STUDIES ON THE MORPHOLOGY AND ECOLOGY OF THE RICE LEAF-BEETLE, *LEMA ORYZAE* KUWAYAMA, WITH SPECIAL REFERENCE TO THE TAXONOMIC ASPECTS[1)]

BY

Satoru KUWAYAMA

With 4 Plates, 13 Text-figures and 8 Charts

CONTENTS

1) This paper is based on the work done at the Hokkaido Agricultural Experiment Station and is published with the approval of the Director.

[*Jour. Facul. Agr., Hokkaido Imp. Univ., Sapporo*, Vol. XXXIII, Pt. 1, March, 1932]

I. INTRODUCTION

In Japan, as is well known, the rice-culture was first begun many centuries ago and it has since developed remarkably year by year, and we can now find rice-fields all over the country from Hokkaido in the north to Taiwan (Formosa) in the south. Unfortunately, however, this crop is not exempt from the attacks of various insect-pests, and up to the present more than one hundred and seventy species have been reported by many research workers as noxious to the rice-culture. Among them the following species are considered to be more serious and decidedly important:

1. Rice locust (*Oxya velox* FABRICIUS).
2. Rice thrips (*Haplothrips oryzae* MATSUMURA).
3. Rice plant-hoppers (*Liburnia furcifera* HORVÁTH, *Liburnia oryzae* MATSUMURA and *Liburnia striatella* FALLÉN).
4. Rice leaf-hoppers (*Nephotettix apicalis cincticeps* UHLER and *Deltocephalus dorsalis* MOTSCHULSKY).
5. Rice bugs (*Podops lurida* BURMEISTER and *Lagynotomus assimulans* DISTANT).
6. Rice caddice-worms (*Setodes argentata* MATSUMURA and *Oecetis nigropunctatus* ULMER).
7. Rice borers or Paddy borers (*Chilo simplex* BUTLER and *Schoenobius incertellus* WALKER).
8. Rice leaf-roller (*Cnaphalocrocis medinalis* GUENÉE).
9. Purplish stem-borer (*Sesamia inferens* WALKER).
10. Rice leaf-caterpillar (*Naranga aenescens* MOORE).
11. Rice leaf-wrapper (*Parnara guttata* BREMER).
12. Rice leaf-beetle (*Lema oryzae* KUWAYAMA).
13. Rice armoured beetle (*Hispa armigera* OLIVIER).
14. Rice root-worm (*Donacia lenzi* SHOENFELDT).
15. Rice curculio (*Echinocnemus bipunctatus* ROELOFS).
16. Rice crane-flies (*Tipula parva* LOEW and *Tipula praepotens* WIEDEMANN).
17. Rice leaf-miner (*Oscinis oryzella* MATSUMURA).
18. Rice ear-maggot (*Chlorops oryzae* MATSUMURA).

Of the foregoing species, rice borers, rice plant-hoppers, rice leaf-hoppers, rice bugs, etc. have been examined in detail by many students, but up to now no thorough research on the rice leaf-beetle has been done, although its injury often surpasses that of all others, as both adults and

larvae devour rice-leaves mercilessly. As the rice leaf-beetle is an old pest and widely distributed over our country, we can enumerate many records of its injuries and general or fragmentary observations, as will be referred to in the next chapter. Several experiments on the controlling measures were conducted by the Imperial Central Agricultural Experiment Station in Tokyo, as well as by the Agricultural Experiment Stations of Fukushima, Gunma, Hiroshima, Hyôgo, Ishikawa, Nagano, Niigata, Shimane, Yamagata, Yamaguchi and many other Prefectures. There are, however, many items needing further researches, especially on the following points, as well as on the experiments on the controlling measures supplementary to those previous works.

1. Identification of the species: The rice leaf-beetle was at first identified as *Lema flavipes* SUFFRIAN, which is undoubtedly a synonym of *L. tristis* HERBST, so the latter name was adopted; but recently another name, *L. melanopa* LINNÉ, has been referred to. However, many ecological characters of our beetle differ very much from the European records of *L. tristis* or *L. melanopa*. Thus a re-examination of the morphological characters and a more precise taxonomic study are quite imperative.

2. Number of generations: The previous records on the number of generations differ from one to three times yearly, not only due to the difference of localities, but also according to the different observers in the same locality. Determination of the number of generations is also a necessary item.

3. Ecological habits: As already stated, there are many obscure passages on the ecology of this beetle. The investigations on this line may throw a light on the consideration of the controlling measures.

4. Surveys on the distribution: The rice leaf-beetle is widely distributed in Japan from Hokkaido to Taiwan and Chosen (Korea), but the injuries done by it are considerably different according to localities. Accurate survey on the distribution may be helpful in determining the original home of this pest.

5. Natural enemies: Up to the present, there are some records on the parasitic Hymenoptera, yet our knowledge in regard to this phase is much inferior to the others. Moreover, there is no record on the predaceans. To control the rice leaf-beetle, the investigation of the natural enemies seems to be the first step.

The serious ravages done by this leaf-beetle in recent times, especially in Hokkaido, have made me carry out somewhat a long and

painstaking investigation. I had this pest under my observation at the Hokkaido Agricultural Experiment Station since 1922, and have tried many experiments along the controlling measures. From my careful examination, I discovered some distinct differences existing between our rice leaf-beetle and *Lema melanopa* of Europe, and *Lema tristis* as well, not only on the morphological characters of the adult, but also on those of the egg and larva. My subsequent study revealed that our species was still undescribed; so I gave it a new name, *Lema oryzae*, in March, 1931. Now, as my studies on the external morphology, taxonomy and some phases of ecology of this pest have nearly done, I proceed to give in the following pages the records of results and discussions.

Before proceeding further, I wish to express my heartiest thanks to Prof. Dr. S. MATSUMURA of the Hokkaido Imperial University, who gave me many helpful suggestions from time to time in the course of this investigation. A grateful acknowledgment is also due to Prof. Dr. T. ESAKI of the Kyushu Imperial University for his kind information and for the loan of several valuable specimens, and to Mr. W. E. H. HODSON of the University of Reading, England, for his kindness in sending me the specimens of *L. melanopa*. To Dr. M. YANO, Assist.-Prof. Dr. T. UCHIDA, Dr. H. KÔNO, Messers. R. TAKAHASHI, J. SONAN and S. MITSUHASHI, I am also indebted in various ways. I must also avail myself of this opportunity to express my hearty thanks to Prof. Dr. S. ITO of the Hokkaido Imperial University, and to Dr. T. ABIKO, Director of the Hokkaido Agricultural Experiment Station, and to the other members in the Experiment Station for their friendly sympathies and assistance, without which it would have been very difficult for me to carry out the work.

II. HISTORICAL SKETCH

It is not certain when our country-men first paid any attention to the economic loss caused by the rice leaf-beetle, but a reference made to this insect appeared as early as 1826, over a century ago, when N. ÔKURA (*72*)[1] issued a remarkable contribution, "Jokôroku", on the controlling measures of the rice-pests. In this paper, he enumerates ten species of "Ina-mushi" or rice-pests. Though the description is very simple, still it is sufficient in enabling us to identify his tenth species "Kogane-mushi", a small shining beetle, with our own rice leaf-beetle.

In 1882, the Industrial Bureau of the Iwate Prefectural Government (*98*)

1) Reference to the bibliography is made by the number in parenthesis.

reported the status of this pest, together with its brief life-history and controlling measures. According to this report, the ravages wrought by the rice leaf-beetle extended all over the rice-fields in Iwate Prefecture. The insect went by the name of "Doroko" or "Katsugi-mushi" among the farmers in that district. N. ÔTSUBO (*77*) of Gifu and Y. SETO (*81*) of Ishikawa published their practical results of controlling this pest, which they called "Doro-mushi", respectively in 1883 and 1884. According to their statements, it is probable that this pest had existed for a long time in those districts.

In 1891, M. ONO (*73*) published a manual of the important insect-pests, and described also the "Doro-oi-mushi". However, according to his description and figure, he seems to have confounded this species with certain other pests. G. OJIMA (*68*) also briefly referred to this pest in his book published in 1892.

In 1896, S. ONUKI (*74*) gave the distribution of the important insect-pests of crops in our country, and stated that the rice leaf-beetle was distributed chiefly in the northern part of Honshu, such as Akita, Yamagata, Iwate, Fukushima, Miyagi, Nagano, Niigata, Ishikawa and Toyama Prefectures, though found also in Tottori, Shimane and Hiroshima Prefectures.

Our knowledge on this pest was greatly extended in 1897. In that year, S. MATSUMURA (*22*) issued a book entitled "Gaichû Kujo Zensho" (Manual of Insect Control), and he identifies the rice leaf-beetle as *Lema flavipes* (SUFF.) among the phytophagous beetles. As far as I am aware of, this is the earliest reference made to the scientific name of this pest. Based on his observations obtained in Nagano Prefecture, C. SASAKI (*78*) published a paper on the life-history. He states that this pest has two generations yearly, and overwinters in the adult-stage, the first appearance of the larva being at the middle of July and the final at the end of September. On the other hand, S. KATÔ (*51*) published a paper on the life-history and controlling measures of this insect in the Ôu district. According to him, there is only one generation per year in that district. The adult appears in rice-nursery from the beginning of May, the eggs deposited being usually hatched from the end of May to the beginning of June. The larva changes to the pupa in the middle and the end of June, and the adult issues in the beginning of July; so the injuries done by it after the transplantation of rice-plant are not severe.

In 1898, S. MATSUMURA (*56*) reported on the status of the principal insect-pests of rice-plant in Hokkaido, enumerating twelve species. According to his investigation the rice leaf-beetle was first discovered at Teine

and Kotoni, near Sapporo, five or six years before that time. Severe injuries were done by this pest also in the previous year at Kameda near Hakodate, and in its vicinity. This beetle produces two or three generations per year. "Nippon Konchûgaku" (Entomology of Japan), an excellent publication by the same author appeared in the same year. It contains also a brief account and figure of this species under the name of "Ine-hamushi" (*Lema flavipes*).

In 1899, two important books on the injurious insects of Japan were furnished by S. MATSUMURA and C. SASAKI. MATSUMURA (*57*) in his "Nippon Gaichû Hen" (Injurious Insects in Japan) recorded this species with text-figures under the name of *Lema flavipes* SUFF. which produces two generations per year in the Sapporo district, and two or three in other infested localities. SAKAKI (*79*) in his "Nippon Nôsakumotsu Gaichû Hen" (Manual of Crop-Pests in Japan) described identical facts in his previous paper (*78*). He used another name *Lema flaviceps* SUFF. and recorded Hokkaido and Nagano, Aomori and Fukushima Prefectures as badly infested districts.

In 1901, Toraji TANAKA (*92*) of the Niigata Agricultural Experiment Station described in detail the rice leaf-beetle, and also its life-history and habits, including the description of a parasitic Chalcid. According to his report this leaf-beetle produces two generations yearly in that Prefecture. The Niigata Agricultural Experiment Station (*122*) added in 1902 one more parasite, which comes under the family of the Ichneumonidae, with a description of adult and fine coloured plate.

In the "Jitsuyô Konchûgaku" (Economic Entomology) published in 1903, S. ONUKI (*75*) followed SASAKI's opinion; and he (*76*) also published in the following year the results of controlling experiments carried out in Yamagata Prefecture. In 1905, I. KUWANA (*52*) regarded this species in his publication. The same year the Yamagata Agricultural Experiment Station (*103*) reported the investigations on three species of the insect-pests of rice-plant, the rice leaf-beetle being one of them. *Lema flavicēps* was adopted as its scientific name, and the number of generations was considered to be twice per year. In 1906, C. ISHIKAWA (*49*) briefly noted this species under the name of *Lema flavipes*.

In his well known "Thousand Insects of Japan", Vol. IV, published in 1907, S. MATSUMURA (*24*) illustrated and described two species of the genus *Lema*, one of which being *Lema flavipes*. The Iwate Agricultural Experiment Station (*99*) stated in 1909 that this pest produces two generations yearly, but the Akita Agricultural Experiment Station (*94, 95*)

reported in 1908 and 1909 the results of the investigations stating that it produces only one generation per year. H. OKAMOTO (*70*) also stated in 1909 that this beetle in Hokkaido has only one generation per year.

In 1910, T. HORI and T. SHIRAKI (*48*) published a general survey on the injurious insects in Taiwan, and in that paper they described the rice leaf-beetle as *Lema flavipes*, which has three generations yearly in that island. In the following year T. SHIRAKI (*83*) also enumerated this species in his "Catalogue Insectorum noxiorum Formosarum".

In 1913, H. OKAMOTO (*71*) published a handbook of the insect-pests in Hokkaido, and dealt with this species which causes severe injuries in the country-sides of Hakodate. He recommended the use of boat-shaped net for the controlling. U. NAWA (*65*) also mentioned this species, referring to *Lema flavipes* as one of the Chrysomelidae in economic importance. In the same year, an excellent paper on this pest was published by J. OKADA (*69*) of the Yamaguchi Agricultural Experiment Station. According to his report, the rice leaf-beetle has occurred in the mountain-districts of that Prefecture for about thirty years, having probably emigrated from Shimane Prefecture, and this has only one generation per year. In this paper, one egg-parasite and three larval parasites were recorded with their characters and percentages of parasitism, illustrated with a coloured plate. In T. SHIRAKI's paper (*84*) published during that year, and also in U. NAWA's paper (*66*) published in 1914, this pest was enumerated, but no new fact was added.

In 1915, T. MURATA (*62*) published a book on the controlling measures of cereal pests. He accepted the name *Lema flavipes* and asserted that it has only one generation yearly. In the same year, S. MATSUMURA (*26*) completed the second volume of his Manual of the Injurious Insects in Japan, and he adopted *Lema tristis* HERBST to the rice leaf-beetle, as *Lema flavipes* is the synonym of the former. He proposed "Ine-doro-hamushi" as its common name in Japan. The number of generations given in his new book accords with his previous paper. Accordingly, the identical name, *Lema tristis*, given to the rice leaf-beetle was used by the same author (*27*) in his Systematic Entomology, Vol. II.

S. TAKAHASHI (*88*), in 1916, stated under the name of *Lema flavipes* that it produces only one generation yearly, and I. KUWANA (*53*), in 1918, maintained the same opinion with regard to the number of generation, while he used the name *Lema flaviceps*. C. SASAKI (*80*) adopted *Lema tristis* to this species in his book published in 1919, but he recognized two generations per year.

In 1922, the Hokkaido Agricultural Experiment Station (*96*) gave a warning on this pest, telling people how rapidly the infested area had spread in recent times. The Shimane Agricultural Experiment Station (*101*, *102*) investigated the life-history, habits, distribution, etc. of the beetle in that Prefecture; and the results of the investigations were published in the annual reports of that Experiment Station for the years 1921 and 1922.

