

14. DISTRIBUTION AND ABUNDANCE OF THE SOUTHERN GREEN STINK BUG, *NEZARA VIRIDULA*

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Introduction

It was in 1955 or so that the southern green stink bug, *Nezara viridula* came out as a pest of paddy in southern Japan. There is no doubt that this insect has long been distributed in southern Japan and that it lived on vegetabels and weeds before becoming a rice pest. According to Hasegawa (1954), Horvath (1879) first recorded *N. viridula* in Nagasaki, Kyushu, Japan. Thereafter, no record of collection had been made until 1952 when Hasegawa (1954) discovered it as a mixed population with the oriental green stink bug, *Nezara antennata*.

Sameshima (1960) who examined the specimens collected in Miyazaki city found that in the beginning of 1950s *N. viridula* was composed of only about 10 per cent in the *Nezara* (*N. viridula* and *N. antennata*) population, but now the area concerned is occupied only by *N. viridula*. Kiritani *et al.*, (1963) also confirmed the same kind of phenomenon in Asso, Wakayama; the percentage of *N. antennata* amounted to 30 per cent in 1953, but this decreased annually until this species was completely replaced by *N. viridula* after 10 years.

Distribution and Original Home

Adults of *N. viridula* is polymorphic. There are at least four basic colour types named as follows: G, O, F and R, and no intermediate types are among these ones. The ratios of G:O:F:R in Wakayama were 87:7:5:1 and these types are controlled by genetic basis (Kiritani, 1970). The type R, which was originally described by Linne, is so different in appearance from the other ones that it looks like a different species. A similar sort of parallel colour variation can be seen also in the population of *N. antennata*. *N. antennata*, however, lacks type F and is different from *N. viridula* in phenotypic frequencies of polymorphs (Kiritani and Yukawa, 1963).

The range of geographical distribution of *N. viridula* covers temperate and tropic areas including south eastern Asia. *N. viridula* invaded Australia in 1961 (Wilson, 1960), New Zealand in 1944 but probably in 1941 (Wilson, 1960) and Hawaii in 1961 (Mitchell, 1963; Davis and Krauses, 1964). In these newly invaded areas, almost all the specimens were G-type except a few examples in Australia and New Zealand where R and Y types were observed respectively (Yukawa and Kiritani, 1965). The fact that only the phenotypic G-type is distributed throughout nearly all the Pacific Islands and also in USA and West Indies suggests that the populations in these areas have established by invasion from the original home or from subsequent centers of distribution (Table 1).

It is in S.E. Asia including Borneo where types other than G were found with relatively high percentages and S.E. Asia is considered as the original home or the center of distribution of this insect.

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Table 1. Percentage frequencies of adult colour types in the world. Figures (Table 2 in Yukawa & Kiritani, 1965) corrected by additional information.

Locality	G	O	F	R	No. of specimens examined
Japan, Honshu, Wakayama	86.6	7.3	5.1	1.0	45,455
Shikoku	78.0	12.3	6.5	3.2	2,016
Kyushu	80.7	8.7	7.1	3.5	1,216
Amami Is.	64.0	16.0	16.0	4.0	25
Okinawa	60.9	17.4	8.7	13.0	69
Formosa	77.8	22.2	0	0	9
Philippine Is.	97.3	2.7	0	0	37
Ceylon	100.0	0	0	0	1
India	50.0	50.0	0	0	2
Borneo	84.0	8.0	4.0	4.0	25
New Guinea	100.0	0	0	0	218
Australia	100.0	0	0	yes	7
New Zealand	yes				
Mariana Is.	99.2	0	0.8	0	130
New Hebrides	100.0	0	0	0	2
Hawaii	100.0	0	0	0	100
Samoa	100.0	0	0	0	42
Society Is.	100.0	0	0	0	23
Solomon Is.	100.0	0	0	0	5
U. S. A. southern part	100.0	0	0	0	90
Honduras	100.0	0	0	0	2
Costa Rica	100.0	0	0	0	4
West Indies	100.0	0	0	0	115
Iraq	100.0	0	0	0	5
Israel	yes				
Ethiopia		yes			
Spain	80.0	20.0	0	0	5

Meaning of Polymorphism and Qualitative Changes of Population

Laboratory experiments showed that there were no appreciable differences between the colour types in respect to various physiological traits of nymphs and adults, except that G-type seemed to be superior in reproductive ability but to be inferior in ability of surviving the winter at least to types R and F (Table 2) (Kiritani, 1970).

