

Variation in populations of the Brown Planthopper *Nilaparvata lugens* (Stål) in South East Asia

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The Brown Planthopper is a major pest of rice in Asia, from India and Pakistan in the west to Japan and Korea in the north to the Solomon Islands and Fiji in the east and to northern Australia in the south (fig. 1). It can reproduce and survive continuously only on rices, *Oryza* species, and their cultivars. Populations occur in the tropical parts of S.E. Asia which are able to destroy some of the newer high yielding cultivars resulting in extensive "hopperburn". Different populations have been isolated at the International Rice Research Institute (IRRI), Philippines, with distinctly different patterns of virulence on rice varieties which possess different genes for resistance (IRRI 1979). These have been termed biotypes 1, 2 and 3 and are maintained respectively on the standard cultivars TNI (no gene for resistance), Mudgo (BPH 1 gene) and ASD 7 (bph 2 gene) at IRRI, where a gene-for-gene relationship has been suggested between virulence of the biotypes and resistance in the rice.

We have investigated individual variation in virulence within these biotype populations and found it to be consistently very great, using amount of honeydew excreted (CLARIDGE & DEN HOLLANDER, 1980) and weight change in 24 hours as measures of virulence. Also selection experiments over at least 10 generations, using the three standard cultivars showed that it is possible to change the virulence characteristics of all of the biotypes very rapidly (CLARIDGE & DEN HOLLANDER, in preparation). Crossing experiments between the biotypes strongly suggest a complex polygenic system of inheritance for

virulence and no gene-for-gene relationship (DEN HOLLANDER & PATHAK, 1981).

We conclude that the biotype concept is not useful in this species and may be positively misleading. Also it is important to emphasise that the "biotypes" from the Philippines represent populations selected by the cultivars on which they have been confined over a period of many generations. They do not represent divergent populations in any real genetic sense, since they are able freely to interbreed with each other. Also since the variation in virulence is more or less continuous they do not represent morphs of a polymorphic population.

The danger of naming or numbering biotypes is much greater when this practice is extended to different geographically separate regions. It is probable that populations from widely different areas may develop superficially similar patterns of virulence when exposed to the same or similar rice cultivars. However such geographically separated populations may be genetically quite different, though having in common the ability to damage a common cultivar. We have therefore commenced a study of *N. lugens* populations from different areas within its overall range. We now have culture populations in Cardiff from widely different areas (fig. 1) and are undertaking virulence measurements under constant conditions and on standard cultivars.

The most startling first results concern those from a population in northern Queensland, Australia, on Blue Bonnet 50 and Star Bonnet, and which we culture in Cardiff on Delta (France) and Towada