S. TAKAHASHI (*89*), in his Agricultural Entomology published in 1923, described a brief account of this species under the name of *L. flavipes*, and holds an opinion that it has one generation per year. In 1924, Tomitaro TANAKA (*91*) recognized this pest as one of the most serious pests to the rice-culture in Tochigi Prefecture. In 1925, the Kankyô-Hokudo Agricultural Experimental Farm in Chosen (*100*) recorded the severe injury of this pest in the Kainei and Shôjô districts in the northern part of Chosen.

Many important papers appeared in 1926. In January, J. MURATA and T. IKEDA (*59*) published a paper on the rice leaf-beetle in Nagano Prefecture. They stated that this pest has been recognized over eighty years ago in that Prefecture, and there is only one generation per year, hibernation occurring in the adult-stage. They adopted the name *Lema tristis* HERBST. In February, C. SHIMOYAMA (*82*) stated a general account of this beetle in Shimane Prefecture. In August, J. SONAN (*85*) published a paper on the "Taiwan-ichimonji-hamushi" (*Morphosphaera* sp.), a pest of *Ficus retusa*, and he added his notes on the rice leaf-beetle in Taiwan. According to his statement, the rice leaf-beetle has recently been identified by a member of the British Museum on the request of T. SHIRAKI as *Lema melanopa* LINNÉ, which is a destructive pest to oats, barley and wheat in the central Europe, and is not as *Lema tristis* or *L. flavipes*. He also reported that this species produces only one generation in that island, the adult appearing from the beginning of February, the mating and oviposition continuing from that time on to the middle of May, the new adult issuing in about 28 days after the egg-laying, and hibernating under the ground of pasture land in mountain-districts during the end of May and the end of June without mating or deposition of eggs. The previous records that there are three generations in that island were not accepted by him, as fairly attested by the careful investigation done by S. INAMURA. In November of the same year, independent of the SONAN's paper, Hiroharu YUASA (*42*) announced the scientific name of the rice leaf-beetle. After a thorough discussion he insisted on adopting *Lema melanopa* LINNÉ to the species under consideration. In March of the following year the same author (*42*) briefly noted the coincidence of his opinion

with that of SONAN. However, K. YOKOYAMA (*40*) adopted *Lema flavipes* in the "Nippon Dôbutsu Zukan", or the Iconography of the Animals in Japan, published in 1927. In the same year, the Hokkaido Agricultural Experiment Station (*97*) noticed once more the rice leaf-beetle in Hokkaido. In the revised edition of his book published in 1915, referred to in the foregoing lines, T. MURATA (*63*) adopted *Lema melanopa* to this species.

In 1928, J. MURATA and I. SEKIYA (*60*) adopted *Lema melanopa* in their report of the experiments on the controlling measures of this pest. S. TAKAHASHI (*90*) followed them in the same year in adopting *Lema melanopa*. R. NODZU (*67*) published also a paper on the rice leaf-beetle in Shimane Prefecture, with a special reference to the controlling measures. He wrote that this pest had been known from 1887 in a part of the Prefecture and had increased year by year, doing a terrible damage upon crops. He stated also that the generation of this pest occurs only once a year. On the contrary, T. MACHIDA and T. AOYAMA (*55*) recorded this pest from Chosen, recognizing two generations a year under the name *Lema flaviceps*. In November of 1928, I (*54*) published a paper on the principal insect-pests of the rice-plant in Hokkaido, and discussed in detail this pest on its distribution, morphology, ecology, injuries and controlling measures. I adopted the name *Lema melanopus* LINNÉ, following YUASA's opinion.

The Board of Agriculture in the Department of Agriculture and Forestry (*93*) published the second report of surveys on the distribution of the insect-pests and diseases of crops in 1929. According to this report, this pest is distributed widely in Hokkaido, in twenty-two prefectures of Honshu as well as in one prefecture of Kyushu. Adoptation of *Lema flaviceps* in this report is noticeable. In February, J. SONAN (*86*) discussed the relation between the outbreaks of insect-pests and geography in Taiwan. He treated the rice leaf-beetle under the name *Lema* (*Crioceris*) *melanopa* as a local pest, and stated that this pest is distributed only in the submontane districts of the north eastern part of the island, and also in Kashôtô-Island. According to him, this pest in Taiwan has a tendency to distribute from the north to the south, and has only one generation a year. In March, J. MURATA and others (*61*) published a report in regard to their studies on the rice leaf-beetle, but I don't see any improvements on its contents, which are almost identical with the preceding papers published in 1926 and 1928. In May of that year, W. E. H. HODSON (*47*) treated the bionomics of *Lema melanopa* in Great Britain, and he has the following to say on the rice leaf-beetle: "A strange record comes from Japan, by Murata

and Ikeda[10]. *L. melanopa* is reported as damaging rice. The adults feed at the end of May and oviposit in June, after mating. More than a hundred eggs are laid in several masses, and the larvae pupate on the leaves 2-3 weeks after hatching. As all European records indicate that the eggs are laid singly, and that the larvae invariably pupate in the soil, it would appear that the beetle has been wrongly identified. The species referred to may be *Lema tristis*, Herbst."

Two papers by me and Hiro. YUASA appeared at the same time in October, 1929. I (*17*) published a short paper on the scientific name of the rice leaf-beetle in Vol. III, No. 3 of the Kontyû. I expressed my hesitation in identifying it with *Lema melanopa* on account of the differences of food-plants, egg-laying habits, pupating habits, as well as on account of recent radical spreading in Hokkaido. Though I reserved to determine taxonomically, yet I proposed to use *Lema oryzae* when it becomes clear to be an undescribed species. On the contrary, Hiro. YUASA (*43*) published a paper on the difference between our rice leaf-beetle and *Lema melanopa* in the same number of the magazine. After discussing the ecological characters of both species, he stated that the difference of pupating habit can not be adopted as a specific feature, while the difference of food-plants is most important; and that until finer morphological differences between both species be found, he would have to look upon our leaf-beetle provisionally as *Lema melanopa*, or merely to consider it as only a physiological race different from European one. In the same year, S. NAKAYAMA (*64*) discussed also the rice leaf-beetle in his annotated list of more important injurious insects in Chosen. He adopted the old name, *Lema flaviceps*. According to him, this species has one generation a year, and abundantly occurs in the mountain-districts.

In March, 1930, S. MATSUMURA (*28*) published a text-book of Agricultural Entomology, and described the rice leaf-beetle, adopting the name *Lema melanopa*. However, the description on the life-history is the same as those in his previous papers published in 1899 and 1915. In the same month, J. SONAN (*87*) refers to this pest in his Lectures on Crop-Pests, published by the Bureau of Plant Industry, Government of Formosa. The description conforms with his previous papers in 1926 and 1929. Last March I (*18*) gave a brief description of the beetle under the name of *Lema oryzae*, which, I think, should take the cognominal priority to all other names.

The works above mentioned are some of the important publications on the rice leaf-beetle. There is, however, room enough to the students of

this important subject in their faithful and painstaking research.

III. MATERIAL AND METHODS

The majority of the rice leaf-beetle of the present study was collected at Kotoni, a suburb of Sapporo, but some were collected in various localities in Hokkaido, such as Nagayama, Kagura and Itchan in the Province of Ishikari, and Ôno in the Province of Oshima. Besides these Hokkaido products, pretty many specimens were placed at my disposal as listed below:

Sender	Locality collected	Date of collection	Collector	Kind of Specimen 1) Adult	Egg	Larva	Pupa & Cocoon
Aomori Agr. Exp. Sta.	Kuroishi-machi, Prov. Mutsu	9-VI-1930	S. ASAHARA	D.A	—	A	—
Akita Agr. Exp. Sta.	Junisho-machi, Prov. Ugo	21-V-1930	R. TAKEDA	D.A	A	—	—
Yamagata Agr. Exp. Sta.	Yamagata, Prov. Uzen	9-VI-1930	D. TOYOTA	D.A	A	A	—
Niigata Agr. Exp. Sta.	Suyoshi-mura, Prov. Echigo	13-VI-1930	N. TAKAHASHI	D.A	—	A	—
Toyama Agr. Exp. Sta.	Horikawa-mura, Prov. Etchu	12-VI-1930 4-VII-1930	S. IWAYAMA	D.A	A	A	A
Ishikawa Agr. Exp. Sta.	Minma-mura, Prov. Kaga	20-VI-1930	K. KATSUMATA	D.A	A	A	A
Nagano Agr. Exp. Sta.	Kawagishi-mura, Prov. Shinano	—	T. ASANUMA	A	—	A	—
Yamanashi Agr. Exp. Sta.	Hotaru-mura, Prov. Kai	19-VI-1930	T. KANZAWA	A	—	A	A
Yamaguchi Agr. Exp. Sta.	Tokusa-mura, Prov. Nagato	5-VII-1930	Tokusa Agr. Soc.	D.A	A	A	A
Agr. Exp. Sta., Gov. Gen. of Chosen	Tokusen, Heian-nando	3-VII-1930	S. MURAMATSU	A	—	A	—
Dept. of Agr., Gov. Res. Inst. of Formosa	Taihoku, Taiwan	13-IV-1930	J. SONAN	D	—	—	—

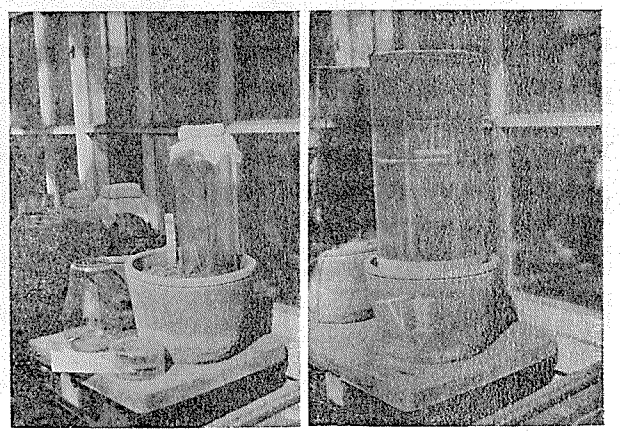
For comparison, I examined the following exotic specimens of *Lema melanopa*.

Sender	Locality collected	Date of Collection	Collector	Kind of Specimen 1) Adult	Egg	Larva	Pupa
Teiso ESAKI	Berlin, Germany	16-VII-1924	T. ESAKI	D	—	—	—
W. E. H. HODSON	Broadclyst, Devon, England	16-VI-1924	W. E. H. HODSON	D.A	A	A	—

1) "D" in the column of the kind of specimen means dried specimens and "A" means alcoholic specimens.

For morphological examination, I used both live and dried specimens, as well as those preserved in the 70 % alcohol. For detail study of fine structure, dissections were made under the PFEIFFER's preparation-microscope by means of fine and sharp needles. When necessary to soften the specimens previous to dissection, they were boiled in the 10 % potassium hydroxide for several minutes, followed by washing in running water and then placed in the glacial acetic acid. After these treatments they were put into the oil of cloves for a few minutes, and then mounted in xylol-balsam or "Euparal" on slide-glass. I examined the details of the structure under the LEITZ's microscope of "G-E" type.

For ecological observations, I made occasional visits to several localities, such as Higashi-Asahigawa and Kagura in the County of Kamikawa, Itchan in the County of Sorachi, and Teine near Sapporo, where the damages done by this beetle were great. For closer observations, I reared the leaf-beetle in a number of some kinds of breeding apparatus placed in a rearing room. I used always porous pot of 25 cm. in diameter and 15 cm. in height, or sometimes of 18 cm. and 15 cm. respectively, and after I filled a wet soil, set out the seedlings or sowed the seeds of rice or other cereals. On rearing, cylinder of wire-screen or glass-cylinder was covered upon the feeding plants. The cylinder of wire-screen is 20 cm. in diameter and 39 cm. in height, covered all over the wall and the top side with a fine mesh screen. One of the glass-cylinder is 10 cm. in diameter and 19 cm. in height, while the other is paper-lantern-shaped and is 12.5 cm. in diameter and 16.5 cm. in height, both covered on the top with a Victoria lawn. In some cases I used a PETRI-dish filled with moist sand, or a test-tube in which rice-leaves were placed.



Text-fig. I

Breeding apparatus used for ecological observations

IV. MORPHOLOGICAL CHARACTERS

1. Adult

(1) General Colouration

The head is shiny black and provided with yellowish white pubescence on the face, the vertex being slightly tinged with blue; the mouth-part is dark yellow in general, but the apices of mandibles dark reddish brown; the labrum, the basal parts of mandibles, the submentum and palpi blackish. The eye is mat black in colour. The antenna is blackish, and is densely covered with grayish yellow pubescence, mixing a few grayish yellow hairs, except the basal two joints, which are shiny dark brown on the upper and dark yellowish brown on the under surface. The prothorax is bright yellowish brown, sometimes changing to reddish brown colour, with the exception of the sternum and the anterior margin that are blackish. The nota of meso- and metathorax are shiny brownish black, but the scutellum is blackish, and the sterna of those are black, being covered with grayish yellow pubescence. The elytra are uniform metallic deep blue or cyaneous in colour, the hind wings are pale brown and the nervures are dark brown, some of them being yellowish. The colouration of legs is similar in three pairs; the coxa is black, the trochanter, femur and tibia are bright brownish yellow, the latter being darkened at the apex and provided with blackish spurs, the tarsus being dark brown, and the claw brownish black; the leg is also covered with grayish yellow pubescence, scarce on the coxa and femur and dense on the tibia and tarsi. The abdomen is shiny brownish black on the tergum and mat black on the sternum, the latter being densely covered with grayish yellow pubescence.