Inter-generational changes in percentage frequency of G-type were examined from 1959 to 1967 covering more than 30 generations (Fig. 1). Percentage frequencies of G-type prior to the severe winter of 1962-3 fluctuated greatly around a mean of 87.9%, while they did to a lesser extent than before with a mean of 85.0% after the winter. Unexpected high percentages of G-type were recorded frequently in summer generations, vis. 1st and 2nd ones. On the other hand, the relative frequencies of G and O types decreased after hibernation in contrast to the increases in those of F and R. This sort of changes in genetic composition related to the winter of 1952-3 was observed in

Table 2. Percentage frequency of colour types among the adults found alive in hibernacula and the winter survival rate (%) in relation to the colour types. Data for the winters from 1961-2 to 1966-7 were pooled (Kiritani, 1970).

	Total No. examined	G	O	F	R
Colour type (%)					
Autumn	4,587	86.81	7.02	5.14	1.02
Spring	1,907	86.31	6.61	5.93	1.15
Winter survival (%)					
Male	2,243	33.28	33.54	37.82	40.00
Female	2,344	48.97	44.72	58.12	54.55
Total	4,587	41.34	39.13	47.88	46.81

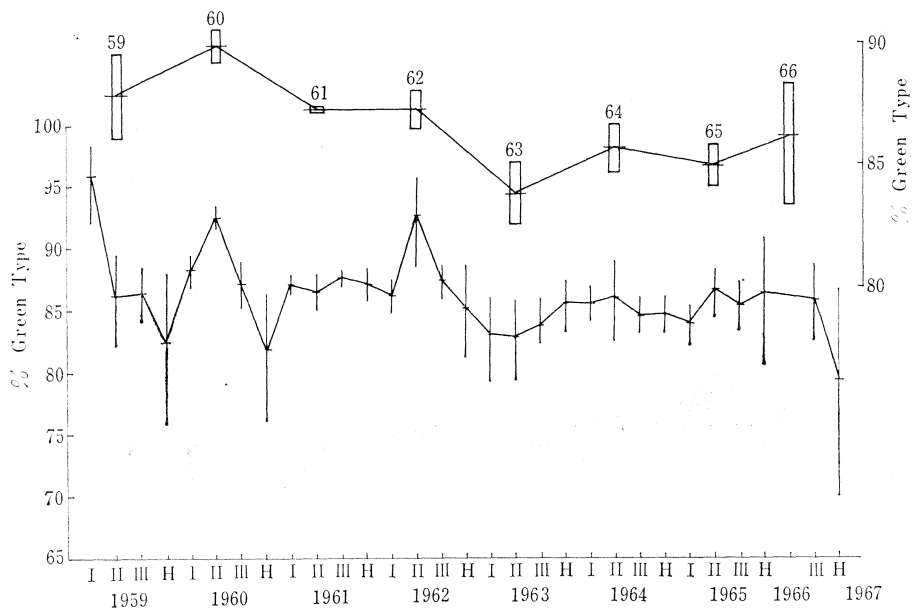


Fig. 1. Changes in percentage frequency of type G from year to year (top) and from generation to generation (bottom) at Asso, Wakayama. Horizontal and vertical lines indicate mean and its 95% fiducial limits, respectively (Kiritani, 1970).

several populations segregated from each other (Fig. 2).

This seasonal alternation of selective activity in the environments is considered to be responsible for retention of the polymorphism. Alternative possible causes, i.e. difference in habitat preference, non-random mating and selective predation by predators among polymorphs, may safely be rejected as irrelevant to the mechanism in maintaining polymorphism (Kiritani, 1970).

