwestern Japan, detailed information has not been available on its life cycle under natural conditions (KAMO et al. 1961; ASAHINA 1963; KIFUNE & KAMO 1964).

The present work describes attempts to study the life cycle of *B. nipponica* in Kyoto. The results of some indoor breeding trials are also reported.

Materials and Methods

Field observations were carried out at a pine-tree prevailing forest on a hillslope, alongside Midoro-ga-ike (the Midoro pond), Kamigyo-ku, Kyoto, in 1982 and 1983. Every time the survey was carried out, the search for insects was made by overturning fallen leaves piling up on the ground and, if possible, continued until several insects were captured.

Most of the adults captured in 1982 and their progeny were reared under indoor conditions. Some of the reared progeny, as well as other individuals collected in the field in 1983, were killed in 70% alcohol in order to identify their instars by measuring their head width. The measurements were made, just after killing insects, on ocular units with a micrometer mounted on a dissecting microscope and calibrated with a stage micrometer.

The insects were reared in plastic containers of 16 cm length × 9 cm width × 11 cm height in which fallen leaves were placed as their hidings. They were fed on a

commercially available product of rabbit food and supplied with enough water.

Results

1. Life cycle in the field

B. nipponica adults emerged in the field early in June (Fig. 1). When captured and reared under indoor conditions, the adults survived until December or later (Fig. 2). Newly hatching nymphs were found late in July and again early in September, suggesting that female adults deposited their oothecae at least twice a year in the field.

The results of head-width measurements with insects captured in the field are shown in Fig. 1. The results indicate that the nymphs molted 7 times, having 7 nymphal instars in the field, and all the nymphs hatching in 1982 did not become adults within the year. Most of the nymphs seemed to overwinter at their penultimate (6th) instar stage irrespective of whether they hatched early or later.

2. Rearing captured adults under the room conditions

The adults captured in the field in 1982 were reared under the room conditions. The average temperature in the room ranged from 30°C in August to 15°C in December with daily fluctuations of less than ±1°C, and was about 5°C higher than that of outdoor one. A 40-watt fluorescent lamp on the ceiling was kept turned on usually from 7: 00 p.m. to 12: 00 p.m. in addition to the indirect light of natural day length

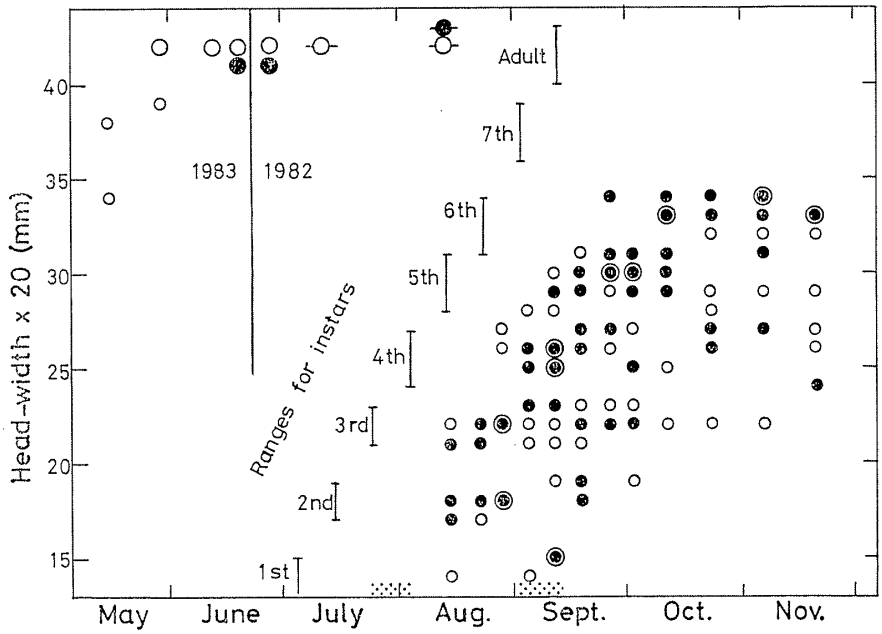

Fig. 1. Results of the head-width measurements with nymphs and adults captured in the field. Number of insects captured, ○: 1, ●: 2–3, ⊙: 4–8. –○– –●–: Adults with oothecae. ▨▨: Period over which nymphs hatched.