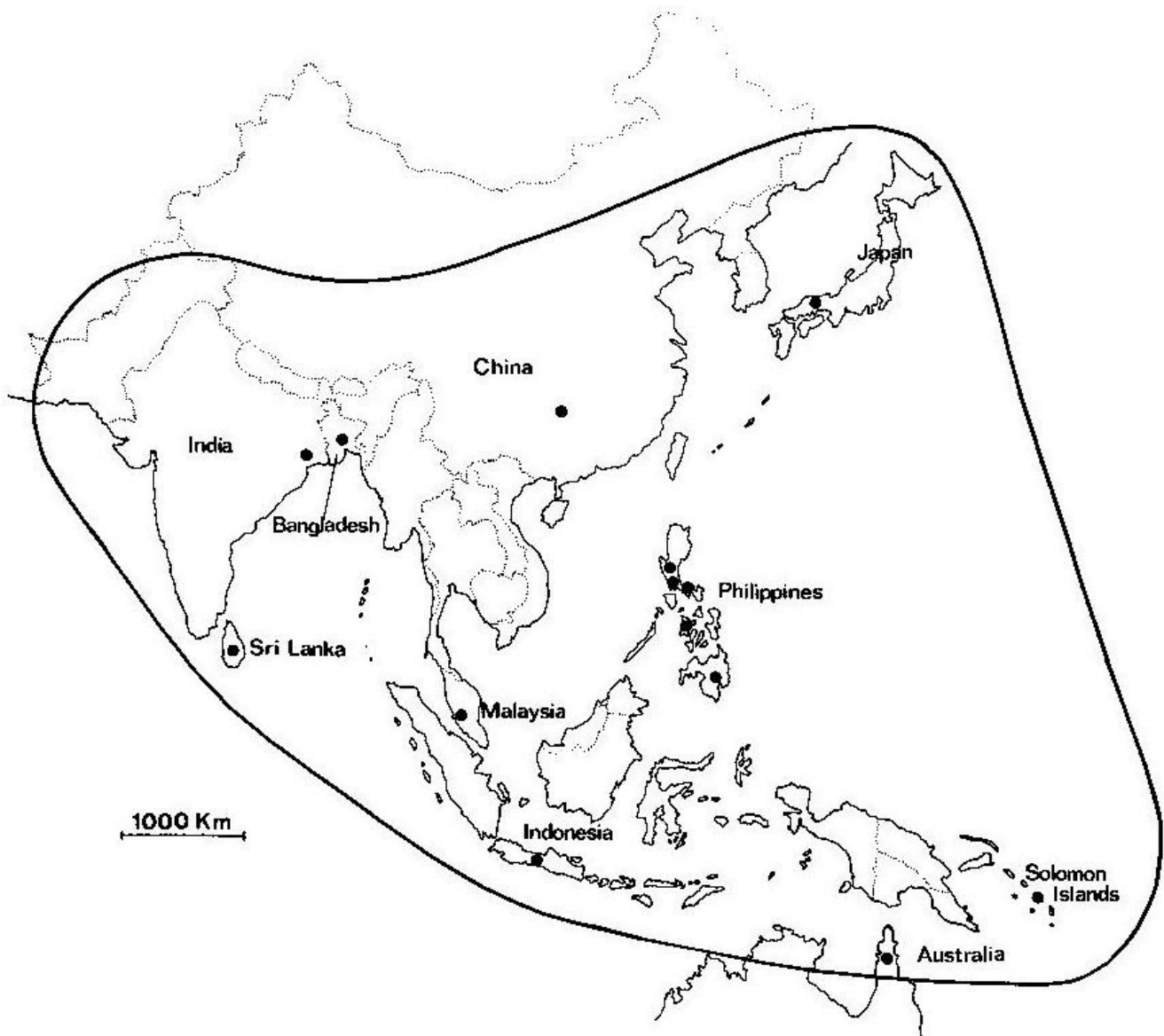


Fig. 1. Map of Asia to show approximate range of distribution of *N. lugens* after KHUSH (in IRRI, 1979). Areas from which culture populations are presently held in Cardiff are marked by ●.

(Japan); This population at first behaved to TNI, the variety supposedly lacking any gene for resistance, as if it were a resistant variety and we had great difficulty in maintaining it in the early generations. However, after ten generations of intense selection a population was produced with virulence characteristics similar to IRRI biotype 1. This example clearly demonstrates the value of such work which may not only lead to a fuller understanding of the nature of virulence in *N. lugens*, but also of resistance in rice.

We have commenced studies on the morphology, biochemistry (electrophoresis) and mating behaviour of geographically separate populations of *N. lugens* and also a programme of hybridisation experiments between them. The percentage of successful matings shows great variation between different populations. Again our first results show that the Australian

population appears to be the most distinct of those so far tested. In all crosses between the Australian and other populations, mating success has been low, usually between 0% and 8%. Of those few crosses which were successful, survival and development of hybrid offspring was usually good. This suggests that some pre-mating barrier to hybridisation exists between this and other populations.

ICHIKAWA and ISHII (1974) and ICHIKAWA (1979) have demonstrated that both sexes of this species produce vibrational signals, transmitted through the substrate, which function as specific signals during courtship. We have recorded these signals using a crystal gramophone pick-up as a transducer. The females produce simple calls consisting of repeated clicks or pulses at a regular rate of repetition (fig. 2). The male call is rather more complex consisting of groups of rapidly and regularly reproduced pulses

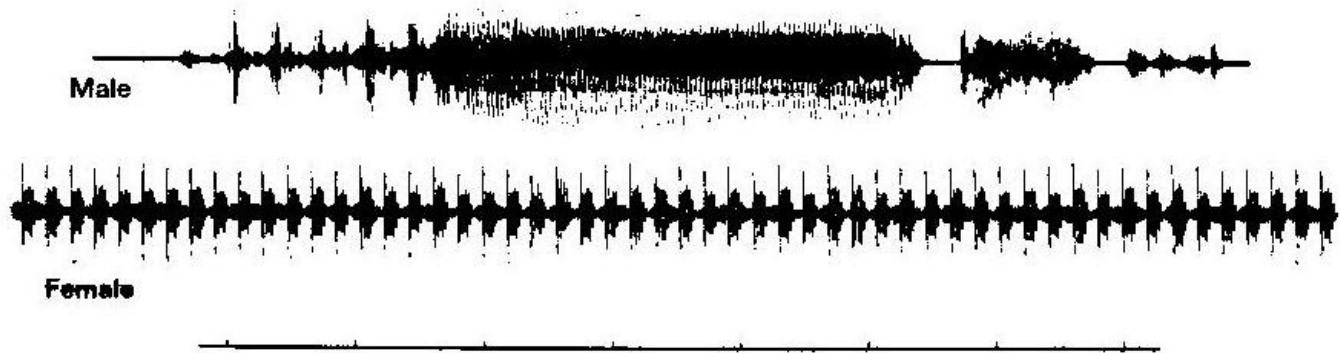


Fig. 2. Oscillograms of parts of calls of male and female *N. lugens* from a Philippine population. Time marks at 0.25 sec. intervals.

preceded by, and often also followed by, groups of less regular pulses (fig. 2).