It was concluded that the polymorphism of this insect seems to be in a transient stage rather than balanced one contributing little to population regulation, but the persistence of *N. viridula* in the periphery range may be assisted by retention of the

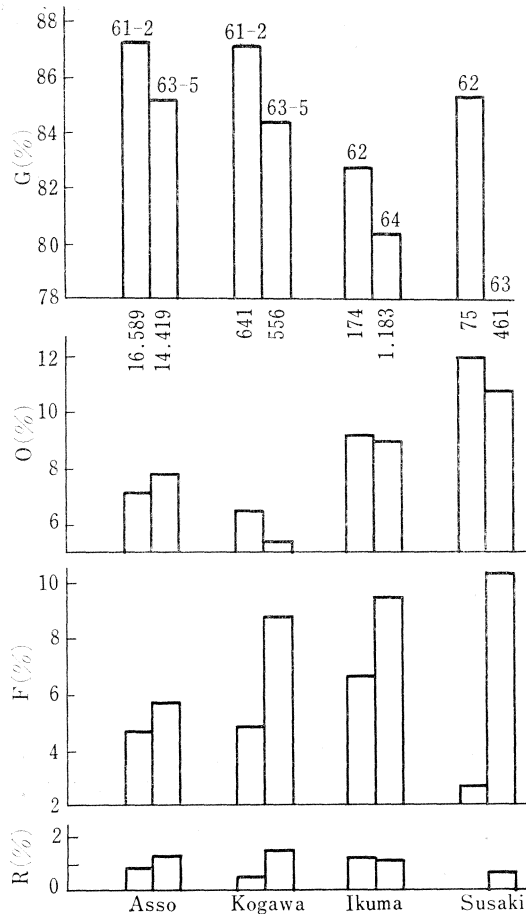


Fig. 2. Effect of the extreme winter of 1962-3 on the percentage frequencies of colour types in the different local populations. Asso, Kogawa and Ikuma are localities in Wakayama and Susaki in Kochi. Numerical figures above and below each column refer to the years and number of specimens examined, respectively (Kiritani, 1970).

polymorphism (Kiritani, 1970).

Replacement of *N. antennata* by *N. viridula* in the Area of Early Planted Paddy

We can find the northern limit of distribution of *N. viridula* in coastal region in Wakayama, Honshu, Japan. Beyond this region and northward, *N. antennata* occupied the same ecological niche in place of *N. viridula*. Hence, in the area where both species are co-existing, the relative proportion of the two species changes in favour of *N. antennata* as one goes up to a higher elevation or toward north (Fig. 3).

The cultivation of early planted paddy amongst the middle-season and late planted paddies enabled *N. viridula* to reproduce successively on rice plant from adults of the 1st generation afterward. Particularly, the coincidence of the emergence period of 1st-

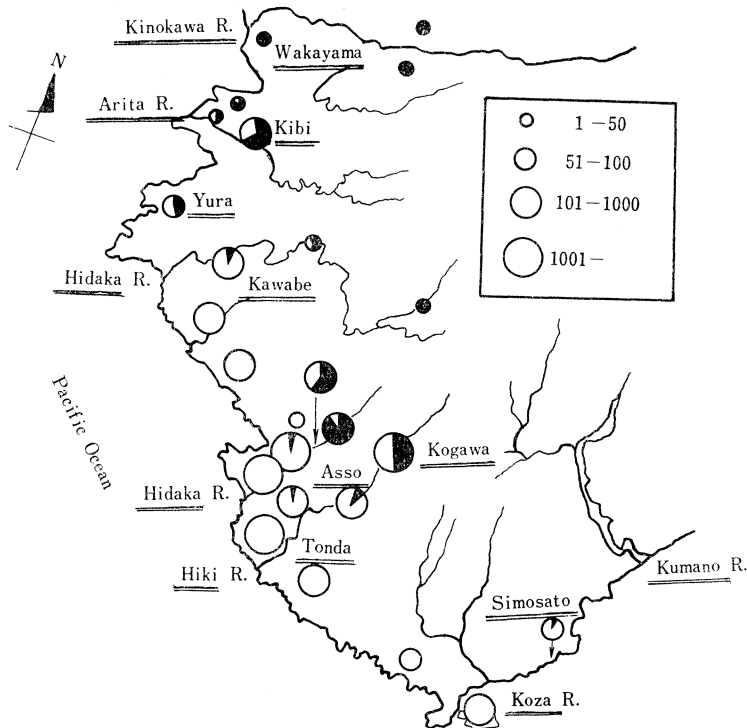


Fig. 3. Showing distribution and relative abundance of the two species in Wakayama prefecture. The size of each circle denotes the number of insects examined. Solid circle: *N. antennata*; open circle: *N. viridula* (Kiritani *et al.*, 1963).

generation adults with the heading time of the early planted paddy provided a suitable site for breeding and oviposition when other host plants were scarce. However, this was not the case for *N. antennata* which emerged later than *N. viridula*.

