nouvelles. *Ibid.* **99**(12): 168-81.
Fain, A and M. Nadchatram. 1962 Acariens nasicoles de Malaisie II. Rhinonyssidae (Mesostigmata) et Turbinoptidae (Sarcoptiformes). *Ibid.* **98**(15): 271-82.
Gretillat, S. 1961 Description de deux nouvelles espèces de Rhinonyssidae (Acarina, Mesostigmata) = *Rallinyssus strandtmanni* n. sp. et *Larinyssus petiti* n. sp. *Vie et Milieu* **12** (1): 151-60.
Iredale, T. 1956 Birds of New Guinea. Georgian House, Melbourne, xv+230 pp.
Nadchatram, M., H. E. McClure and L. K. Chong. 1964 Host distribution of nasal mites (Acarina) of birds in Malaysia. *Feder. Mus. J.* **9** (NS): 102-14.
Peters, J. L. 1934 Check-list of birds of the world II. Harvard Univ. Press, Cambridge, xvii+401 pp.
Strandtmann, R. W. 1948 The mesostigmatic nasal mites of birds. I. Two new genera from shore and marsh birds. *J. Parasit.* **34**(6): 505-14.
Wilson, N. 1964 An evaluation of Yunker's technique for the recovery of nasal mites from birds. *J. Med. Ent.* **1**(1): 117.
1964 New records and descriptions of Rhinonyssidae, mostly from New Guinea (Acarina: Mesostigmata). *Pacific Ins.* **6**(2): 357-88.

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POLYMORPHISM IN THE SOUTHERN GREEN STINK BUG

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Abstract: A probable mechanism in the formation of geographical variation of *Nezara viridula* is suggested. The original home of this species is also suggested in view of the distribution of genetic color variations in the world.

The southern green stink bug, *Nezara viridula* Linné, is widely distributed throughout the world and infests various kinds of cultivated plants sometimes causing serious damage. Since Linné's (1758) description of *viridula* as a new species from West Indies several adult forms of this species have been named. Kiritani & Yukawa (1963) observed some additional types among Japanese specimens (Table 1).

In SE Asia the population of *N. viridula* consists of several types, but in other areas,

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Table 1. Forms of *Nezara viridula* Linné.

Type	Name	Color pattern
G	f. *smaragdula* Fabricius	entirely green
O	f. *torquata* Fabricius	median and lateral lobes, anterior margin of pronotum yellow
R	f. *viridula* Linné	green spots on yellow ground color
Y	f. *aurantica* Costa	entirely yellow, orange or pink
B	f. *vicaria* Walker f. *chlorocephala* Westwood	entirely brown
C		entirely cobalt
F		in addition to the characteristics of O-typc, connexivum yellow
OR		combination of O and R types
FR		combination of F and R types

Table 2. Percentage of each type in the world (%).

Locality	G	O	F	R	No. of examined specimens
Japan, Honshu, Wakayama	87.6	7.1	4.6	0.7	22867
Shikoku	78.9	11.6	7.3	2.1	807
Kyushu	80.8	8.3	7.5	3.4	983
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 Guinca	100.0	0	0	0	218
Australia	100.0	0	0	*	7
New Zealand	**				
Mariana Is.	99.2	0	0.8	0	130
New Hebrides	100.0	0	0	0	2
Hawaii	100.0	0	0	0	***
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
Ethiopia		****			
Spain	80.0	20.0	0	0	5

* Wilson, F. 1961. Personal communication. ** Cumber, R.A. 1949.
*** Over 100 specimens were examined. **** Jannone, G. 1954.

e.g. Hawaii, it consists entirely of the G-type. Thus the question was raised whether the geographical differences in the occurrence and frequency of each type might suggest the original home of this species and a probable mechanism of the formation of geographical variation.

The specimens used here are from Bishop Museum (Honolulu), Chicago Nat. Hist. Mus., Amer. Mus. Nat. Hist. (New York), Intern. Rice Res. Inst. (Manila), Nat. Inst. Agric. Sci. (Tokyo), Nat. Shikoku Agric. Expt. Sta., Tokushima, Kochi, Miyazaki, Kumamoto, Nagasaki and Wakayama Agric. Expt. Stations, Kagawa, Kyushu and Ehime Universities.