(2) The Dimensions

The rice leaf-beetle is a slender and moderate sized one among the Chrysomelids. There is some difference in shape between both sexes, the male being usually smaller and slenderer than the female. As in other species, this beetle differs widely in dimensions among individuals. I will first record my data on fifty specimens, each of different sex, obtained from various localities in Hokkaido and Honshu in the following table:

Table I—*The dimensions of one hundred specimens of rice leaf-beetle*

No.	♂			♀		
	Length of body	Width of body	Length of antenna	Length of body	Width of body	Length of antenna
	mm.	mm.	mm.	mm.	mm.	mm.
1	4.2	1.6	2.2	4.7	1.8	2.0
2	4.3	1.6	2.0	4.8	1.7	2.2
3	4.4	1.6	2.1	4.8	1.75	2.1
4	4.5	1.65	1.9	4.8	1.8	2.1
5	4.2	1.55	2.1	4.6	1.8	2.0
6	4.5	1.65	2.1	4.8	1.8	2.1
7	4.2	1.6	1.9	4.9	1.8	2.2
8	4.4	1.65	2.0	4.8	1.8	1.9
9	4.1	1.5	1.9	4.9	1.8	2.1
10	4.5	1.6	1.9	4.7	1.8	2.1
11	4.2	1.6	2.2	4.6	1.7	2.0
12	4.3	1.6	1.9	4.6	1.8	?
13	4.4	1.6	2.2	4.6	1.7	2.0
14	4.3	1.5	2.2	4.8	1.8	2.0
15	4.2	1.4	2.1	4.7	1.65	2.1
16	4.1	1.5	1.9	5.0	1.85	1.9
17	4.3	1.6	2.1	4.6	1.7	1.9
18	4.0	1.45	2.2	4.8	1.8	2.1
19	4.6	1.6	2.1	4.6	1.7	2.2
20	4.1	1.5	?	4.9	1.75	2.0
21	4.0	1.5	2.0	4.6	1.75	1.8
22	4.6	1.6	2.2	5.2	1.8	2.1
23	4.2	1.45	2.1	5.1	1.7	2.0
24	4.2	1.55	1.9	4.9	1.7	2.1
25	4.1	1.5	1.9	4.7	1.7	1.9
26	4.2	1.6	2.1	4.6	1.7	2.0
27	4.1	1.5	2.0	4.6	1.7	1.9

No.	♂			♀		
	Length of body	Width of body	Length of antenna	Length of body	Width of body	Length of antenna
	mm.	mm.	mm.	mm.	mm.	mm.
28	4.5	1.6	2.0	5.0	1.8	2.2
29	4.2	1.5	2.0	4.7	1.8	2.0
30	4.1	1.5	2.0	4.9	1.8	2.2
31	4.2	1.45	2.0	5.0	1.8	2.0
32	4.1	1.5	2.0	5.2	1.8	2.25
33	4.2	1.6	1.9	4.7	1.7	2.1
34	4.0	1.5	1.9	4.8	1.75	2.2
35	4.1	1.5	2.0	4.5	1.65	2.0
36	4.2	1.5	2.0	4.6	1.8	2.0
37	3.9	1.45	1.7	4.6	1.7	2.0
38	4.2	1.6	2.0	4.4	1.8	1.9
39	4.4	1.6	1.8	4.5	1.75	1.9
40	4.0	1.5	2.0	4.7	1.8	2.0
41	4.1	1.6	2.0	4.6	1.75	2 0
42	4.3	1.5	1.7	4.5	1.65	1.9
43	4.3	1.65	2.2	4.5	1.7	2.1
44	4.4	1.5	1.9	4.7	1.65	2.0
45	4.1	1.6	1.9	4.5	1.65	1.9
46	4.3	1.5	1.8	5.3	1.7	2.2
47	4.1	1.6	2.0	5.3	1.75	2.1
48	4.2	1.5	2.1	5.0	1.8	2.0
49	4.0	1.5	2.2	4.6	1.7	2.0
50	4.2	1.5	2.1	4.9	1.65	2.0
Average	4.23	1.55	2.01	4.76	1.75	2.04
Maximum	4.6	1.65	2.2	5.3	1.85	2.25
Minimum	3.9	1.4	1.7	4.4	1.65	1.9
Range	0.7	0.25	0.5	0.9	0.2	0.35

As shown in the above table, the variation in the dimensions occurs similarly in both sexes, that is the percentage-ranges of variations between the extremes, as compared with the averages, are 16.5 per cent in the male and 18.9 per cent in the female on the length of body, and 16.1 per cent in the male and 11.4 per cent in the female on the width of body. The size of the female is much larger than that of the opposite sex, being the average-ranges of 0.53 mm. and 0.20 mm. in the length and width respectively. However, the ratio of the length to the width resembles very much between both sexes, as represented by 2.75 : 1 in the male against 2.72 : 1 in the female.

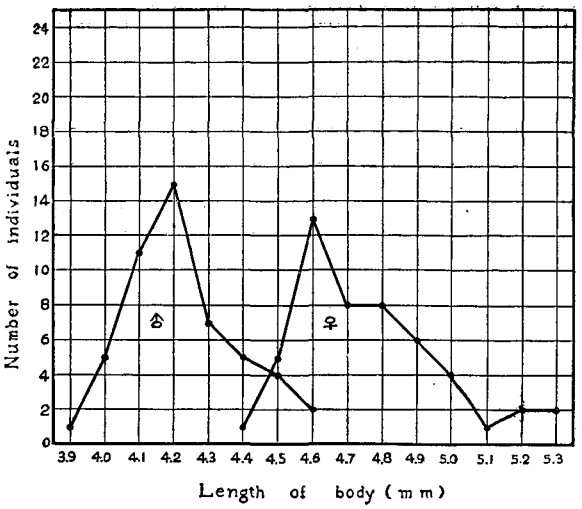


Chart I

Variation in the body-length of the adult

(3) The Structure

The Head [Pl. I-fig. 1] The head of this insect is comparatively small; it is about wide as the prothorax, and is not much elongated or constricted towards the mouth-part, being about 0.95 mm. in width and 0.8 mm. in length. The vertex is often covered by the prothorax, and is smooth with a few very minute punctures, and is not pilose. The frons is slightly raised and impressed with rather a short but distinct longitudinal groove in the middle of the smoother upper part; its lower part is provided with a few coarser punctures and sparse pubescence; on

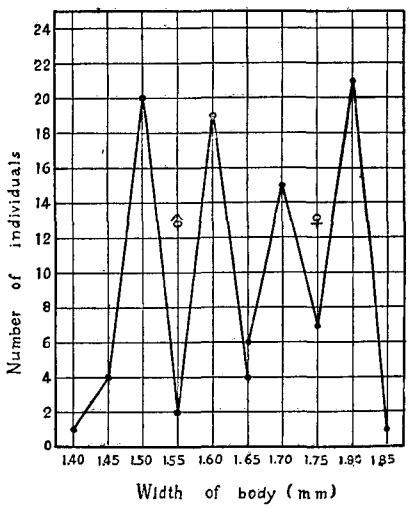


Chart II

Variation in the body-width of the adult

each side of the frons there is a deep hollow along the eye, the lower ends of both hollows being combined at the top of the clypeus. The part between the hollow and the eye is covered with rather dense pubescence. The clypeus is distinct from the frons, triangular in shape, sparsely punctured and is covered with dense pubescence. The genae are not broad and covered with dense pubescence; the temporae or postgenae are well developed and smooth with fine crinkles and sparse punctures; the gula is trapezoid in shape, smoothly polished, and bordered at the temporae by deep gular sutures (Sutura gularis).

Lateral to the frons there is a pair of large hemispherical compound eyes or oculi; the facet of ommatidia are hexagonal as usual and about 0.02 mm. in length; the oculata is narrow around the margin of the eye. Between the eyes, anteriorly from the lower part of the frons, arises a pair of antennae, the bases of which are separated. The antenna is filiform, the length being about 2.0 mm. in the male and 2.1 mm. in the female, and with eleven joints including the scape. The scape is elongated, longer than the third joint but shorter than the fourth, and the broadest among the antennal joints; the pedicel is the shortest and equally wide and long; these basal two joints are smooth and shiny with a few hairs; beyond the pedicel we find nine joints of the flagellum, which are cylindrical with the exception of somewhat cone-shaped terminal one, and each ventro-apical margin of the sixth to terminal joints is dented, thus often making the apical half of the antennae a curve downwards or inwards alive or dead. Each flagellum is provided with about four setae on the distal part, and is coverd with pubescence densely on the whole surface; the interjoint-membrane is brownish in colour, only visible by dissection. The flagella are gradually broadened towards the distal joint; the terminal and fifth joints are the longest of all, followed by the sixth to tenth joints, then the fourth joint which is three-fourths as long as the fifth, and the third joint is the shortest. The following data are average of eight examples of males and four of females measured by me on the specimens from Hokkaido.

Table II—*The measurements of the antennal joints of the rice leaf-beetle*

Joint	♂				♀			
	Length	Width	Ratio of length to width	Length-ratio to the pedicel	Length	Width	Ratio of length to width	Length-ratio to the pedicel
	mm.	mm.			mm.	mm.		
I (Scape)	0.162	0.132	1.23	1.69	0.168	0.141	1.19	1.83
II (Pedicel)	0.096	0.094	1.02	1.00	0.092	0.096	0.96	1.00
III (Flagellum)	0.150	0.095	1.58	1.56	0.160	0.093	1.72	1.74
IV (")	0.174	0.096	1.81	1.81	0.180	0.096	1.88	1.96
V (")	0.233	0.102	2.28	2.43	0.239	0.100	2.39	2.60
VI (")	0.213	0.116	1.84	2.22	0.208	0.110	1.89	2.26
VII (")	0.213	0.121	1.76	2.22	0.214	0.112	1.91	2.33
VIII (")	0.210	0.125	1.68	2.19	0.208	0.113	1.84	2.26
IX (")	0.205	0.120	1.71	2.14	0.208	0.108	1.93	2.26
X (")	0.199	0.125	1.59	2.07	0.208	0.114	1.82	2.26
XI (")	0.234	0.118	1.98	2.44	0.240	0.112	2.14	2.61
Total length	2.091				2.125			

The mouth-part [Pl. I-figs. 2 & 3] is formed typically for biting. The labrum is a distinct and chitinized transverse plate, connected with the lower margin of the clypeus, blackish in colour, with a few short hairs and punctures at the basal side. It is about 0.26 mm. in width and 0.13 mm. in length, and roundly ended at the apical margin with a deep impression in the middle; the inner side is provided with moderate dense pubescence. The mandibles are stout, at the outer margin being convex and at the inner concave, thus making a sharp apex, and there is an obtuse dentation at the middle of the inner margin of the right mandible. The length is about 0.24 mm. and the width at the base is about 0.15 mm. The maxillae are rather complex. Each cardo is an inverted cone in shape, and is apparently articulated to the submentum; the stipes is short and cylindrical, and its upper end leans outwardly and is concave, 0.11 mm. in length and 0.10 mm. in width, provided with a few short hairs; the palpifer is short and narrow, with a few short hairs. The lacinia, or the inner lobe

is composed of its ground-body framed with subgalea, ovoidal in shape, measuring about 0.08 mm. in length and 0.06 mm. in width; the inner margin of the lacinia is decked with beautiful tufts of long hairs of about 0.08 mm. in length, which appear like a brush; the maxillary palpus is very conspicuous and four-jointed; the basal joint is very short, the second and third subequal, the terminal obtuse conical, and as long as the rest of the palpus; the third is provided with a long bristle at the outer apex. The measurements of these joints are as follows:

Table III—*Measurements of the maxillary palpus of the adult*

Joint	Length	Width	Length-ratio to the first joint
	mm.	mm.	
I	0.020	0.042	1
II	0.056	0.064	2.8
III	0.042	0.064	2.1
IV	0.112	0.053	5.6

The submentum is trapezoid in shape, the length being 0.19 mm., the width 0.16 mm. at the upper edge and 0.24 mm. at the lower edge, provided with fine but rather sparse punctures and pubescence; four large punctures along both sides. In the labium, the mentum is well-developed and transverse, with a few punctures; its upper margin is deeply dented and concave; the prementum and palpiger are also developed. The ligula is rather long, its anterior edge being entire, with a shallow depression at the middle, and is fringed with thick hairs, as in the lacinia. The labial palpus is three-jointed, somewhat homologous with the maxillary palpus, the basal one is very short, the terminal very long; the latter joins at the apical part of the inner side of the second, thus giving the palpus a geniculate form. The measurement of the joints are as follows:

Table IV—*Measurements of the labial palpus of the adult*

Joint	Length	Width	Length-ratio to the first joint
	mm.	mm.	
I	0.028	0.048	1
II	0.064	0.039	2.3
III	0.090	0.042	3.2

The Thorax Among the thoracic segments the prothorax is the largest and is freely movable. The prothorax [Pl. I-fig. 5] is subcylindrical, lacking the lateral margins; its length is as long as the width which is subequal to that of the head; it is distinctly constricted just before the base; a perpendicular space occupies the deepest part of the constriction, being provided with deep punctures, a rather conspicuous transverse groove at a short distance in the front of the basal margin; the anterior and posterior margins are parallel; seen from the side both margins draw near towards the venter, thus becoming narrower towards the lower part; pronotum is composed of a single sclerite and scattered with rather coarse punctures, shiny but not pilose; its chitinous shield covers the whole of the dorsal and lateral regions, a distinct pleuron being hardly visible. The pleurosternal sutures are distinct; prosternum is rather small, with close punctures and dense whitish pubescence. The coxal cavities are entire. They are closed behind by a meeting of the epimera, the structures of which are homologous with those of the prosternum; the episternum is narrow. The meso- and metathorax are fused together as in the ordinary feature; they are wide and about 1.7 times as broad as the prothorax; the mesothorax is considerably reduced, while the metathorax is largely developed. We can easily recognize praescutum, scutum, scutellum and postscutellum in the notum of mesothorax. The praescutum is narrow and connected with the scutum perpendicularly; the scutum is large and rather rectangular in shape, about 0.38 mm. in width and 0.24 mm. in length, its anterior margin is concave and the hind margin convex posteriorly, and the median furrow being distinct, the surface shagreen, but not pilose, while the postero-lateral sides are provided with whitish pubescence; the scutellum is subtrigonate and curved upwards at about two-thirds behind, and is provided with moderate coarse punctures and whitish pubescence; its posterior apex is dilated, with a thick, impunctated linguiform attachment, so the apex is angulated; the postscutellum is narrow and sharply pointed at the sides. With exception of the posterior half of scutellum, the entire dorsal surface of mesothorax is covered by the prothorax and elytra. The mesosternum is narrow and trapezoidal, being situated in the front of the large mid coxal cavities which are closed; the meso-episterna are triangular in shape; the sternum and episterna both are closely punctured, with rather long dense pubescence. The meso-epimera are subequal in shape with the episterna and are provided with close punctures but not pilose; the parapteron or anterior wing process is rather small. The notum of the metathorax [Pl. I-fig. 10] is shiny and lacks punctures; the praescutum is a sclerite of

narrow and transverse form, extending all over the whole front of the scutum and scutellum; the scutellum is a sclerite of long and narrow rectangular form, situated at the middle of notum, its apex extending to the postnotum, three longitudinal keels are running on its surface. The scutum, which constitutes the largest portion of metanotum, is quadrate in shape and is divided by the scutellum into two plates, each being slightly elevated at the discal portion; the postnotum or postscutellum is very narrow; the parapteron or posterior wing process is comparatively large. The metanotum is wholly covered by the elytra. The metasternum [Pl. I-fig. 6] is a large subquadrate plate, the middle of the anterior margin is produced and that of the posterior is deeply dented; its median furrow is distinct, but it does not reach to the anterior margin of the sternum; posterior to the sternum we find the hind coxal cavities which are separated; the surface of metasternum is scattered with whitish, tolerably long pubescence and fine punctures; the metapoststernum, if my orientation be correct, is a narrow region of the identical character to the metasternum; at the middle dent of the hind margin of metasternum a pair of stout processes are provided. The meta-episternum is a comparatively large and elongated sclerite, lateral to the metasternum; it is cuneiform in shape, and adjoins to the epimerum by a longitudinal keel, and is covered with close punctures and long pubescence; it is divided into two pieces, respectively prae-episternum and post-episternum, the former is triangular and the latter subrectangular in shape. The meta-epimeron is elongate, being provided with punctures and pubescence as in the episternum. The thoracic spiracles are elliptical in shape, and are larger than the abdominal spiracles.