These conditions worked in favour of *N. viridula* resulting finally in a predominance of this species over *N. antennata*. In the area where *N. antennata* became rare species, most of the newly emerged females of *N. antennata*, being deprived of the chance of intra-specific matings, deposit unfertilized eggs followed by inter-specific mating.

Such a process continues until the completion of replacement of *N. antennata* by *N. viridula* as has been observed in Asso, Wakayama (Kiritani *et al.*, 1963). The fact that the inter-specific mating turned out to be a key factor in eliminating either species when the relative frequency of the two species runs to the extreme, is very interesting from the view point that it accords with the pest eradication program releasing sterile males in principle.

Life Tables from Egg to Adult Emergence

So far we have developed 7 life tables to elucidate the factors responsible for mortality and their way of action (Kiritani & Hokyo, 1962; Kiritani, 1964). More than 95% of mortality was recorded from egg deposition to adult emergence irrespective of the generation. Particularly, the total mortality was invariably highest in the first generation (Table 3). Mortalities during the young stages, i.e. egg to 2nd instar inclusive,

Table 3. Life tables of *Nezare viridula* (Kiritani, 1964).

Generation and year	Host plant	No. of eggs deposited	Mortality during the stages of		
			Egg	Egg, 1st, 2nd instars	Egg+nymph
1st, 1961	potato	1,849	74.74	95.48	99.00<
2nd, 1961	paddy	7,830	27.32	67.51	95.80
3rd, 1961	paddy	3,942	29.27	88.92	94.41
3rd, 1961*	paddy	3,005	34.38	88.29	92.05
1st, 1962	potato	3,610	71.38	94.07	98.18
1st, 1962	paddy	714	59.11	85.44	96.36
2nd, 1962	paddy	11,453	30.62	81.25	95.85

* Spiders were erradicated every other day.

amounted to 80% in 2nd and 3rd generation and to 95% in the 1st generation. The total mortality for each generation was largely accountable for by the mortality during young stages.

Life tables indicated that mortality factors worked in such a way as stage specific, i.e. parasites against eggs (Table 4), weather (storm, heavy rainfall etc.) against 1st instar nymphs (Table 5), predators specially spiders against 2nd instar ones (Table 6), and direct or indirect deaths associated with moulting occurred mainly after the 3rd instar (Table 7).

Eggs and young nymphs were affected by the mortality factors as a group unit or all-or-none way, since they form an egg-mass and nymphal aggregation(s) as originated from an individual egg-mass. Whereas old nymphs leading solitary life suffer mortality as an individual unit. The mortality due to all-or-none type factors amounted to 92% and 31% by the end of 2nd instar (Table 8), but did to 95.5% and 88-9% in

Table 5. Stage specific mortality caused by the typhoon of Sept. 16th, 1961 and of July 27th, 1962 on the 3rd and 2nd generation eggs of *N. viridula*.

Stage	3rd generation, 1961			2nd generation, 1962		
	No. observed	No. affected	per cent mortality	No. observed	No. affected	per cent mortality
Egg of						
0-1 days old	2,040 (20)*	257 (5)*	12.6	1,125	510	4.5
2-3 days old	711 (7)	116 (4)	16.3	1,724	324	18.8
4-5 days old	1,710 (18)	212 (10)	12.4	976	189	19.4
L-1 at hatch	1,474 (18)	275 (5)	18.7	113	86	76.1
L-1	751 (9)	462 (5)	61.5	155	113	72.9
L-2	212 (2)	0 (0)	0.0	133	52	39.1
L-3	—	—	—	32	11	31.3
L-4	—	—	—	20	3	15.0
L-5	—	—	—	36	3	8.3
Newly emerged adults	—	—	—	28	3	10.8

* Number of egg-masses or larval colonies in parentheses.

Table 4. Life table for the latest brood of the 1st generation of 1962 in the paddy field (Kirifani & Nakasuji, 1967).