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RESULT AND DISCUSSION

There are no intermediate forms between such forms as G, O, F and R, which seem to be fundamental. They are easily distinguished from each other. The B-type, however, should be excluded from these types because it is merely a reversible color variation caused by physiological conditions. This color variation occurs in all types during hibernation in temperate regions, but in Hawaii it is observable during the dry season. Types C and Y are very rare, i.e. about one per 5000 specimens, but types OR and FR are commonner than the former two, that is about one per 1000. Theoretically other combinations of types, e.g. FY, OC, etc. might be expected, but, so far, they have not been observed.

In regard to the hereditary basis of these types, Kiritani, Hokyo & Kimura (unpublished) observed that about 1000 specimens of F_1, F_2 and F_3 ensued from 15 pairs of G-type in 1962 and 1963, all of which belonged to the G-type. Further experiments indicated that at least four types, G, O, F and R were under genetical control. By the inbreeding of each type, both parental and G types were predominant in F_1 generation, but in F_2 generation all the progeny phenotypically belonged to the parental type (Kiritani & Kimura, unpublished). The appearance of each type was not linked with sex (Kiritani & Yukawa 1963).

The relative frequency of each form in the world (Table 2) was based on the results obtained from field investigations, examinations of specimens and data reported by other authors. It is in SE Asia including Borneo, where types other than G were found with relatively high percentages. In Japan, it can be seen that the percentage of G-type is inclined to increase as one goes northeastward away from Okinawa via Amami, Kyushu–Shikoku to Wakayama, Honshu, along the Japanese islands. The increase of the percentage of G-type along the Japanese islands may be explained by the probability of invasion of G-type rather than an ecological cline.

N. viridula invaded Australia in 1916 (Wilson), New Zealand in 1944 but probably in 1941 (Wilson) and Hawaii in 1961 (Davis; Mitchell). 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. In explanation of these facts, it is reasonable to assume that the commonest phenotype, G, had a more favorable chance than others in expanding its distribution range. The distribution of this insect in the Pacific islands seems to have been established partly by invasion directly from the original home and mostly by the dispersal from island to island, or from subsequent centers of distribution (see also Davis 1963). In the latter case, if the invading population is small and there is no selective difference among types, genetic drift would be more decisive in the determination of the variation frequencies. Consequently, it might be expected that types other than G could be seen with relatively high percentages in some islands. The fact that only the phenotypic G-type is distributed throughout nearly all the Pacific islands, might suggest the subsequent invasion to these islands. Probably the same consideration could be applied to the populations in the American continent. Though O and R types were reported from Spain and Ethiopia, the number of specimens examined are not enough to conclude that the dispersion of this insect was from Asia via India and Iraq to the Mediterranean area and Ethiopia.

CONCLUSION

It should be emphasized that in reference to the geographical variation of a species, it is very important to consider not only selection by environmental factors after establishment, but also the initial genetic composition of the imported population. The relative frequency of polymorphs among newly established populations of *Nezara viridula* is primarily determined by the initial genetic composition of the population and subsequently by the process of both genetic drift and natural selection. Based on the above discussion, SE Asia is considered as the original home or the center of distribution of this insect.

REFERENCES

Cumber, R. A. 1949. *N.Z. J. Agric.* **49**: 563-64.

Davis, C. J. 1964. *Proc. Hawaii. Ent. Soc.* **18**(3) : 369-76.

Jannone, G. 1954. *Rev. Appl. Ent.* A, **42**(7) : 229.

Kiritani, K. & J. Yukawa. 1963. *Rostoria* **5**: 19-21.

Linné, C. 1758. *Syst. Nat.* (Ed. X), 444 p.

Mitchell, W. C. 1963. Univ. Hawaii Cooperative Extension Leaflet, July, 1963.

Wilson, F. 1960. A review of the biological control of insects and weeds in Australia and Australian New Guinea, p. 29-30, Comm. Inst. Biol. Control, Ottawa, 1960.