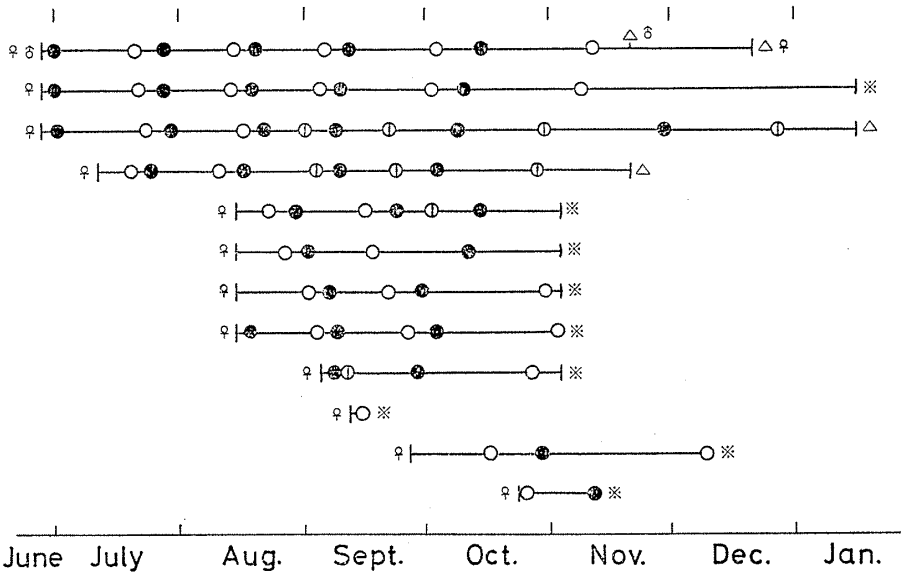

Fig. 2. Records on adults captured in the field and reared under the room conditions. Date when: ⊢: Insects were captured. ●: Oothecae were protruded. ○: Oothecae were deposited and nymphs hatched. ⓘ: Oothecae were dropped without hatching. ⊣△: Insects died. ⊣※: Observations were stopped.

through the window.

The records are shown in Table 1 and Fig. 2. The 3 female adults captured late in June survived for more than another 5 or 6 months until December or later, and 2 of them produced 5 fertile oothecae each. The male adult captured on the same day as the females survived for nearly 5 months. Nymphs hatched from each ootheca upon its deposition by each adult. The greatest number of nymphs hatching from an ootheca was 43.

3. Rearing nymphs under the room conditions

Newly hatching nymphs produced by the adults captured in the field were also reared in the room. The cummulative adult emergence curves for 5 broods of insects from 5 oothecae are shown in Fig. 3A–E. In contrast to the fact that even the nymphs hatching early did not become adults in the field (Fig. 1), most of the nymphs hatching on the corresponding period became second-generation adults under the room conditions quickly in warmer months and slowly in cooler one.

Fig. 4 shows the results of head-width measurements carried out with the insects in warmer months. The nymphs became adults after molting 6 times. The well-defined 6 instars are clearly fewer than 7 in the field (Fig. 1) and at 30°C in darkness (Fig. 5).

4. Rearing nymphs at 30°C in darkness

Fig. 5 shows the results of head-width measurements with nymphs reared at

Table 1. Records on female adults captured in the field and reared under room temperature conditions in 1982.

No.	Date when captured	Ootheca held when captured	No. of nymphs hatching per oothecae	Duration of incubation period, and (pre-protrusion period), of oothecae in days
1	June 27	No	32 33 27 23 19	20 (7) 18 (5) 17 (4) 22 (11) 28
2	〃	No	43 42 32 30 12	21 (6) 17 (5) 17 (5) 23 (8) 29
3	〃	No	24 30	22 (6) 18 (5)
4	July 11	Yes	39 13	(4) 18 (6)
5	Aug. 14	Yes	31 34	(6) 18 (8)
6	〃	Yes	34 36	(6) 16 (23)
7	〃	Yes	32 38 32	(4) 16 (8) 31
8	〃	No	20 25 25	17 (5) 18 (7) 30
9	Sept. 4	No	30	29
10	Sept. 11	Yes	36	
11	Sept. 26	Yes	14 31	(13) 42
12	Oct. 23	Yes	32	(16)