Age interval (x)	Duration in days	Mode of life	No. of egg-masses or larval colonies at beginning of x	No. alive at beginning of x (lx)	Factors responsible for dx (dxF)	No. dying during x (dx)	dx as % (100 qx)	Accumulated mortality as % (Dx)
Egg	5	egg en masse	9	713	parasite unfertilized embryonic death	325 1 96	45.52 0.14 13.45	
L-1	3	aggregation on egg shells	5	291	rain fall unknown	422 54 68	59.11 18.56 23.37	59.11
L-2	4	feed in group(s)	5	169	rain fall failure in ecdysis (2→3) unknown	122 9 9 47	41.93 5.33 5.33 27.81	76.30
L-3	4	beginning of dispersal	4	104	failure in ecdysis (3→4) unknown	65 24 4	38.47 23.08 3.85	85.44
L-4	5	dispersal	4	76	failure in ecdysis (4→5) unknown	28 22 3	26.93 28.95 3.85	89.36
L-5	7	individual	4	51	typhoon unknown	25 10 15	32.90 19.61 29.41	92.86
Adult			2	31	typhoon death at emergence ♂ ♂ among survivors sterile ♀	25 5 7 10 1	49.02 16.13 22.58 32.26 3.22	96.36
Reproductive ♀				8		23	74.19	98.88

N-1-16

Table 6. Observation records of predation in 1961-2. Figures show the number of cases observed and the number of victims is in the parentheses (Kiritani, 1964).

Predator	Egg	L-1	L-2	L-3	L-4	L-5	Adult
Spiders ¹⁾	—	4 (8)	22 (>333)	6 (10)	7 (7)	1 (1)	3 (3)
Assassin fly ²⁾	—	—	—	—	—	—	3 (3)
Frogs	—	—	4 (>26)	—	2 (2)	2 (2)	—
<i>Nabis capsiformis</i> ³⁾	—	1 (64)	2 (2)	—	—	—	—
<i>Eusarcoris guttiger</i> ⁴⁾	1 (41)	—	—	—	—	—	—
<i>Zicrona coerulea</i> ⁴⁾	—	—	1 (2)	—	—	—	—
The 2nd instar nymphs of <i>N. viridula</i> ⁴⁾	1 (94)	—	—	—	—	—	—
Total	2 (135)	5 (72)	29 (>363)	6 (10)	9 (9)	3 (3)	6 (6)

- 1) Mainly, *Misumena yunohamensis* (Thomisidae), *Neoscona doenitzi* (Argiopidae) and *Oxyopes sertatus* (Oxyopidae).
- 2) *Promachus yesonicus*.
- 3) Nabidae.
- 4) Pentatomidae.

Table 7. Mortality due to the failure in ecdysis in relation to the total mortality of each instar in breeding experiment at 25°C.

Stage	No. of dead larvae during ecdysis to the total deaths (%)
2nd instar	30
3rd instar	39
4th instar	50
5th instar	100

- 1) Moulting from the 2nd to 3rd instar and so on.

Table 8. Life tables of *N. viridula* in terms of the numbers of egg-masses and nymphal colonies (data from Kiritani & Hokyo, 1962).

1st generation, 1961 (potato)

Stage	Initial No. of egg masses or nymphal colonies	Factors responsible for DX	No. of egg masses or nymphal colonies disappeared during X	EX as % of LX	Accumulated number of colonies disappeared as %
(x)	(lx)	(dx F)	(dx)	(qx)	(Dx)
Egg	24	egg parasites	18	75.0	75.0
1st instar	6	heavy rain-fall spiders	2 1	} 50.0	87.0
2nd instar	3	spiders	1		33.3
3rd instar	2				

3rd generation, 1961 (late planted paddy)

	(lx)	(dx F)	(dx)	(qx)	(Dx)
Egg	71	egg parasites	8	11.3	11.3
1st instar	63	typhoon unknown	5 3	} 12.7	22.5
2nd instar	55	spiders unknown	3 3	} 10.9	31.0
3rd instar	49				

the total mortality in 1st and 3rd generations in 1961, respectively. Therefore, the differences, i.e. 2.5 and 57-8%, are the mortality due to individual type factors. The importance of all-or-none type mortality in the 1st generation compared with the 3rd one is largely accountable for by the difference in activity of egg parasites, *Asolcus mitsukurii* and *Telemomus nakagawai* between generations, in other words 75% and 11% of the egg masses were completely parasitized in 1st and 3rd generation, respectively (Table 8).

