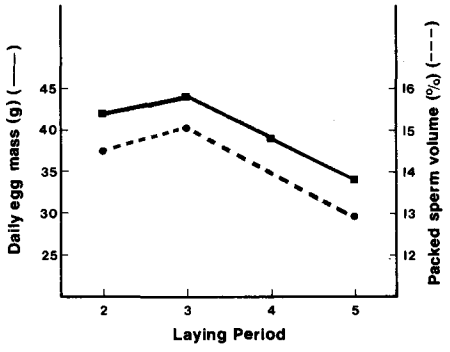
fecundity[3]. Total semen volume, however, may not be an accurate measure of total cell mass because approximately 75% of its volume is a supernatant fluid[4].

Our procedure involved the collection of egg mass data from 400 females for 5 28-day periods starting at 154 days of age. Individual egg records were recorded for 5 periods; mean egg weights were obtained from eggs collected during the 2 week of each period. Daily egg mass was defined as the total egg mass produced during the 140-day period divided by the days after females reached sexual maturity. Semen samples were collected[5] from 146 males during the 2nd, 3rd and 5th laying periods. Triplicate samples of each male's semen were placed in micro hematocrit tubes and centrifuged at 12,000 to 15,000 rpm for 3 min, and then packed sperm volume (PSV) percentages were read on a micro capillary reader. The mean PSV values of males were observed to parallel the mean daily egg mass curve of full sib females (figure) in the 2nd, 3rd and 5th laying periods. The levels of both PSV and egg mass were highest in the 3rd laying period and lowest in the 5th period.



Mean daily egg mass of females and packed sperm volume of male sibs.

Daily egg mass of females and packed sperm volume of males by line

Line	Daily egg mass Generation S_0	S_1	S_1-S_0	Packed sperm volume Period 3	5
	(g)	(g)	(g)	(%)	(%)
EMS1	39.89	46.64	6.75	16.79	12.36
EMS2	41.18	45.22	4.04	14.03	12.05
$\bar{x}$	40.54	45.93	5.39	15.41	12.21
EMR1	42.30	44.19	1.89	13.31	10.68
EMR2	40.29	42.77	2.48	13.34	10.60
$\bar{x}$	41.30	43.48	2.18	13.32	10.64

In tests to investigate possible genetic ramifications of these observations, males with both intermediate and high PSV and females with high egg mass were utilized to establish 4 selected lines. 2 replicate lines (EMS1 and EMS2) were established by mating 6 males/line with high PSV values with 24 females/line with high egg mass values; and 2 replicate lines (EMR1 and EMR2) were established by mating 6 males/line with intermediate PSV values with 24 females/line with high egg mass values. The mean daily egg masses of females from the 2 lines mated to intermediate males (EMR1 and EMR2 lines) were 1.89 and 2.48 g greater in the S_1 generation than in the S_0 (base) generation (table). Contrariwise, the selection gains in the S_1 generation obtained in lines (EMS1 and EMS2) in which males were selected for high PSV values and females were selected for egg mass were 6.75 and 4.04 g greater than corresponding values in the S_0 generation. The average gain in daily egg mass across replications was twice as great for EMS lines (5.39 g) as for the EMR (2.18 g) lines (table). The magnitude of this difference may be important because selection in the EMR lines was for only females, whereas selection in the EMS lines was for both sexes. Therefore, the EMS lines may have had the equivalent of twice the selection pressure the EMR lines had.

The mean PSV of S_1 generation males in the EMS1 and EMS2 lines were higher than corresponding values of males in the EMR1 and EMR2 lines in both period 3 and period 5 (table). These findings indicate an apparent response to selection in PSV. These data suggest a close relationship between neuroendocrine systems involving PSV in the male and egg mass in the female. This information may prove to be a valuable selection tool because of the intense selection pressure that could be applied to males when selection is for a sex limited trait.

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A chromosome study of the parthenogenetic rice water weevil, *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Curculionidae), in Japan

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Summary. The chromosomes of the so-called rice water weevil, *Lissorhoptrus oryzophilus* Kuschel obtained from Tokoname City, Aichi Prefecture, were studied in both oogonial and oocyte-maturation divisions in squash and sectioned slides, respectively. The chromosome number was confirmed as exactly 33 in both divisions. No reduction division takes place. It is therefore concluded that *Lissorhoptrus oryzophilus* is a parthenogenetic triploid in Tokoname City.

The rice water weevil, *Lissorhoptrus oryzophilus* Kuschel, a member of the tribe Hydronomi, subfamily Curculioninae (Lissorhoptrinae) is known as a serious rice pest in North America. In the USA both males and females abound in most areas; in California, however, only female insects are found. In the early spring of 1976, farmers found peculiar small weevils in paddy-fields located in the so-called Maeyama area (formally, Hattanda, Kanayama), Tokoname City at Chita peninsula, Aichi Prefecture, Japan. Immediately, staff of the Ministry of Agriculture, Japan, began detailed research on the weevil species. Some specimens were sent to Dr G. Kuschel in New Zealand for

identification. He identified them as being *L. oryzophilus* Kuschel and he requested male insects. In the meantime, our curculionid taxonomist Dr K. Morimoto dissected 80 specimens and found that they were all females[1]. From this result he suggested that the species might propagate parthenogenetically and asked me for a cytological investigation. On the other hand, Dr Morimoto carefully checked more than 600 specimens of insects belonging to the genus *Lissorhoptrus* coming from the US National Museum, and he confirms Dr Kuschel's identification.