The elytra [Pl. I-fig. 7], the highly modified fore wings, are elongate and wholly cover the abdomen, and the surface is convex, somewhat thinner compared with that of *Lema melanopa*, shining but not pilose; both sides are parallel and roundly ended at the apex; the elytral suture is straight; near the base and across the suture, there is a transverse depression, which is shallow and ill-defined; the shoulders are angulated and obliquely notched; the surface is deeply impressed with regularly striated punctures set in about eleven rows on each elytron, while the shoulders are impunctate; the punctures are large except those in the basal space adjoining the shoulder; besides these striated punctures, the surface of elytron is scattered with shallow and minute punctures. The number of the striated punctures in each row is not constant, not only among the individuals but even in both elytra of one individual. I examined ten elytra in calculating the number of the punctation, and the data are tabulated in

the following table.

Table V—*Number of the striated punctures in each elytron*

Row from the inner side	Maximum	Minimum	Average
I	10	7	7.8
II	41	30	34.4
III	37	31	33.0
IV	40	29	32.9
V	34	26	29.9
VI	34	26	30.2
VII	34	27	30.4
VIII	34	26	29.5
IX	35	27	31.1
X	41	34	35.8
XI	41	32	36.4

Laterally seen, the edge of the elytron is slightly concave at the middle, and the epipleuron is very narrow and indistinct, slightly projected below the shoulder, and gradually tapers towards the apical portion. The ratio of the length to the width in each elytron is about 3.1 : 1, being similar in both sexes. The data examined are as follows:

Table VI—*The length and width of the elytron*

Sex	Number of examination	Length			Width			Ratio
		Max.	Min.	Average	Max.	Min.	Average	
		mm.	mm.	mm.	mm.	mm.	mm.	
♀	4	3.60	3.50	3.55	1.15	1.15	1.15	3.09 : 1
♂	10	3.35	3.25	3.28	1.15	0.95	1.04	3.15 : 1

The wings [Pl. I–fig. 11], or the hind wings, are large, membranous and folded beneath the elytra, as in the ordinary feature. They are elongate and

somewhat fan-shaped, hyaline, but slightly darkened with a brownish tint and are densely provided with fine cilia all over the surface; the marginal fringe is very short and colourless; the apex is bluntly pointed and the hind margin is slightly dented at the terminals of nervures. Each wing measures about 4.5 mm. in length and 1.9 mm. in width, and the nervures are well modified. The costa lies along the costal edge of the wing extending as long as the basal half of the costal margin; the subcosta is easily recognizable as a concave nervure, fusing with the costa at the basal and distal portions. The third nervure from the costal edge is a well developed and curved radius, and terminates at the five-ninths basad of the costal margin. The above three nervures are closely crowded at the base of the costal margin of the wing and form the principal articulation with the posterior wing-process, from which the wing rises. The marginal portion of the wing in the neighborhood of the apical parts of the subcosta and radius is thickened, also the nervure is obese itself, and forms the pterostigma. Near the base of wing the arculus is distinct, and to the radius a faint nervure is parallel. The basal part of the radial sector is atrophied, leaving the outer part as a backward-projection which is called as the central recurrent; the subrectangular central cell is formed beyond the apical part of the radial stem by two radial cross-veins; beyond the outer corner of the cell a short portion of the radial sector appears also like a detached dot. The second radio-medial cross-vein swings into the basal atrophied portion of the radial sector; about the half of the first radio-medial cross-vein is provided with a long process on the outer side, and the lower portion of the cross-vein is faint. The basal part of media fades out, leaving the main part of it; the apex curves downwards, fusing to the cubitus, and is known as the medial recurrent. The first media which fades out at the basal and apical portions, is only a representative in the nearly veinless apical region. The cubitus is strongly developed, running obliquely towards the outer margin and its terminal portion curves upwards; the medio-cubital cross-vein is smoothly connected with the curved apical portions of the media and cubitus; from the centre of this fused portion a straight and apically atrophied nervure, which is known as the fusion of the fourth media and cubitus, runs. The anal region is quite simple, only two distinct anal nervures being present. These may be identified as the second and third branches of the second anal; the second branch is simple and atrophied at the basal half, while the third branch is fully developed but curved upwards basad, and is associated with the third anal, which is rather fine and fused at the apical one-third of the

former anal branch.

The legs [Pl. I–fig. 14] are long and stout, adapted for walking. There is no distinct difference in structure between the fore, middle and hind legs; the hind leg is the longest and the fore leg is the shortest of all in both sexes; no distinct sexual difference in structure is traceable, except the larger sizes in three pairs of the female than those of the male in the dimension of their bodies. The length and width of the leg-segments measured are shown in the following table.

Table VII—*Length of the leg-segments of the adult*

Segment	♂			♀		
	Fore leg	Middle leg	Hind leg	Fore leg	Middle leg	Hind leg
	mm.	mm.	mm.	mm.	mm.	mm.
Coxa	0.372	0.384	0.600	0.368	0.448	0.741
Trochanter	0.164	0.168	0.160	0.176	0.168	0.168
Femur	0.896	0.952	1.024	0.928	1.008	1.093
Tibia	0.840	0.884	0.896	0.901	0.960	0.976
Tarsus	0.752	0.776	0.792	0.760	0.843	0.869
1st joint	0.236	0.240	0.252	0.229	0.256	0.272
2nd joint	0.156	0.164	0.164	0.160	0.187	0.155
3rd joint	0.196	0.175	0.192	0.208	0.213	0.208
4th joint	0.092	0.096	0.088	0.080	0.096	0.096
5th joint	0.260	0.304	0.296	0.296	0.325	0.331
Claws	0.116	0.132	0.132	0.120	0.155	0.144
Total	2.976	3.128	3.444	3.077	3.414	3.823

Note: Average of three individuals of each sex. Measured from the lateral aspect.

Table VIII—*Largest width of leg-segments of the adult*

Segment	♂			♀		
	Fore leg	Middle leg	Hind leg	Fore leg	Middle leg	Hind leg
	mm.	mm.	mm.	mm.	mm.	mm.
Coxa	0.300	0.320	0.268	0.288	0.325	0.267
Trochanter	0.124	0.154	0.140	0.128	0.144	0.144

Segment	♂			♀		
	Fore leg	Middle leg	Hind leg	Fore leg	Middle leg	Hind leg
	mm.	mm.	mm.	mm.	mm.	mm.
Femur	0.284	0.304	0.318	0.309	0.336	0.325
Tibia	0.148	0.156	0.156	0.155	0.165	0.165
1st tarsal joint	0.120	0.104	0.104	0.117	0.096	0.101
2nd tarsal joint	0.120	0.108	0.116	0.128	0.101	0.117
3rd tarsal joint	0.084	0.080	0.080	0.075	0.091	0.085
4th tarsal joint	0.060	0.060	0.061	0.048	0.053	0.072
5th tarsal joint	0.080	0.080	0.080	0.092	0.093	0.091
Claws	0.048	0.064	0.064	0.056	0.064	0.069

Note: The same as in the Table VII.

The legs are composed of the typical segments. The proximal segment or coxa is movable, globular in the fore and middle legs, and semi-cylindrical in the hind leg. The outer surface of each coxa is provided with fine punctures and moderately dense pubescence; the distal end of coxa possesses a pair of well chitinized coilae, and the trochanter is attached between the coilae to the coxa by a coria, the trochacoria. The trochanter is short, subtriangular in outline, and bears a few hairs on its distal region. The femur is the longest and the broadest of segments, spindle-shaped, being attained the broadest width at the middle, and bears moderately dense pubescence on the entire surface. The femacoria is reduced to an oblique immovable femasuture between well chitinized margins of the trochanter and the femur. The distal end of the femur is thickly chitinized and dilated into a flange-shaped fematroclia and blunt tibiartis, the tibia-flexis being inserted into the former. The tibia is also very long but slightly shorter and much slenderer than the femur, gradually dilating towards the distal end. The proximal portion of the tibia is acutely curved and dilated into a broad tibiacoria, which together with the tibia is articulated to the femur. The tibia is covered with many fine hairs, markedly longer and more denser on the ventro-distal part. At the ventro-distal end, two subequal, stout calcaria or tibial spurs, which are slightly curved inwardly and about 0.056 mm. in length, are provided. Along the lateral margins of the distal end of the tibia appears a series of about eight spine-like setae. The tarsus is five-jointed and covered with fine hairs and pubescence,

except the hidden fourth joint, which is polished; the ventral surface of the third joint is densely pubescent like a carpet. The third joint is bilobed and receives the minute fourth joint at its base, so that the fourth joint and the proximal part of the fifth joint are buried between the two lobes of the third joint. The fourth and fifth joints are anchylosed, the former being very small. The fifth joint is the longest of all, slender, slightly curved and broadened. It is followed in length by the first joint and then the third and second, but the first and second are much dilated distad, and each lobe of the third is flattened. The first joint of the tarsus, or the basitarsus, is articulated to the tibia by an insertion of the broad flexis into a cavity of the well chitinized tibiatroclia. The claws are very heavily chitinized, curved ventrad and sharply pointed, simple, much longer than the fourth tarsal joint, the basal parts joining with one another.

The Abdomen In the abdomen, seven tergites and five sternites, subcylindrical in shape, and roundly terminated at the apex, are clearly visible, but the so-called pygidium is not exposed. The sternites [Pl. I-figs. 12, 13; Pl. II-fig. 9] are heavily chitinized and provided closely with fine punctures, and are covered with dense pubescence. The first visible sternum which is really the third, is much larger than the others, and its proximal margin is much concave; from the centre of that sternum a large triangular intercoxal process is protruded; the first and second sterna known as the sclerites of coxal furrow, are crescent in shape, without punctures, and perpendicularly situated anterior to the third. The fourth, fifth and sixth sterna are of a transverse rectangular form tapering posteriorly in width. The seventh or terminal sternum is a transverse oval form and much narrower in width than the preceding sternum. The difference in the shape of this sclerite between both sexes is scarcely recognizable. The intersternal membrane is smooth, pale brown in colour and does not show any marking.

The measurements of the abdominal sterna are tabulated in the following table:

Table IX—*Size of the abdominal sterna of the adult*

Abdominal sternum	♂		♀	
	Width	Length	Width	Length
	mm.	mm.	mm.	mm.
3rd sternum	1.75	0.70	1.88	0.85
4th sternum	1.80	0.28	1.88	0.33

Abdominal sternum	♂		♀	
	Width	Length	Width	Length
	mm.	mm.	mm.	mm.
5th sternum	1.64	0.25	1.73	0.30
6th sternum	1.45	0.27	1.48	0.30
7th sternum	1.08	0.37	1.15	0.40

Note: Measured on the largest portion of the sternum.

The tergites [Pl. I-fig. 9], except the basal and the terminal ones, are transverse rectangular in shape, uniformly polished, subchitinous, scattered with a very few short hairs, and fringed with dense fine golden hairs along the hind margins. The first tergite is more membranous, with two pairs of transverse chitinous plates of the homogeneous character with those of other tergites. The seventh and eighth tergites are semicircular in shape, long, harder in texture than the other terga, the former tergite covering the latter in a lingual shape; the apex of the former slightly protrudes than the terminal margin of the latter; at the centre of the proximal part of the seventh tergite, there are two adjoined dark reddish oval regions finely wrinkled transversly but not pilose; the other part is provided only with fine pubescence, while the distal part is densely clothed with long hairs. The pleural membrane is light smoky in colour; the abdominal spiracles are oval in shape, and well defined by the chitinous rings.

The genitalia of both sexes are withdrawn deeply into the abdomen and concealed. Among the male genital organs [Pl. II-fig. 2], the penis is spatulate in shape, glossy yellow, and well chitinized, with a few fine punctures. Seen laterally, the lower margin is straight, while the upper margin is convex, sharply pointing at the apex; an oval apical opening is situated at the dorso-distal part. At the distal one-third of each lateral fold, there is a conspicuous S-shaped reddish brown marking. The average measurement of the ten individuals is 0.824 mm. in length and 0.243 mm. in height. The eighth sternite is comparatively large, separated in two sections, and is clothed with fine hairs along the distal margin, and forms so-called genital plate.

In the female genitalia [Pl. II-fig. 1], the eighth sternite or genital plate is solid and reddish brown, and is divided longitudinally into two sections; it has fine hairs along the posterior margin, and is fused with the ninth tergite, which is clearly shown by the chitinous rod or apodeme. At the centre of the posterior margin of the eighth tergite, its chitinous plate

which is clothed with hairs, is interrupted. The broad ovipositor is soft, and is provided at its apex with a pair of genital palpi. The genital palpus is a short dark brownish chitinous rod of about 0.16 mm. in length, 0.10 mm. in width and 0.06 mm. in height, provided with whitish hairs densely at the apex.

2. Egg

The Colouration The colour of the egg varies with the age of the embryo. Immediately after oviposition it is shiny yellow, soon darkening to brown, two or three days later it changes to brownish black until the time of its hatching.

The Size The length and width of the egg also vary considerably among individuals. The following table shows the result of the measurements of fifty eggs collected in various localities of Hokkaido and Yamagata, Ishikawa, Toyama and Yamaguchi Prefectures.