Hibernation

Overwintering takes place among the leaves of ever-green trees such as cryptomeria, yucca, Chinese juniper etc. at an adult stage. Autumn migration from breeding place to hibernacula continued almost 4 months from middle September to middle January in the following year. Adults seemed to feed on food plant more than one week before arriving at hibernacula and males likely begin autumn migration earlier than females. Spring migration, from hibernacula to food plants, occurred during the period of late March to early April. This return migration, in contrast to the autumn migration, completed within about three weeks and males as in the autumn migration left hibernacula earlier than females (Kiritani & Hokyo, 1970).

Corpses of adult bugs as well as living ones are usually well preserved in such hibernacula as cryptomeria having a complex meshwork of shoots and leaves. Therefore, surveys on wintering mortality were carried out in late March for 16 overwintering sites from 1962 to 1967 (Kiritani *et al.*, 1962; 1966; Kiritani & Hokyo, 1970).

Factors which are responsible for the winter mortality may be divided into two categories: extrinsic and intrinsic ones. Extrinsic factors involve winter weather and sorts of hibernacula and intrinsic ones are composed of sex, body size, and genetic colour type. (Kiritani *et al.*, 1966; Kiritani & Hokyo, 1970).

Table 9. Winter mortality in relation to the kind of hibernaculum.

Year	No. examined			Mortality (%)		
	Cryptomeria	Yucca	Chinese juniper	Cryptomeria	Yucca	Chinese juniper
1961-2	666	131	386	37.9	63.6	86.0
1962-3	492	16	281	95.2	100.0	100.0
1963-4	297	23	336	23.1	21.7	72.1
1964-5	801	102	293	22.2	43.1	67.2
1065-6	129	51	104	43.4	66.7	76.9
1966-7	124	72	191	83.9	52.8	91.6
Total	2,509	395	1,591	Aver. 45.1	56.0	82.3

In normal winter, the wintering mortality ranged from 50 to 80 per cent. However, the highest mortality, viz. 97.5% was observed in the severe winter of 1962-3 and all the insects hibernating in yucca and Chinese juniper were found dead, but some survived the winter in cryptomeria (Table 9). Among the three kinds of hibernacula examined, the lowest mean mortality of 45.1% was recorded in cryptomeria which was followed by 56.0% and 82.3% in yucca and Chinese juniper, respectively.

Kiritani (1963) found that the male passes the winter in a state of quiescence rather than diapause, while the female is diapausing. This is considered to be related more or less to the differential mortality in the sexes; more females than males survive during hibernation (Table 10). This follows a shift of sex ratio in favour of females after hibernation. The winter mortality is also closely associated with the body size. Since the winter mortality decreases with an increase in body size (Table 11), the mean body size of adults which have hibernated becomes large as compared with that of before hibernation.

Table 10. Change in sex ratio after hibernation due to the differential winter mortality between the sexes.

	1961-2	1962-3	1963-4	1964-5	1965-6	1966-7
Alive { ♂	234	6	119	274	47	28
{ ♀	280	15	230	503	67	41
Dead { ♂	377	407	199	235	90	177
{ ♀	290	408	121	185	80	141
Sex ratio ¹⁾ { Before	48.3	50.6	52.5	57.5	51.8	47.0
{ After	54.5	71.4	65.9	64.7	58.8	59.4
{ p	< 0.01	< 0.05	< 0.01	< 0.01	> 0.10	< 0.10
Mortality { ♂	61.7	98.5	62.6	46.2	65.7	86.3
{ ♀	50.9	96.5	34.5	27.8	54.4	77.5
{ p	< 0.10	> 0.10	< 0.10	< 0.10	< 0.10	> 0.10

1) $\frac{\text{♀}}{\text{♂} + \text{♀}} \times 100$

Table 11. Wintermortality in relation to the width of thorax in the winter of 1964-65 (Kiritani, *et al.*, 1966).