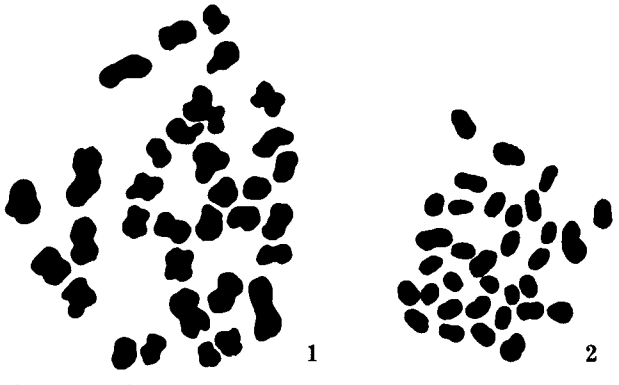
Material and methods. I collected *L. oryzophilus* Kuschel from a paddy-field in the Maeyama area, Tokoname City, in mid-July 1976, and ovarioles and eggs obtained from 60 individuals were studied. The dissection showed that they were all females. Their ovarioles were squashed according to Smith's method and stained with an aqueous solution of 0.6% methyl green and 0.15% basic fuchsin (1:1)[2,3]. Numerous eggs were fixed in a modified Bouin's solution and embedded in paraffin. Sections were cut at 10 µm and stained in Heidenhain's iron-haematoxylin. The camera-lucida drawings were made at about ×3600 and reduced to ×3100 approximately for publication.

Results and discussion. Only 3 oogonial metaphases were found in squashes from 2 specimens, and the best one is shown in the figure. 2 of them showed exactly 33 chromosomes and the remaining one 30 chromosomes. The karyotype of this species is constituted by chromosomes of various sizes, mostly meta- or submetacentrics (figure 1). The size difference of the chromosomes is gradual. No sex chromosomes were observed. In all the sectioned material, only 1 good maturation plate was found: the one shown in figure 2. A clear metaphase of the maturation division had exactly 33 chromosomes.

So far 56 parthenogenetic weevil species and races from Europe, Australia, Canada, and Japan have been studied cytologically; it has been established that the phenomenon of parthenogenesis generally occurred in connection with polyploidy[4-14]. They are members of 5 closely allied subfamilies, Brachyderinae, Otiorrhynchinae, Eremninae, Leptopinae, and Cylindrorrhyninae. Excluding the European *Polydrosus mollis* and the Japanese *Scepticus insularis* with 22 chromosomes (2×), there are 30 triploids having 33 or 30 chromosomes (3×), 15 tetraploids with 44 chromosomes (4×), 5 pentaploids with 55 chromosomes (5×), and 2 Japanese hexaploids carrying 66 chromosomes (6×). These forms are characterized by the basic number of 11. The exception is 2 triploid species, *Listroderes costirostris* and *Eusomus ovulum*, with 30 chromosomes suggesting a basic number of 10[7,12,14]. It is interesting to note that several species have 2 or 3 races with a different degree of polyploidy, in addition to the diploid bisexual race. All the parthenogenetic weevils so far studied cytologically are of an apomictic, thelytokous type in which the eggs undergo 1 maturation division, and the chromosomes divide equationally, so that no reduction takes place. As a result, every egg develops into a female with a genic constitution similar to that of the mother.

Lissorhoptrus oryzophilus, here studied, had 33 chromosomes in oogonial metaphases as well as at the maturation division. The fact clearly shows that no reduction division takes place. We conclude that the species propagates parthenogenetically in Japan. In 1977, the insects are distributed very widely. The spreading of the population is being closely followed, but no males have hitherto been obtained. This appears to be the first instance of parthenogenesis found among members of the subfamily Curculioninae (Lissorhoptinae).

Recently, Research Division, Yokohama Plant Protection Station informed us that for more than 100 years this species was widely distributed in the central-eastern part of the USA (from Michigan to Florida). At that time, the food plants were weeds at the water's edge. When farmers began to cultivate rice, the insect became a serious pest. In Arkansas, Louisiana, and Texas the insect was called 'rice root maggot'. In 1881, it was revealed that the insect was a species of the Curculionidae. Since then, there was no information about the spreading of the weevil from this area for a long time. However, in June 1950 the weevil species was first found in Biggs City north of Sacramento, California. Then, in 1972 the species was found in Dominica. It is interesting that in its original habitat the species propagates bisexually; however, in California and Dominica no males have so far been found. In 1975, several farmers in Tokoname City imported dry fodder for their cows from California. From this fact the Ministry of Agriculture of Japan supposed that the weevils were introduced to Japan together with the fodder. In the USA, entomologists are mostly working on ecology, chemical and insecticidal control of the weevils, but no cytological study has been carried out. From the above situation, no correlation can be suggested in this species between polyploidy and altitude or Würm ice age at which it might have become established. The origin of the triploid parthenogenetic race in this species is, at present, quite unknown.



Figures 1 and 2. Chromosomes of *Lissorhoptrus oryzophilus* Kuschel. *1* Oogonial metaphase with 33 chromosomes. *2* Oocyte maturation division at metaphase showing 33 chromosomes. ×3100.

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