Table X—*Length and width of the egg of the rice leaf-beetle*

No.	Length	Width near narrow end	Width near broad end	No.	Length	Width near narrow end	Width near broad end
	mm.	mm.	mm.		mm.	mm.	mm.
1	0.775	0.325	0.375	15	0.800	0.350	0.425
2	0.775	0.300	0.350	16	0.800	0.325	0.400
3	0.750	0.300	0.350	17	0.825	0.350	0.425
4	0.750	0.325	0.350	18	0.800	0.350	0.400
5	0.800	0.350	0.400	19	0.800	0.350	0.450
6	0.800	0.350	0.400	20	0.800	0.350	0.425
7	0.750	0.325	0.350	21	0.825	0.375	0.450
8	0.800	0.275	0.350	22	0.800	0.350	0.400
9	0.750	0.300	0.350	23	0.800	0.350	0.425
10	0.750	0.300	0.350	24	0.850	0.375	0.450
11	0.825	0.350	0.400	25	0.800	0.400	0.450
12	0.825	0.350	0.400	26	0.850	0.350	0.375
13	0.825	0.350	0.400	27	0.850	0.350	0.400
14	0.850	0.350	0.400	28	0.800	0.350	0.425

No.	Length	Width near narrow end	Width near broad end	No.	Length	Width near narrow end	Width near broad end
	mm.	mm.	mm.		mm.	mm.	mm.
29	0.850	0.350	0.425	40	0.850	0.350	0.400
30	0.850	0.425	0.425	41	0.800	0.350	0.400
31	0.800	0.350	0.400	42	0.825	0.350	0.425
32	0.775	0.375	0.375	43	0.850	0.400	0.450
33	0.800	0.325	0.400	44	0.875	0.375	0.425
34	0.750	0.350	0.400	45	0.800	0.350	0.400
35	0.800	0.325	0.375	46	0.775	0.350	0.400
36	0.875	0.325	0.400	47	0.800	0.325	0.400
37	0.800	0.325	0.400	48	0.800	0.350	0.425
38	0.800	0.350	0.450	49	0.850	0.325	0.400
39	0.850	0.350	0.450	50	0.800	0.375	0.450
				Average	0.807	0.346	0.404
				Maximum	0.875	0.425	0.450
				Minimum	0.750	0.275	0.350
				Range	0.125	0.150	0.100

As is seen in the preceding table, the range between the maximum and the mininum is quite wide, representing 15.5 per cent in the length, 43.4 per cent in the width near narrow end and 24.8 per cent in that of near broad end, as compared with the averages. In a word, the width is more variable than the length. These variations may probably be due to the conditions of the oviposited places.

The Shape [Pl. II–fig. 4a] The egg is elongate ovoid in shape, rounded at the narrow end and somewhat angulated at the broad end. The length is about twice as much as the broadest width. It is covered with a glutinous secretion, which hardens on contact with air. The chorion is rather thick, and it does not show any marking or crinkle on the surface.

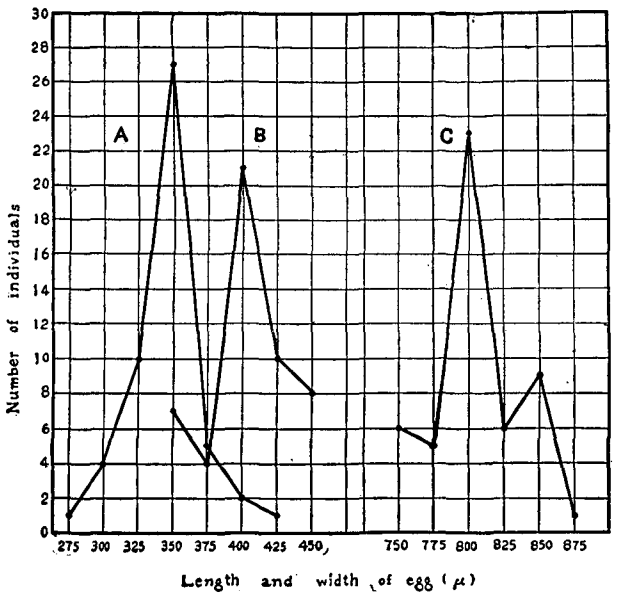


Chart III

Variation in the size of egg

Curve A
Width near narrow end

Curve B
Width near broad end

Curve C
Length

3. Larva

(1) Colour Description of Full-Grown Larva

The head is shiny black with a brownish tint, though paler on the lower half of the frons; around the neck, from the occiput to the antennal portions, there is a light yellowish band, the margins of which are irregular but well defined. The head is provided with brownish long setae; the eyes are yellowish; the mouth-part is generally blackish with reddish brown apices of mandibles and yellowish brown submental lobe. The body is pale bright yellow, but on account of minute brownish cuticular nodules and minute setaceous hairs covering the integument, it has assumed a dirty yellowish colour. The prothoracal shield, tubercles, spiracles and primary setae are brown; some dark brownish spots are scattered over the shield. The chitinous portions at the base of the articles of the thoracic legs are blackish; the proximal part of the first article, greater distal part of the second and whole of the third are coloured with brown, some brownish coloured portions resulting from the cloud of spots; the claws are yellowish brown.

(2) The Structure of Full-Grown Larva

The full-grown larva is eruciform and spindle-shaped, the fourth abdominal segment being the largest and gradually tapering towards the fore and hinder parts. The head is rather flat; the body is much flattened ventrad and conspicuously arched dorsad. It averages 4.7 mm. in the body-length, 2.1 mm. in the extreme width and 2.3 mm. in the extreme height.

The head [Pl. II-figs. 6 & 7] is directed obliquely forward and downward, strongly chitinized. The cranium is narrower than the prothorax, its extreme width in comparison with the extreme width of the prothorax being 2 : 3; when removed it is as broad as long, not including the mandibles; narrower in front than at the middle. The surface is polished but slightly wrinkled. The frons is obtuse triangular in shape, wider than long, the proportion of width to length being about 3 : 2; the sutural margins are distinctly limited but a little sinuate, the sutures of both sides being slightly convex at the anterior half and slightly concave at the posterior half, the posterior frontal angle obtuse. In the frons, there are two parallel rows of minute tubercular lines from the apex to the proximal one-fourth. Near the anterior margin of the frons there are four setae; two are exteriorly placed between the articulation of mandible and the base of antenna, the others are interiorly placed; outside the interior marginal setae two frontal punctures are situated; behind the interior marginal setae and towards the middle of frontal sutures there are two setae; we also find near the posterior angle two setae. The epistoma is represented by the thickened anterior margin of the frons, with which it is fused; it is dark in colour, with the anterior margin nearly straight, and the lateral angles slightly produced and elevated where they support the dorsal articulation of the mandibles. The epicranial suture is rather long, and the proportion of it to the length of frons being 1 : 1.1; epicranial setae consist of three setae of posterior group, two setae of anterior group, one seta of ocellar group and two setae of lateral group in each epicranium, and the epicranial punctures are represented by one in each the posterior and lateral groups. The clypeus is about seven times as wide as long, trapezoidal, with four setae near the proximal margin. The antennae are rather short, conical, apparently three-jointed, the basal joint is the largest in diameter, seven times as wide as long, with some tubercular processes around the joint; the second joint is narrower in diameter but longer in height than the basal joint, about three times as wide as long, with four conical processes on the apical surface; the apical joint is situated on the side of the apical

surface of the preceding joint, conical in shape and nearly colourless, the proportion of the basal width to length being 1 : 2. The occipital foramen is very large and round; the gena is well developed and with one seta near the base. Four round and elevated eyes or ocelli are situated at the base of the epicranium, and arranged in semicircular shape. The labrum is trapezoidal in shape, about two and a half times as wide as long at the proximal portion, the width is much narrower than the clypeus, while the length is twice as long as the clypeus; at the middle of the anterior margin with a deep cleft, and between this cleft and the apical angles three notches are engraved at the margin; two rather shorter setae are placed close the anterior angle and the other two near the lateral margin. The mandibles are rather stout, triangular, with five teeth in two series on the anterior half of the upper and lower edges of the inner side; the apical tooth is larger than the others and acute, the subapical two and the third or median two teeth obtuse; the basal or molar teeth are not represented. The lateral area of the mandible has an impression and two long hairs. The maxillae are much complex and longer than broad; the cardo is distinct and transversely triangular, much chitinized; the stipes is long and rectangular; the palpifer is transverse and distinctly articulated; the lacinia interna is spoon-shaped and as long as the stipes, but much slenderer; the lacinia externa is well developed, bluntly pointed at the apex, and the inner face is armed with a number of stout lacinial setae; the maxillary palpi are three-jointed, conical in shape, gradually tapering towards the distal joints, while the lengths are subequal one with the other, and bluntly pointed at the apex of the terminal which is provided with a few sensory processes, each joint being provided with one or two setae on the side. The labium, in ventral aspect, has a large, membranous submental lobe, attached to and contiguous to the integument of the prothoracic sterna and laterally to that of the maxilla. The mentum is represented by a median semicircular chitinous plate and provided with two long setae on the inner disc; the mentum, palpiger and ligula are fused, and the labial palpi are short, conical, and only one-jointed, with a few sensory processes; the inner part of the ligula is membranous and contiguous with the pharynx.

The thorax [Pl. II-fig. 6] and abdomen are distinct, the former being composed of three segments, each bearing a pair of jointed legs, and the latter composed of ten segments, the last representing only the anal lobes. Except the dorsal plate of the prothorax and the tenth abdominal segment, the body-wall is beset densely with brownish cuticular nodules; behind the posterior half of the metathorax to the ninth abdominal segment, each

nodule is provided with a short curved setaceous hair with the exception of those on the ventral sclerites [see Pl. II-fig. 8]. These setaceous hair are no doubt convenient to cover the excreta over the body.

The prothorax is modified dorsally into a strongly chitinized prothoracal or cervical shield, which is rectangulur in shape and divided into two lateral parts by the dorso-median line. Each plate of the shield is scattered with many dark brownish spots; five prominent setae are arranged along the anterior margin and the three along the posterior margin, each seta being sprouted from a brownish round small tubercle. From these setal arrangement, it is recognizable that the shield is formed by the fusion of tubercles I to VIII. Ventro-lateral tubercle, which bears two prominent setae and formed by the fusion of IX and X, is large and transverse. The round tubercles XI and XII, each bearing one seta as in the other thoracic segments, are associated with the base of the leg; the ventral tubercle XIII is small, and possesses a short seta.

The meso- and meta-thorax are exactly like each other, on the former segment a spiracle is present above the anterior ventro-lateral tubercle (IX). There is one dorsal suture on each segment; on each side behind this suture five setae, which are represented dorsal and dorso-lateral tubercles, are arranged in a line, the tubercles becoming gradually smaller towards the upper, and the first dorsal one being non-chitinized and setiferous only. The large lateral tubercle bears three large setae, which may be interpreted as a fusion of tubercles VI, VII and VIII; a round anterior and a round posterior ventro-lateral tubercles, IX and X respectively, each bears a large seta; an anterior and a posterior basal tubercles, XI and XII, are associated with the base of the leg, the former being weakly chitinized and with a short seta, the latter bearing one large seta; an anterior and a posterior ventral tubercles, XIII and XIV respectively, are both on the venter, the former being very small, and only setiferous, while the latter is large and has two setae. The mesothoracic spiracle [Pl. II-fig. 8] is comparatively large, slightly raised with a well chitinized margin, the ring is ovoidal in shape and at its upper margin has two unequal tubercular processes.

The legs are similar in three pairs and each composed of five joints; conical in shape, gradually tapering towards the apical joints. The proximal and second joints fit closely into a socket formed by an infolded body-wall with which they are continuous, and provided with several setae, thus it is hard to recognize these joints from the outer side. The third joint or the apparent first article is large and less chitinized, with two long

setae on the outer side, while it is margined at the anterior and posterior proximal portions with chitinous ring-shaped plate hoisted at the outer side. The fourth joint is chitinized, cylindrical in shape, with two setae at the externo-distal portion and more than five at the inner side. The distal joint is short, strongly chitinized, provided with two long setae at the externo-proximal portion and the four at the apical margin, and bears a single inwardly curved claw and one sensory process situated at the inner apical side.

The abdominal segments, from the first to the seventh, have the identical arrangement of setiferous tubercles and one dorsal suture. An anterior dorsal (I) and an anterior dorso-lateral (III) tubercles are situated before the suture, the latter being non-chitinized and setiferous; a posterior dorsal (II) and two dorso-lateral (IV and VI) are arranged in one series, similar in shape, each with a long seta; two lateral tubercles (VII and VIII) are situated obliquely near each other; the ventro-lateral tubercles are composed of three isolated ones around the spiracles, the one being situated above and the others behind; a basal tubercle is situated far below the spiracle, lacking the ventral tubercles. The eighth abdominal segment is similar to the ones above mentioned, but the arrangement of the setiferous tubercles is slightly modified. The ninth abdominal segment is not modified into an anal shield dorsally, and bears six setae on each side. The tenth abdominal segment is very small, having no tubercles nor setae, but with an anal process. There are eight pairs of the abdominal spiracles, borne just below the tubercle IX on the first eight abdominal segments; they are homogeneous with the thoracic spiracles, but rather smaller except the pair of the first abdominal segment, the size of which is apparently similar to that of the thoracic one.

(3) Description of the Newly Hatched Larva and the Change during Growth

The newly hatched larva has a similar colouration to that of the full-grown larva in general. However, the head is entirely blackish, with no yellowish band around the neck; and the distal three joints of thoracic legs are almost brownish black, without markings; and the prothoracal shield is entirely brownish. The arrangements of setae and tubercles are apparently the same, but a little closer; the head being comparatively large. The inner teeth of mandibles, as well as the apical one are rather sharp. The colouration above mentioned is also the same in the second and third instars.

4. Pupa and Cocoon

(1) Pupa

The Colouration The pupa is bright yellow in colour when first formed. After a few days, the colour of wing-pad changes to a deep yellow, while the other parts change to rather a light yellow. On the eve of emergence the eyes become brownish black in colour and the apices of mandibles are tinged with reddish brown. At this time the dorsal parts of abdomen change also to dark colour.

The Dimensions The size and shape of the pupae differ according to their future sexes. The data of the length and the width measured are as follows:

Table XI—*The length and the width of the pupa of the rice leaf-beetle*

No.	♂		♀	
	Length of body	Width of body	Length of body	Width of body
	mm.	mm.	mm.	mm.
1	3.6	2.1	4.4	2.4
2	3.8	2.1	4.6	2.1
3	3 9	1.8	5.0	2.3
4	3.9	2.0	4.2	2.1
	4.0	2.1	4.4	2.0
6	4.0	2.3	4.4	2.3
7			4.2	2.2
8			4.4	2.2
9			4.5	2.2
10			4.2	2.0
Average	3.87	2.07	4.43	2.18
Maximum	4.0	2.3	5.0	2.4
Minimum	3.6	1.8	4.2	2.0
Range	0.4	0.5	0.8	0.4

As is seen in the above table, the pupa to be transformed into the female is larger and more elongate than that of the male. The ratio of

the length and the width is 2.03 : 1 in the female and 1.82 : 1 in the male.