Width of thorax (mm)	Male		Female	
	No. examined	Mortality (%)	No. examined	Mortality (%)
6.1-6.5	2	100.0	—	—
6.6-7.0	66	59.1	14	57.1
7.1-7.5	223	43.0	72	31.9
7.6-8.0	219	44.7	316	29.4
8.1-8.5	—	—	258	21.3
8.6-9.0	—	—	27	18.5

As regards colour types, types G and O are more cold susceptible than those of F and R (Table 2) (Kiritani, 1970). Consequently, population composition changes greatly after hibernation so that it consists of more females, more F and R types, and more large individuals than the population prior to hibernation.

Population Dynamics of *Nezara viridula*

As stated previously, the recent increase of *N. viridula* in Japan has been induced by the cultivations of early planted paddy. This situation may be explained as follows: first, the emergence period of 1st-generation adults coincided with the heading of early planted paddy which provided very suitable host for the insect; secondary, adults are able to disperse a long distance to seek for new host plants, e.g. rice plant, leaving their natural enemies, e.g. egg parasites, behind in the original breeding places, e.g. potato (Kiritani, 1964; Kiritani *et al.* 1965); thirdly, the mean size of egg-masses increased by a rate of 15% giving means of 75, 86 and 97 eggs per mass for 1st, 2nd and 3rd generations, respectively (Kiritani & Hokyo, 1965). By contrast, the percentage parasitism of eggs decreased from 1st to 3rd generation in such a way as to improve their survival rate (Kiritani & Hokyo, 1970).

It deserves special mention that the existence of the early planted paddy is not enough to warrant the propagation of *N. viridula*. Those localities where middle-season and late planted paddies were replaced by an overall cultivation of early planted paddy in a short term, the propagation of *N. viridula* hardly occurred. The same is true for certain areas of Kochi where rice is cropped twice a year, because the ears of rice are practically absent between the time of harvest of the first crop and the heading time of the second crop.

On the other hand, in those localities where cultivation of early planted paddy spread slowly and was finally counter balanced by that of middle-season and late planted paddies, the damage of paddy caused by this insect suddenly became a serious problem for the growers. Therefore, the continuous cultivation of early, middle-season and late paddies in an area is essential for the successful propagation of this insect (Kiritani, 1966).

Sooner or later, this increase in population density was counter-balanced by environmental capacity and density-dependent processes. The annual changes in the population densities before and after hibernation for the period of autumn in 1961 to spring in 1967 are shown in Fig. 4, based on the data obtained from the surveys on the wintering

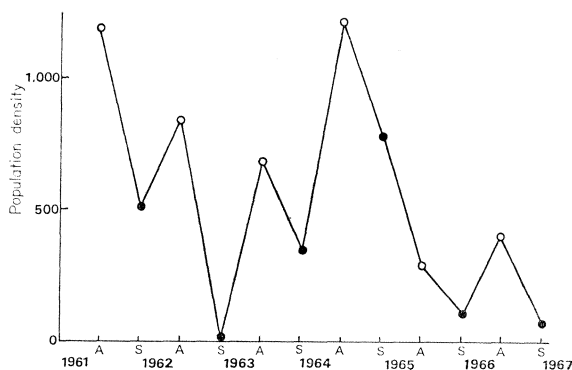


Fig. 4. Annual fluctuations in population density of adults before (autumn) and after (spring) hibernation.

mortality in hibernacula. By dividing the population trend curve into two phases: hibernating and breeding seasons, further analysis were made.

(1) Overwintering mortality

The number of adults after hibernation or spring population was plotted against

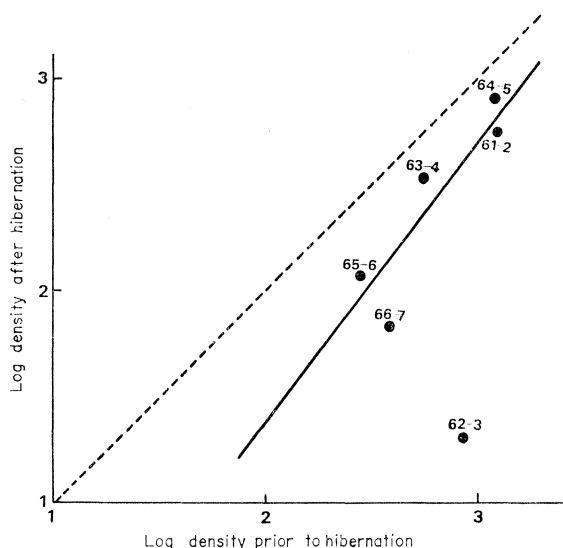


Fig. 5. Relationship between population densities before and after hibernation.