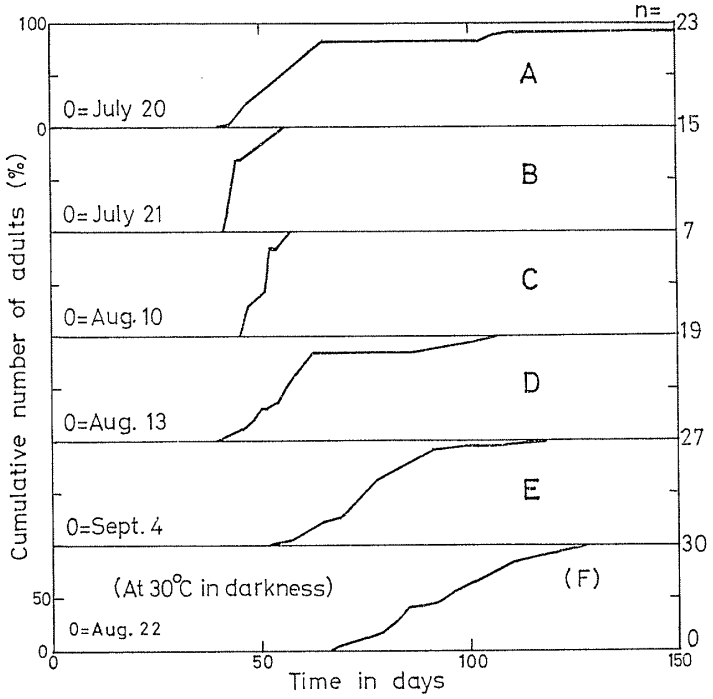

Fig. 3. Cumulative adult emergence curves for 5 broods of insects reared under the room conditions (A–E), and a brood at 30°C. in darkness (F).

30°C in darkness in an incubator. The duration of the penultimate (6th) instar period was prolonged even at this high temperature, causing the retardation of adult emergence. The cummulative number of emerging adults is shown in Figs. 3F and 5.

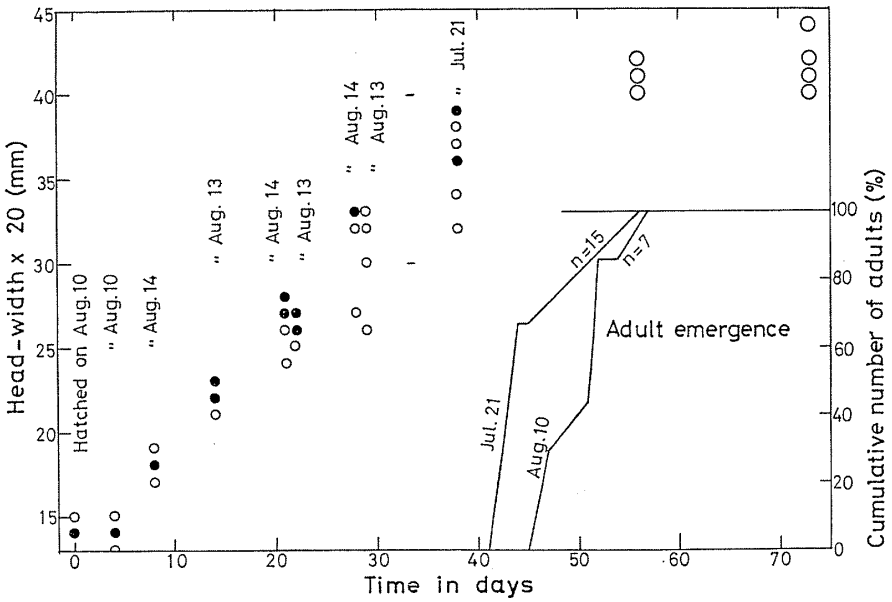

Fig. 4. Results of the head-width measurements with insects reared under the room conditions in wormer months. Number of insects measured, ○: 1–2, ●: 3–8.