The Structure The pupa of the rice leaf-beetle is typical "pupa libera", enveloped in a thin transparent membrane. It is spindle-shaped, somewhat flattened at the ventral surface and slightly convex at the dorsal surface. The head is bent ventrad; three thoracic segments are distinct; eight abdominal segments in addition to the anal plate are visible. The wing-sheaths cover the ventro-lateral sides of abdomen, and their rather sharp apices are extended to the middle of the fifth abdominal segment in the female, and to the distal end of the sixth in the male. The body is nude, almost wanting the setae on the surface. The head is rather small but produced. On the vertex there are two oblique protuberances; the eye-portions are also raised. The antennal sheaths are long and curved dorsally, the apices being extended to the proximal one-third of the elytral sheaths, and the jointed rings distinct. The clypeal portion is transverse, while the labrum is semicircular and dented at the centre of the free margin. The mandibles are rather long and stout, situated at the lateral sides of the mouth-part, the apices are separated widely; the other portions of the mouth-part, such as, maxillary palpi, labial palpi, glossa, etc., are visible behind the mandibles, the apices of them being not longer than the apices of the latter. The prothorax is semicylindrical dorsad, with a transverse furrow dorso-basad and a small tubercle near the centre of dorso-posterior margin; the anterior margin extends around the vertex, and is provided with a pair of tubercles at the middle. The apex of the hind tarsus is slightly protruded beyond the apex of the wing-sheath. The fore and middle legs are exposed over the wing-sheath, both being subequal, and the femora and tibiae are transversely parallel; the hind legs are under the wing-sheath, and the tarsi which situated ventrad between the wing-sheaths are only visible. Both anterior and posterior wing-sheaths are similar in shape and size, making the apices of uniform length. Several rows of longitudinal stripes are visible on the elytral-sheath. The mesonotum is quadrate in shape, the larger part being represented by the mesoscutum, and near the centre of the posterior margin there is a prominent tubercular process which is undoubtedly the mesoscutellum. The metanotum is much larger than the mesonotum, transverse and rectangular in shape, but the posterior margin is somewhat dilated at the centre. The metascutellum is recognizable as a central longitudinal deep furrow which extends the entire length of the notum. The lateral sclerite, divided by the metascutellum, is separated by a suture into two portions, that is, rather

smaller metapraescutum and larger metascutum. The abdomen is subcylindrical, and the segments are homogeneous and gradually taper towards the apex; a dark dorso-longitudinal line is visible. The abdominal spiracles are rather small and semicircular. The eighth segment bears a pair of inwardly curved caudal spines.

(2) Cocoon

The Form and Colour The cocoon is ellipsoidal in shape, and when it is formed on the surface of leaf, the side sticking is more or less flattened. It is compact but fragile in texture and is whitish in colour, sometimes being slightly tinged with a dull yellow or a pale brown. The outer surface of cocoon is not smooth, and we see frequently many tubercular processes over it, while the inner surface is entirely smooth.

The Size The size of the cocoon is variable among individuals. I examined fifty cocoons stuck to the rice-leaves, and the results are tabulated below:

Table XII—*Variation in the size of cocoons of the rice leaf-beetle*

No.	Length	Width	Height	No.	Length	Width	Height
	mm.	mm.	mm.		mm.	mm.	mm.
1	5.5	2.3	1.5	15	5.0	3.0	2.5
2	5.5	3.0	2.0	16	5.0	3.0	1.9
3	5.0	3.5	2.3	17	5.0	3.0	1.8
4	5.5	2.5	2.0	18	5.5	3.2	1.8
5	5.5	3.5	2.2	19	5.0	3.8	2.2
6	6.5	2.2	2.2	20	5.3	3.0	2.4
7	5.0	3.7	1.7	21	5.0	2.8	2.4
8	5.5	3.0	2.0	22	5.7	2.5	2.7
9	6.0	3.5	2.0	23	5.5	3.0	2.6
10	4.8	2.4	1.7	24	5.0	3.3	2.3
11	5.7	3.5	1.9	25	6.0	2.8	2.0
12	7.0	2.8	1.9	26	4.7	3.0	2.2
13	5.0	2.7	2.0	27	5.3	3.7	2.4
14	5.5	2.8	2.1	28	5.0	2.7	2.1

No.	Length	Width	Height	No.	Length	Width	Height
	mm.	mm.	mm.		mm.	mm.	mm.
29	4.5	2.5	2.2	40	4.7	2.5	2.2
30	5.5	2.5	2.5	41	6.5	2.5	1.9
31	5.0	3.0	2.5	42	7.0	2.8	1.8
32	4.7	2.7	2.1	43	6.0	3.2	2.0
33	5.0	2.5	1.9	44	6.0	2.5	1.7
34	5.5	3.0	2.3	45	5.7	3.2	2.1
35	5.2	2.8	2.2	46	4.7	2.4	1.9
36	5.0	3.0	2.1	47	5.5	2.5	1.7
37	5.0	3.0	2.2	48	5.7	3.2	1.9
38	5.2	2.3	2.0	49	4.5	2.7	2.0
39	4.3	2.7	2.3	50	5.0	2.5	2.4
				Average	5.34	2.88	2.08
				Maximum	7.0	3.8	2.7
				Minimum	4.3	2.2	1.5
				Range	2.7	1.6	1.2

As is seen in the above table, the range between the extremes is fairly wide. Resembling the case in the size of eggs, this variation may be due to the condition of the full-grown larva, pupating place, etc.

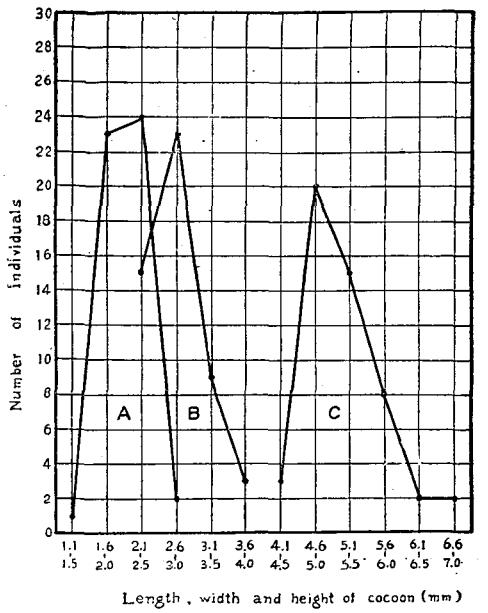


Chart IV

Variation in the size of cocoons

Curve A Height

Curve B Width

Curve C Length

V. ECOLOGICAL CHARACTERS

1. Number of Generations and Seasonal History

As already stated, there are various accounts on the number of generations, some claiming only one generation yearly for the rice leaf-beetle, some two, while others sometimes three generations. However, as far as my observations go, only one generation of this beetle is produced annually in our districts. This observation is in accord with those of H. OKAMOTO (*70*, *71*) in Hokkaido, J. MURATA and T. IKEDA (*59*) in Nagano Prefecture, R. NODZU (*67*) in Shimane Prefecture, J. OKADA (*69*) in Yamaguchi Prefecture, J. SONAN (*85–87*) in Taiwan, etc. According to the observations in Hokkaido, the rice leaf-beetle passes the winter as adults hidden away in the debris of the adjacent mountain-bush, under the roots of grasses of a wind-break, in the shallow part under a ground of the road-bank of the foot-path between rice-fields, and occasionally about buildings. They leave their winter-quarters quite early in spring, and begin to feed on the leaves of young rice-plants and to pair. They may be found in the field even before rice-plants come up, in the latter part of May. In early June, the first eggs are laid in masses on the leaves of

rice-plant; June 8 was the earliest date recorded the egg-laying in 1930. The adults appear abundantly during the latter part of June, and the female may continue to deposit her eggs at least as late as the end of July, though the emergence of adult succeeded by the earlier oviposition begins to occur during this time. However, the overwintering adults are not common in the field after mid-July. The length of the egg-stage varies from one week to two weeks, the larval life occupies from thirteen to twenty days and on the average about two weeks, and the pupal stage also about two weeks. The earliest date on which I have found an adult of the new generation, was on July 22 in 1930, but the new generation of beetles does not become common until much later during this month or early in August. As the oviposition-period lasts more than one month, all stages of this beetle may be found simultaneously, but the adults which emerge in each summer neither pair nor oviposit until the next year, although they do feed freely on the foliage until mid-August when they seek hibernating quarters.

The life-cycle is shown in the following chart.

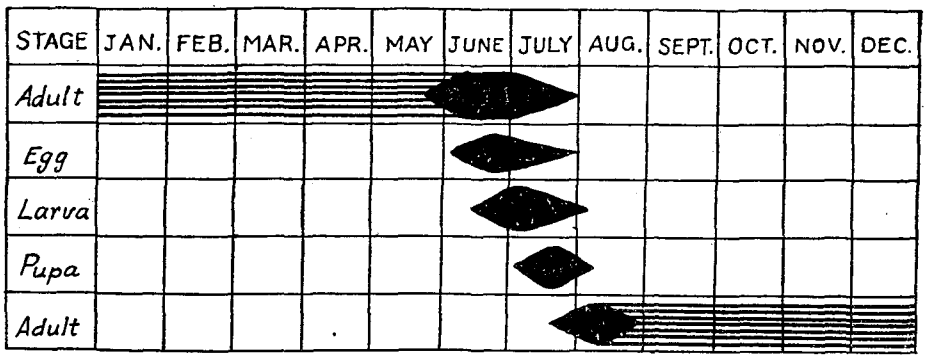


Chart V

Life-cycle of *Lema oryzae* in Hokkaido

2. On the Adult

Emergence In Hokkaido, as stated in the preceding pages, the emergence of adult under natural conditions occurs at the latter part of July and continues throughout August. This long duration of the emergence may be not only due to the difference of oviposition-period in the springtime, but also to the nutrition during the larval stage, pupating place and

other conditions. The process of emergence takes place in the cocoon, and the newly emerged beetle stands still one or two days within. When the beetle is able to fly by the hardening of its exoskeleton, it cuts a round hole of about 1.5 mm. in diameter near one end of the cocoon and goes away. The newly flying beetle seeks hibernating quarters a short time after of its feeding freely on the foliage.

Duration of Life The adult-life is a long one. It is almost impossible to determine the length of the life of adult in the field, as this beetle hibernates in the adult-stage, and it is also doubtful whether the breeding experiments give a true estimation of the length of life or not. However, according to my observations on the beetles confined in the breeding cages in 1930, one of the longest survivors among the hibernating beetles was found on July 24, but by August 1 none could be found. From these experiments, we may say that the adult exhibits a considerable degree of longevity as about one year or a little longer.

Time of Appearance in Spring As mentioned previously, the adult usually reappear in the latter part of May in the vicinity of Sapporo. This date is almost the same everywhere in Japan, with the exception of Taiwan, in where, according to J. SONAN (*85–87*) it appears from early February. Some comparison are given as follows:

Table XIII—*Time of the appearance of adult in some localities in Japan*

Locality	The earliest date of appearance in sprin	Observer
Kamikawa district, Prov. Ishikari	End of May	S. KUWAYAMA
Uriu district, Prov. Ishikari	"	"
Sapporo district, Prov. Ishikari	"	"
Kawabe district, Prov. Ugo	End of May — Early in June	Akita Agr. Exp. Sta.
Morioka, Prov. Rikuchû	Middle of May	Iwate Agr. Exp. Sta.
Yamagata, Prov. Uzen	End of May	Yamagata Agr. Exp. Sta.
Nagaoka, Prov. Echigo	"	Niigata Agr. Exp. Sta.

Locality	The earliest date of appearance in spring	Observer
Nagano, Prov. Shinano	End of May — End of June	Nagano Agr. Exp. Sta.
Hinokawa district, Prov. Idzumo	End of May	Shimane Agr. Exp. Sta.
Yamaguchi, Prov. Suwô	End of May — Early in June	Yamaguchi Agr. Exp. Sta.
Kainei district, Chosen	May — June	Kankyô-Hokudo Agr. Exp. Farm

It may be noticed, as compared with other insects, that there is only slight difference on the reappearing dates in many localities, where climate varies considerably.

Mating [Pl. III-figs. 1 & 2] On the reappearance of the adult in spring, the mating commences on a warm day early in June. The mating seems rather unique. At mating, the male embraces the anterior portion of the abdomen of the female, so that its head comes in contact with the base of the elytra of the other party. The paired beetles stand still on the upper surface of leaves or stems, and they often wander about in this state, especially so when disturbed. The duration of mating varies greatly. In one case the mating lasted for one hour, but in other cases it continued two or three hours and sometimes longer. On this account my observations coincide with those of R. NODZU (*67*). The mating occurs at any time in the day, especially during the warm and quiet daytime. The copulation of one male or female repeatedly takes place during its long life in spring. Not infrequently a female, just after pairing with a male, joins with another male. As I observed in many cases, the female contains generally very few fertile eggs in her ovaries as compared with the total number of eggs oviposited; thus to let the female keep up the prolific oviposition during her long life frequent mating may be needed. W. E. H. HODSON (*47*) stated in regard to *L. melanopa* that "it would seem that one union is sufficient, for females isolated immediately after copulating have continued to lay fertile eggs for a number of weeks". In these facts our leaf-beetle differs from *L. melanopa.*

Preoviposition-Period The preoviposition-period of our leaf-beetle is one of the longest among the insect-groups. As previously noted, the adults which emerge in summer, early or late in the season, neither pair nor oviposit unexceptionally until the next year. After eating the foliage of rice-

plant for some time, the newly emerged adults hide themselves and rest for a considerable time through three quarters of the year, that is, through summer, autumn and winter. This phenomenon has a different appearance from the ordinary hibernation or estivation of other insects. The fact that the annual generation is restricted to only one in spite of the differences of localities with different climatic conditions, and that the first appearances of the adults in spring in many localities are much the same, may be considered as special characteristics of this beetle itself. As O. NÜSSLIN and R. S. MACDOUGALL observed on *Pissodes* spp. of the Curculionidae, and as J. SONAN (*85*) regarded on *Morphosphaera* sp. of the Chrysomelidae, I suppose the sexual glands of this beetle may require a longer time for ripening after emergence, and so the beetle is only able to proceed to an efficient copulation in the following year. If this is the case, this characteristic is most adapted to the continuation of the generations. Really, this beetle has not a character of intermittent great outbreak, while its injury has a tendency to increase gradually year after year, or at least maintain the similar conditions.

Oviposition [Pl. II-fig. 5; Pl. III-fig. 2] Our observations show that the female oviposits only in daytime and never in the night. Eggs are usually placed on the upper surface of leaves, and occasionally they are found on the under surface of leaves and on the young shoots of the rice-plant. The following table shows the positions of egg-masses on leaves under natural conditions in 1930.