that prior to hibernation or autumn population in the preceding year both on log scale. A regression line calculated for five winters to the exclusion of 1962–3 when the winter was unusually severe showed $b=1.38$, suggesting the inverse density-dependent process (Fig. 5). It should be also noted that three points located above the regression line were the years when female sex ratios prior to hibernation ranged 52 to 58%, whereas those two points below the line were 47 and 48% (Table 10). Since more females survive the winter than males, populations having high female sex ratios prior to hibernation could be expected to leave more survivors in spring than otherwise. As stated previously, the winter mortality seems to be determined by various kinds of factors, intrinsic as well as extrinsic, so that, presently, there is no evidence to relate the winter mortality with the population density before hibernation.

(2) Rate of population increase

The rates of population increase from spring to autumn are plotted against the population densities in spring both on log scale (Fig. 6). The rate of population increase clearly decreases density-dependently with an increase in the density of spring population suggesting that regulatory mechanisms of population density are working either intermittently or throughout the breeding seasons.

Evidence obtained from field and laboratory observations so far indicated that, among the factors which seem to be responsible for the regulation of population density of *N. viridula*, adult stage was most important in this feed-back system. It has been suggested that the mating frequency of overwintered adults in the field decreased with increasing density of adults, presumably by interference among adults (Kiritani & Hokyō, 1970). Laboratory experiments also showed that the low frequency of matings was also associated with the reduction in number of eggs deposited. This reduction in fecundity is not only induced by such direct interference as occurred among adults, but also by the reduction in body weight of adults resulting from overcrowding among nymphs (Kiritani & Kimura, 1965). In this respect, field-borne adults were compared with those reared on the same but caged host plants with two different densities of egg masses. Field-borne adults were medium in body weight and size be-

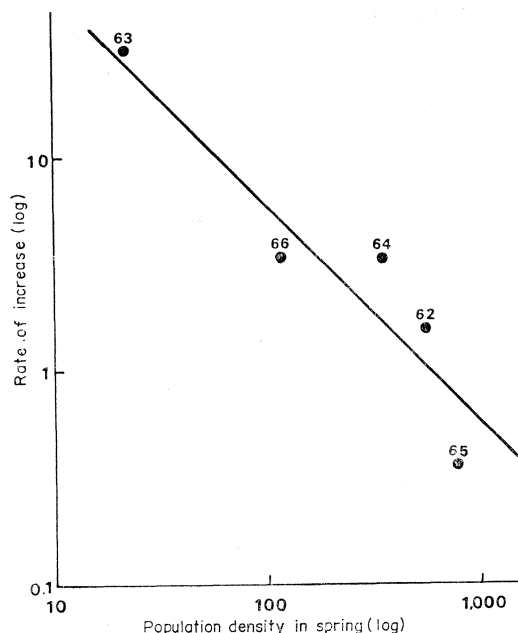


Fig. 6. Relationship between the population density in spring and the rate of increase from spring to autumn.

tween those developed under the densities of 2 and 10 egg masses per 36 hills (Kiritani & Hokyō, 1970). This provides a further evidence of density effect that operates under natural conditions.

The endless increase of the population is checked, therefore, by deleterious effects associated with overpopulation which occurred locally. The extent to which such overpopulation occurs is determined by the relative abundance of host plants to the current level of the population. It should be remarked that even when the general of *Nezara* population seemed to be low, there still exists the possibility of over-population in some places.

The wintering mortality, on the other hand, occurs independently with the population density. When the severity of winter exceeds the physiological tolerance limit of the insect, the only safety valve which prevents *N. viridula* from extinction would be the heterogeneity of hibernacula. It is concluded therefore that the abundance of *N. viridula* is determined by density dependent and density independent processes which work alternatively in breeding season and in winter.

Discussion

M. B. Kalode, India: Do you have any information on the alternate host plants of *Nezara viridula* on which this insect can complete its life cycle?

Answer: There are many kinds of host plants on which *N. viridula* can complete its life cycle, e.g. potatoes, beans, cucumbers, sesame, rape, weeds such as smartweeds etc. We should, however, discriminate the host plants on which it can complete its life cycle from those on which adults infest only for feeding.

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