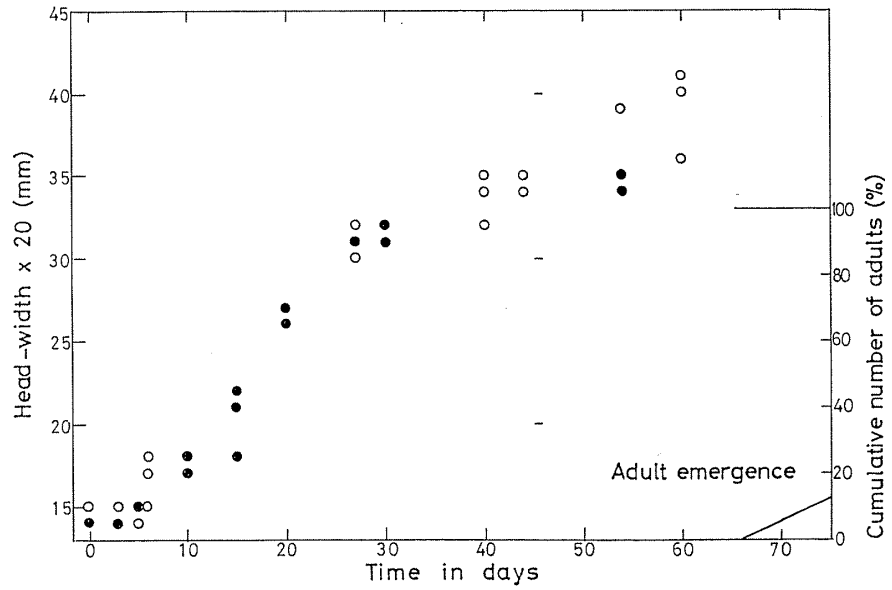

Fig. 5. Results of the head-width measurements with insects reared at 30°C in darkness. Number of insects measured, ○: 1–2, ●: 3–8.

5. *Progeny production of second-generation adults*

The second-generation adults obtained under the room conditions hardly produced their progeny, though the copulation and the deposition of oothecae occurred very often in the rearing containers. While 102 oothecae were deposited by 37 female adults, only 3 of them were fertile.

Table 2. Results of the outdoor exposure of insects from January 5 to March 20, 1983. (Temperature ranged from 3°C to 8°C in the container.)

Container	Rearing conditions before exposure: Date of hatch	Temperature: Rearing	Temperature: Just before exposure	Stage and Sex exposed	No. of insects: Exposed	No. of insects: Surviving	Survival in %
No. 1	Aug. 16	30°C	30°C	Adult ♂	2	0	0
				Adult ♀	4	0	0
				Final instar	9	5	56
No. 2	Sept. 4	Room temperature	15°C	Adult ♂	14	0	0
				Adult ♀	15	10	67
				Final instar	1	1	100
	Oct. 2	Room temperature	15°C	Penultimate instar	24	22	92
	Nov. 8	Room temperature	15°C	3rd instar	7	1	14
No. 3	?	Room temperature	15°C	Adult ♂	23	2	9
				Adult ♀	20	7	35
				3rd to final instar	177	141*	80*

* Most of the surviving nymphs were 5th, 6th, and 7th (final) instars.

6. Chilling exposure of reared insects

Some of the containers with insects reared in the 30°C incubator, as well as of those in the room, were exposed to the outdoor temperature from January 5, to March 20, 1983. The containers were kept in another larger plastic container at the bottom of which some amount of water was served in order to keep the air humidity high, and the larger container was placed in a carton box which was kept outdoors in the shade. After March 20, the containers were kept under the room conditions again.

The results of the exposure are shown in Table 2. The penultimate and final instar nymphs were most tolerant against the winter cold and most of them became adults and produced progeny after returning to the room, though the number of the new adults and their progeny was not counted. The old adults exposed to the outdoor conditions were not so tolerant and the younger nymphs died out during the exposure.

Discussion

Fig. 1 seems to indicate that *B. nipponica* has only 1 generation a year in the field. Female adults seem to have an innate capacity of producing 5 or more oothecae in their whole life (Fig. 2, Table 1), though only 2 of them might be realized in the field (Fig. 1).

The synchronization of nymphal growth at the penultimate instar stage in the

field (Fig. 1), the retardation of growth at the same (penultimate) instar stage in darkness even at 30°C (Fig. 5), and the cold hardiness of this stage (Table 2) indicate that this species enters diapause at the penultimate instar stage before overwintering in the field.

The facts that the second-generation adults obtained under the room conditions hardly produced their progeny and that they had passed through fewer nymphal instars in warmer months (Fig. 4 and Result 5) suggest that the emergence of second-generation adults within a year is rather abnormal in this species.

The investigation of the possibility that the emergence of second-generation adults is induced by prolonged illumination in the room must be the subject of future research.

Literature

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