Table XIV—*Positions of egg-masses on the rice-leaves*

Position / Number	Upper surface	Under surface	Total
Total number examined	356	18	374
Percentages of ditto	95.2	4.8	100.0

According to these observations, over 95 per cent of the egg-masses are placed on the upper surface of leaves, and it seems that the oviposition on other parts of the plant are not normal.

The eggs are usually placed in mass, and when they are singly placed it is considered to be abnormal. The egg-masses are variable in shape, making a line, several rows or irregular form. However, the eggs rather

roughly stand in a mass.

When a beetle attempts to deposit eggs, it at first slowly walks about the surface of leaves, as if searching for a suitable place. If the place is found, the beetle extends its ovipositor, and lays a soft shiny yellow egg horizontally to the leaf. By exposure to air, the egg hardens rapidly its integument, and as it is covered with a glutinous secretion, the egg then adheres firmly to the leaf. The oviposition of one egg may take only a few minutes if circumstances are quite favourable. In an egg-mass, it lost usually not much time in succeeding ovipositions. If conditions are favourable, a female deposits more than ten or occasionally more than twenty eggs, or from one to five egg-masses, in a day. This fact was observed also by J. OKADA (*69*) in Yamaguchi Prefecture and by R. NODZU (*67*) in Shimane Prefecture. Contrary to these experiments on our species, W. E. H. HODSON (*47*) stated on *Lema melanopa* that "no female was observed to lay more than three eggs within 24 hours, one only being usual". His observation on *L. melanopa* that "during cool spells egg-laying was suspended entirely for several days at a time" was also recognizable in our case, but the difference in number of oviposition per day between *L. melanopa* and *L. oryzae* may be one of the noticeable facts in ecological point of view.

The number of eggs laid by a single female and the duration of egg-laying vary considerably among the individuals. Therefore, in 1930, I carefully observed with breeding glass-cylinders, in each of which a pair of the beetles was reared on the rice-plant. The results are detailed below:

Table XV—*The activities of the egg-laying of the adult in Hokkaido*

No.	Date of capture	The beginning of oviposition	The end of oviposition	Duration of egg-laying	Total number of egg-masses	Extreme number of eggs in an egg-mass	Total number of eggs laid	Average number of egg-laying per day
1	10/VI	12/VI	30/VI	18 days	5	2—17	33	1.8
2	"	"	1/VII	19	13	1—10	79	4.2
3	"	14/VI	"	17	9	2— 9	39	2.3
4	"	17/VI	30/VI	13	13	1— 9	37	2.9
5	"	11/VI	19/VI	8	3	2—17	64	8.0
Average				15.0	9.6		50.4	3.8

The above-mentioned observations show that a female in confinement deposited about fifty eggs, distributed in about ten egg-masses, during the egg-laying period which was fifteen days on the average. One of the females examined laid about eighty eggs during its life-time. However, this was much less than expected, probably owing to unfavourable conditions. The figures mentioned above show much less than those obtained by R. NODZU (*67*) and J. MURATA and others (*59*, *61*), but much more than that of J. OKADA (*69*). For reference, some examples observed by these students in Shimane, Nagano and Yamaguchi Prefectures, are tabulated as follows:

Table XVI—*Activities of the egg-laying of the adult in different localities*

Locality observed	Year	Number of observed female	Duration of oviposition		Total number of egg-masses laid		Total number of eggs laid		Observer
			Average	Extremes	Average	Extremes	Average	Extremes	
			days	days					
Yamaguchi	1911–'12	20	—	—	3.2	2–6	21.7	16–38	J. OKADA
Shimane	1921	6	29.0	12–45	27.5	8–44	152.8	85–211	R. NODZU
"	1922	5	19.0	12–24	25.0	4–36	97.2	20–134	"
Nagano	1925	—	—	—	15.0	10–40	150.0	80–200	J. MURATA & others

According to these observations as well as my own, female in the field under more favourable conditions may be able to lay more than one hundred eggs during the period from about half a month to a month. The daily rate of oviposition varies with the differences of individuals and temperature. In some instances a single female deposited several egg-masses within 24 hours, whereas in other instances a period of several days was elapsed between the successive depositions of egg-masses.

It is also noticeable that the female in confinement frequently deposited her eggs on the interior of glass-cylinder and wire-screen as well as on the leaves of plants which were provided for egg-deposition. However, this tendency becomes conspicuous only when the host plants turn to droop, or some wrong plant is used.

General Behaviour [Pl. III-fig. 1] The adult-beetle is rather sluggish in habits, usually resting on the upper surface of the rice-leaves. However, it is diurnally active and flies freely when it is warm and calm. When the

beetle feels a slight danger approaching, it simply removes to the neighbouring leaves by walking, but if it is much disturbed, the beetle falls down to the surface of water or the ground, feigning death for a few seconds, and then runs or flies rapidly for other places.

The beetles, as in *L. melanopa* after the observations by W. E. H. HODSON (*47*), show at all times a gregarious tendency. This character is most marked in June, when the beetles assemble in groups for the purpose of mating. The beetles also invariably prefer sunny places, so the ovipositions are less on the rice-plants along shady foot-path. It is less active in cloudy and windy wheather, resting on the under surface of leaves or shelters in a grass-shade.

J. SONAN (*86*) stated that when the adults are in taking up winter-quarters, they are attracted by the artificial light in evening, from two or three to ten beetles being attracted every day by the lamp of mountain-cottage in Taiwan. Unfortunately, I have not met such a case in Hokkaido.

The beetle feeds on the leaves of rice-plant during its active time. However, in every spring, when the rice-plant is not yet grown, the beetle feeds temporarily on other Gramineous plants. On the feeding habits I intend to discuss later once more.

3. On the Egg

Incubation The length of the egg-stage varies according to temperature, weather and place of oviposition. During the middle of June in 1930, I observed the incubation-period upon two series of eggs on the rice-plant, one of which was placed in an ordinary breeding house, while the other in the green house. The results obtained are as follows:

Table XVII—*The incubation-period of the rice leaf-beetle*

Series	Date of egg-laying	Date of hatching	Incubation-period	Daily mean temperature during incubation-period
In ordinary breeding house	11/VI	22/VI	11 days	16.1 °C
	12/VI	21/VI	9	16.2 °C
	20/VI	27/VI	7	16.9 °C
In green house	13/VI	18/VI	5	21.5 °C

As is seen in the preceding table, the higher temperature has a tendency to help the acceleration of the incubation-period of egg. In the field in the vicinity of Sapporo, the incubation-period varies usually from one to two weeks.

During incubation, the colour-change of the egg is due to the development of the embryo. The egg when laid is shiny yellow, and as stated before, the colour soon changes to brown, and within two or three days it becomes blackish brown or nearly black prior to hatching.

Number of Eggs per Egg-mass The majority of the egg-masses collected in the field in Hokkaido have contained from three to twelve eggs, although the number of eggs per egg-mass is considerably variable. From one to forty-six eggs have been found in an individual egg-mass. The following table gives the data obtained in 1929 and 1930 on the material from Kagura, Kamikawa district and Itchan, Uriu district, both in the Province of Ishikari.

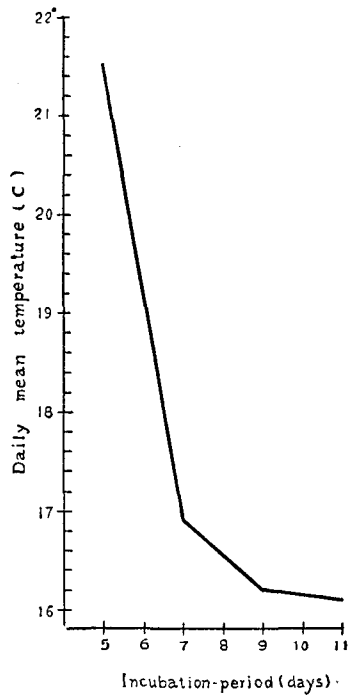


Chart VI

Relation between the incubation-period and temperature

Table XVIII—*Variation of number of eggs per egg-mass*

Class (Number of eggs per egg-mass)	Material in 1929		Material in 1930	
	Frequency	Percentage	Frequency	Percentage
		%		%
1	5	0.25	6	1.37
2	72	3.60	23	5.24
3	122	6.10	25	5.69
4	148	7.40	32	7.28
5	167	8.35	35	7.97
6	172	8.60	28	6.38
7	199	9.95	42	9.57

Class (Number of eggs per egg-mass)	Material in 1929		Material in 1930	
	Frequency	Percentage	Frequency	Percentage
		%		%
8	168	8.40	36	8.20
9	168	8.40	41	9.34
10	139	6.95	41	9.34
11	112	5.60	28	6.38
12	117	5.85	21	4.78
13	91	4.55	15	3.42
14	69	3.45	15	3.42
15	66	3.30	18	4.10
16	46	2.30	8	1.82
17	42	2.10	8	1.82
18	29	1.45	4	0.91
19	24	1.20	3	0.68
20	11	0.55	4	0.91
21	13	0.65	—	—
22	8	0.40	—	—
23	3	0.15	1	0.23
24	2	0.10	2	0.46
25	—	—	—	—
26	2	0.10	—	—
27	1	0.05	—	—
28	—	—	—	—
29	2	0.10	1	0.23
30	—	—	—	—
31	1	0.05	—	—
32	—	—	—	—
33	—	—	—	—
34	—	—	—	—
35	—	—	—	—
36	—	—	—	—

Class (Number of eggs per egg-mass)	Material in 1929		Material in 1930	
	Frequency	Percentage	Frequency	Percentage
		%		%
37	—	—	—	—
38	—	—	—	—
39	—	—	1	0.23
40	—	—	—	—
41	—	—	1	0.23
42	—	—	—	—
43	—	—	—	—
44	—	—	—	—
45	—	—	—	—
46	1	0.05	—	—
Total	2000	100.00	439	100.00

These data can be represented graphically by the curves which are shown in the Chart VII. The figures on the ordinate show the number of individuals, and those on the abscissa the number of eggs per egg-mass. These data[1] give, in the whole, an asymmetrical curve of moderately distributed type, the maximum frequency being attained at the seven eggs-class.

1) Based on the data obtained in these two years, I endeavored to calculate some values regarding variations. On the calculation, I am indebted to Dr. M. TAMBO for his kind advice. The results are as follows:

		For the material in 1929	1930
Mean	$(M) = G + \frac{\Sigma[f(V-G)]}{n} =$	8.908	8.763
Median	$(me) =$ (By the proportional part) $=$	8.208	8.286
Mode	$= M - 3(M-me) =$	6.809	7.332
Standard deviation	$(\sigma) = \pm\sqrt{\frac{\Sigma[f(V-G)^2]}{n} - b^2} =$	±4.361	±4.958
Standard error of σ	$= \pm\frac{\sigma}{\sqrt{2n}} =$	±0.069	±0.167

Note: Symbols in the formulae indicate as follows:—
Σ = Summation; G = assumed mean; n = total number of variates;
f = number of variates in the class or frequency; V = class value;
$b = \frac{\Sigma[f(V-G)]}{n}$

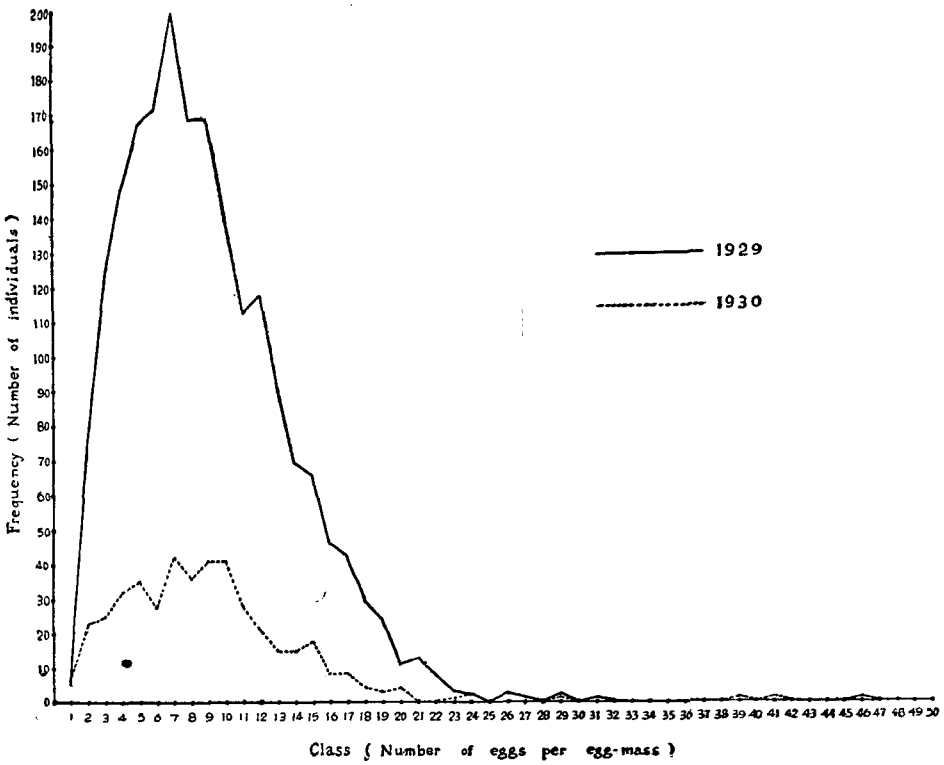


Chart VII

Curve showing frequency of the number of eggs per egg-mass

4. On the Larva

Hatching and Habits of the Newly Hatched Larva Hatching is accomplished by the young larva by means of cutting a longitudinal slit towards the narrow end of the egg and crawls forth. It is quite probable that the young larva does not eat the egg-shell, while the larva commences immediately to feed on the rice-leaf in the proximal part.

General Habits of Larva [Pl. III-fig. 3] The larva is rather inactive and sluggish in habit. When still young the larva remains with the brothers of the same egg-mass on the leaf oviposited, and feeds on the leaf, marking some minute stripes on it. After feeding for a few days on the first leaf, the larva generally migrates to a leaf higher up the plant. The larva

has the habit of commencing its feeding near the tip and of gradually descending towards the base of the leaf. Contrary to the adult, the larva is more active under wet and cloudy weather, so that a very dry and sunny or windy weather is deteriorating to its life. Really, during the daytime the larva comes down to the lower part of plant and is rather inactive, usually resting on the surface of leaves. It is most active both in the morning and the evening as well as at night, and feeds on the rice-leaves ravenously.