ICHIKAWA and ISHII (1974) showed that female calls have a characteristic pulse repetition frequency, clearly different from two other species of rice-feeding Delphacidae, *Sogatella furcifera* (Horv.) and *Laodelphax striatellus* (Fall.), but they made no detailed studies of male calls. We have estimated the pulse repetition frequencies within the major units of the male calls for different populations of *N. lugens*, using the same techniques as employed previously by CLARIDGE and REYNOLDS (1973) for studies on *On-copsis* calls.

Our results for the Australian population of *N. lugens* are especially interesting. For example, they differ very significantly from the Philippine popula-

tions in pulse repetition frequency (fig. 3). It is possible that within populations of *N. lugens* pulse repetition frequencies of male songs act as specific mate recognition signals to which females may be closely tuned. Thus the differences between these signals in the two allopatric populations studied here may account for the low levels of hybridisation between them in the laboratory.

We are indebted to many workers in Asia, especially those at IRRI, for their help and particularly for providing us with culture populations. The work briefly reported here forms part of a study on *N. lugens* supported by the Centre for Overseas Pest Research, London, and the Overseas Development Administration of the U.K. Government.

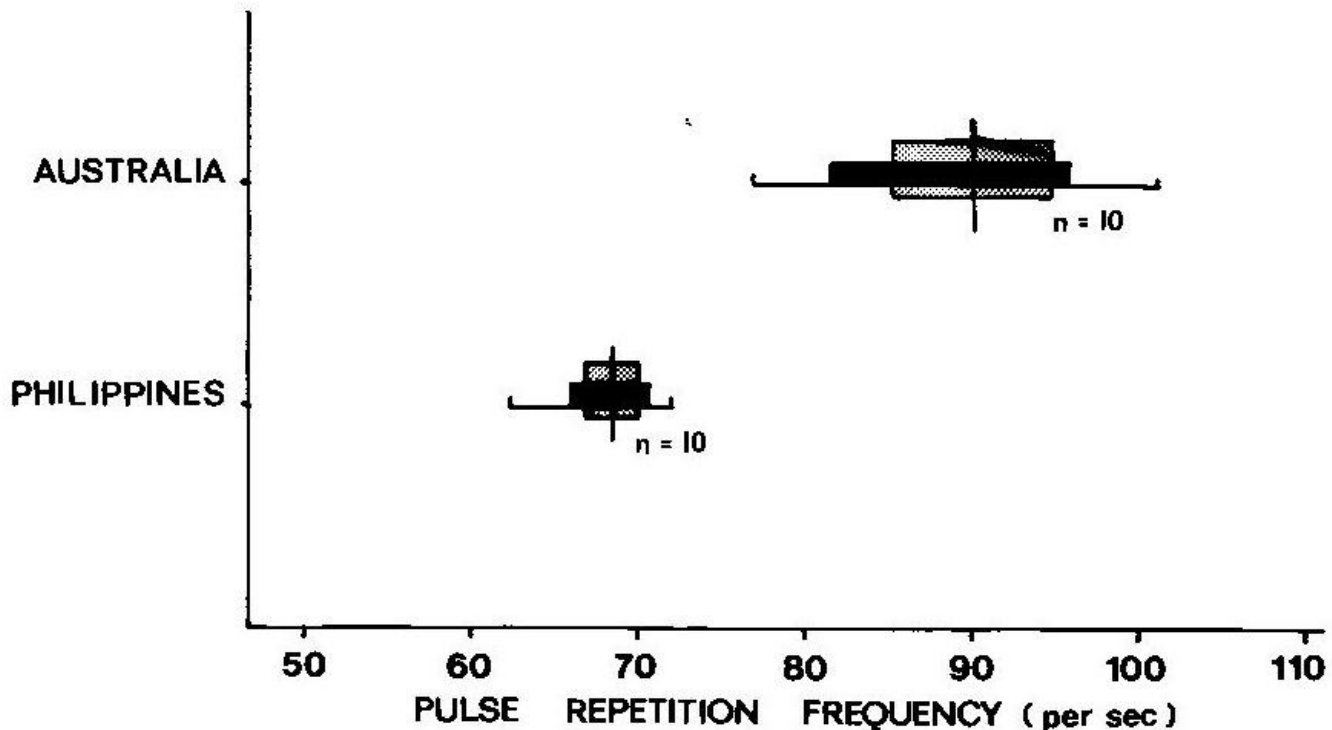


Fig. 3. Summaries of pulse repetition frequencies for male calls of populations from Australia (Queensland) and the Philippines (Luzon). Means (vertical lines), standard deviations (stippled bars), ranges of means (black bars) and total ranges of measurements for each sample are given. The difference between the means is strongly significant ($t = 12.85$, $P < 0.001$).

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