As already observed on the other members of the genus *Lema* by senior students, one of the most remarkable habits of the present larva is to cover the body with excreta. By a peculiar provision the anus projects forwards and upwards. The excreta, mixed with mucous secretion which acts as diluting and spreading agent, flow forwards over the body. The excreta are dark green or sometimes blackish green in colour and are retained on the back by some curved hairs provided over the dorsal region and sides. The shape of the larva covered with the excreta, is nearly globular seen from the upper side and hemispherical from the lateral sides. The surface of the excreta covering the body is smooth, and the texture of those is soft. The larva remains covered with these excreta during the greater part of its active life, only being bare for a short time after each moult and immediately before pupating. When the excreta are removed artificially, the larva soon restores the excreta on the back almost as its original state within a few hours. When the larva covered by the excreta sticks on the rice-leaf, it is often mistaken as a lump of mud. The various Japanese names of this insect "Ine-doro-hamushi", "Doro-oi-mushi", "Doro-mushi", "Doroko", "Dorokatsugi", "Katsugi", "Dorokaburi", "Kurosuke", "Funmushi", "Beromushi", etc. come generally from this curious habit of larva.

Time of Appearance The larva appears usually at the latter part of of June, the earliest date in 1930 in the vicinity of Sapporo being June 20, and accelerates in hatching during July. The maximum appearance is usually reached at the beginning of July; and at this time some of the full-grown larvae begin to pupate. The appearance of larva is kept up to a certain extent, till the beginning of August, and ceases entirely at the middle of the said month.

Moulting, Growth and Length of Larval Stage Since it varies considerably according to temperature, humidity, food-plants, and some other conditions, it is not definitely known how long it takes for the larval stage, but some observations show that it takes about from thirteen to nineteen

days under natural conditions. For instance, under my breeding experiments in 1930, the larva hatched on June 20 reached its full-growth and pupated on July 9, comprising nineteen days for larval stage prior to the formation of cocoon. During its growth, as in the case of other insects, the larva has several ecdyses. According to my observations as well as the measurements of the width of head-capsules, there are invariably three moults making four instars. The width of head and body-length in the four instars measured by me are tabulated in the following table:

Table XIX—*Measurements of the width of head and the body-length in the four larval instars*

Item / Instar / Measurement in mm.	The width of head				Body-length			
	I	II	III	IV	I	II	III	IV
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Average	0.342	0.487	0.670	0.862	1.14	1.89	2.45	4.73
Maximum	0.368	0.528	0.720	0.896	1.25	2.30	3.60	6.40
Minimum	0.312	0.448	0.608	0.824	1.00	1.25	1.80	3.20
Range	0.056	0.080	0.112	0.072	0.25	1.05	1.80	3.20

Note: Numbers of individuals examined are 15 in the first instar, 12 in the second instar, 20 in each the third and fourth instars.

According to these data, the average width of the head of the fourth instar or full-grown stadium is about 2.5 times of that of the first instar or newly hatched stadium, while the average body-length of the fourth instar is about 4.2 times of that of the first instar. However, since the number of individuals in each instar examined is not sufficient, the biometrical consideration on the larval growth is reserved for some future occasion.

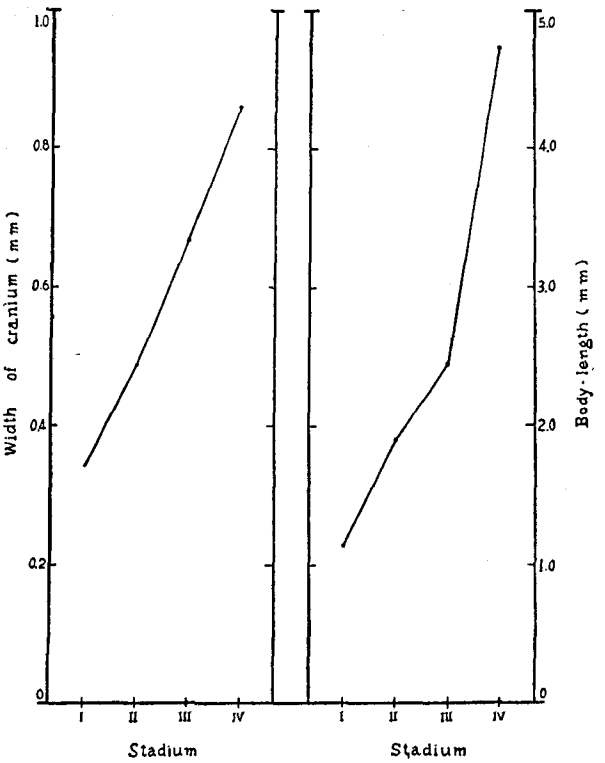


Chart VIII

Growth-curves in the cranium-width and the body-length of larva

5. On the Pupa

Formation of Cocoon and Pupation On becoming fully fed in the fourth instar, the larva slough off the excreta. The larva crawls about on the surface of the leaves for a while, and if a suitable place is found it begins to form the cocoon. Sometimes the larva crawls down the plant, especially in the case of upland rice-field, and forms the cocoon on the surface of the ground [see Pl. IV-fig. 2], and occasionally enters into the soil and pupates under the ground. On the formation of cocoon, the full-grown larva secretes a white, foamy mucous substance throughout the mouth, which may be the secretion of salivary gland. Since the secretion hardens rapidly by the exposure to air, a whitish ellipsoidal cocoon is formed when the secretion covers wholly over the larva. Even in the case of the formation of cocoon on or under the ground, the cocoon is not always constructed with sand, though some particles of soil are at-

tached on the surface of cocoon [see Pl. IV-fig. 3]. My observations upon the formation of cocoon of *Lema oryzae* are quite different from those of W. E. H. HODSON (*47*) in the case of *L. melanopa*, but bear a striking resemblance to those of S. HÄNSEL (*46*) in the case of *L. cyanella*.

When the formation of cocoon is completed, the larva enters the quiescent prepupal stage for a few days, and then the prepupa sheds the skin and changes into a yellowish pupa in the cocoon. The pupa invariably faces to the leaf by its ventral side.

Duration of Pupal Stage The length of exact pupal stage is not fully known. However, according to my field observations, the pupal stage lasts from ten days to two weeks, including prepupal stage. Four examples which formed the cocoon on July 9, 1930, were observed to emerge equally on July 22, giving a total life in the cocoon of 13 days.

Location of Cocoon [Pl. III-fig. 4; Pl. IV-fig 2] As stated in the preceding pages, this beetle pupates usually on the rice-leaves, while it pupates also on the surface of ground or under the ground. The latter frequently occurs in the case of upland rice-field. However, I observed in 1930 at Teine, Sapporo district, Province of Ishikari, that some of the full-grown larvae have entered into the soil of the foot-path of ordinary rice-field, constructing a white cocoon under the ground.

In breeding apparatus, covered by the cylinder of wire-screen, during the month of July, 1930, I tried many experiments in order to find out the location of cocoon in the case of upland rice-field. I began to rear thirty nearly full-grown larvae in each apparatus on July 5 and examined them at the end of that month. The results were as follows:

Table XX—*Location of cocoon in the case of upland rice-field*

Apparatus No.	Number of cocoon				
	On the leaves	On the wire-screen	On the surface of ground	Under the ground	Total
I	4	—	14	4	22
II	5	—	10	6	21
III	9	—	10	3	22
IV	10	—	9	5	24
V	11	—	8	4	23

Apparatus No.	Number of cocoon				
	On the leaves	On the wire-screen	On the surface of ground	Under the ground	Total
VI	1	1	17	9	28
VII	9	—	6	1	16
VIII	8	—	14	4	26
Total	57	1	88	36	182
Percentage	31.3	0.6	48.3	19.8	100.0

From the result of this experiment, in the case of upland rice-field, about a half of the total individuals formed the cocoon on the surface of ground, while about one-third of them formed it on the leaves. In order to find out the depth of its interment when it is formed under the ground, I carefully hunted out the cocoon in the soil of above mentioned breeding apparatus. The results are tabulated below:

Table XXI—*Depth of cocoon in the soil*

Position / Number	Less than 3 cm.	Less than 6 cm.	Less than 9 cm.	Less than 12 cm.	Total
Number examined	34	1	1	0	36
Percentage of ditto	94.4	2.8	2.8	0	100.0

As is seen in the above table, the majority of the cocoons in the soil domicile at the depth less than 3 cm.

It is well known, however, that in the ordinary rice-field most of the cocoons are formed on the leaves, probably due to the irrigation-water on the ground. In this case, the greater part of the cocoons domicile on the upper surface of the leaves [see Pl. III-fig 4]. For an example, according to my examination on the material presented by the Toyama Agricultural Experiment Station, the number of the cocoons on the upper surface of the leaves was twenty-five and one on the under, the percentage of them being

96.2 and 3.8 respectively. The cocoons on the leaves are singly formed in general, but occasionally two cocoons are attached end by end ; the actual numbers were twenty-two in the former case and two in the latter, these being 84.6 per cent and 15.4 per cent respectively.

6. Feeding Habits and Food-Plants

Feeding Habits [Pl. IV–fig. 1] Both the adult and larva feed by gnawing out many longitudinal stripes from the rice-leaves. The marks by their feeding are quite similar, but the marks by the former are rather narrower and shorter than those by the latter [see Pl. III–figs 1 & 3]. The resultant injury is almost indistinguishable from the injuries caused by the adult of the rice leaf-miner (*Oscinis oryzella* MATSUMURA), the very young larva of the rice leaf-caterpillar (*Naranga aenescens* MOORE), the adult of the rice armoured beetle (*Hispa armigera* OLIVIER), etc. The feeding is effected by the removal of parallel longitudinal stripes, leaving the sclerenchyma around the vascular bundle from the leaves, the epidermis of the lower surface being left intact. Really, it is unusual to find the adult or larva feeding on the lower surface. The reason that the feeding is restricted on the upper surface is probably due, as explained by S. HÄNSEL (*46*) in the case of *L. cyanella*, to the fact that the cell of the upper epidermis is larger and has a thinner membrane than that of the lower epidermis. When ravenously fed, the leaves are partly skeletonized and splitted lengthways. The marks of feeding are whitish at first, gradually changing to dull yellow or brownish, and then that part withers.

Food-Plants As far as I am aware of, the rice-plant (*Oryza sativa*) is only a representative as the staple food-plant, or the principal host-plant, not only on my field observations but also based on many previous records of this beetle. However, I observed that the reappeared beetle in spring occasionally finds some nutriment in certain Gramineous plants, such as "Kita-yoshi" (*Phragmites communis*), Orchard grass (*Dactylis glomerata*), Timothy (*Phleum pratense*), etc., especially during the period when the rice-plant has not yet grown. In regard to these temporary food-plants, the Akita, Ishikawa and Yamaguchi Agricultural Experiment Stations and also the Department of Agriculture, Government Research Institute of Formosa have kindly communicated to our Agricultural Experiment Station by our request. These plants are listed in the following lines:

In Akita and Ishikawa Prefectures (Provs. of Ugo & Kaga)

Zizania latifolia ("Makomo")

In Yamaguchi Prefecture (Prov. of Nagato)

Imperata cylindrica var. *Koenigii* ("Chigaya")

In Taiwan (Formosa)

Panicum proliferum ("Ônukakibi")

Ischaemum rugosum var. *segetum* ("Taiwan-aiashi")

Isachne globosa ("Chigo-zasa")

Rottboellia compressa var. *genuina* ("Kobano-ushinoshippei")

Leersia hexandra ("Taiwan-ashikaki")

These are, however, regarded only on the adult-beetle, and no such food-plants are known to the larva.

Experiments on the Food-Plant Selection If our leaf-beetle is really *Lema melanopa*, it should be reared satisfactorily on barley, oats, wheat, Orchard grass, Timothy, etc., which are known as its favourite food-plants in Europe. Nevertheless, though these crops are cultivated extensively in Hokkaido they have heretofore received no damage whatever in the field by our beetle. To solve these problems many experiments were conducted during the months of June and July in 1930 on the rice-plant (*Oryza sativa*), oats (*Avena sativa*), barley (*Hordeum sativum* var. *hexastichon*), naked barley (*Hordeum sativum* var. *vulgare* f. *coeleste*), wheat (*Triticum sativum* var. *vulgare*), rye (*Secale cereale*), Orchard grass (*Dactylis glomerata*) and Timothy (*Phleum pratense*).

A. On the adult The glass-cylinders were used as the breeding-apparatus, and in each of which a pair of the beetle were placed. The results obtained are as follows:

Table XXII—*Experiment No. 1 (Food-plant selection of the adult)*

Apparatus No.	Food-plant	Variety of food-plant	Beginning date of rearing	Height of plant at beginning	Conditions on June 18				Conditions on June 30						Total number of eggs deposited
					Total number of plants	Total number of leaves	Number of infested leaves	Percentage of infestation	Total number of plants	Total number of leaves	Number of infested leaves	Percentage of infestation	life or death of adult ♂	life or death of adult ♀	
								%				%			
1	Rice	Bodzu No. 5	10/VI	Ca 25 cm.	24	94	54	57.4	24	94	74	78.7	+	±	32
2	"	"	"	"	23	94	41	43.6	23	94	67	71.3	+	+	78
3	"	"	"	"	16	64	34	53.1	16	64	60	93.8	+	+	35
4	"	"	"	Ca 10 cm.	16	40	19	47.5	16	40	40	100.0	+	+	37
5	"	"	"	"	16	42	23	54.8	16	42	42	100.0	+	—	62
6	"	"	"	"	14	30	17	56.7	14	30	30	100.0	+	+	11
7	"	"	"	"	10	22	15	68.2	10	22	22	100.0	—	—	23
8	"	"	"	"	16	40	24	60.0	16	40	40	100.0	+	+	48
Average (or Total)					(135)	(426)	(227)	53.3	(135)	(426)	(375)	88.0			40.8
11	Oats	Victory No. 1	10/VI	Ca 20 cm.	6	24	2	8.3	6	24	4	16.7	—	—	2
12	"	"	"	"	7	31	1	3.2	7	31	2	6.5	+	+	0
13	"	"	"	"	7	28	0	0	7	28	1	3.6	+	+	0
Average (or Total)					(20)	(83)	(3)	3.6	(20)	(83)	(7)	8.4			0.7
14	Orchard grass	—	10/VI	Ca 15 cm.	25	97	0	0	43	135	4	3.0	—	±	0
15	Timothy	—	10/VI	Ca 11 cm.	25	97	0	0	45	150	12	8.0	+	—	0

Note: The mark "+" means living, "—" being dead and "±" flying away.

Table XXIII—*Experiment No. 2 (Food-plant selection of the adult)*

Apparatus No.	Food-plant	Variety of food-plant	Beginning date of rearing	Conditions on June 22				Conditions on July 1						Total number of eggs deposited
				Total number of plants	Total number of leaves	Number of infested leaves	Percentage of infestation	Total number of plants	Total number of leaves	Number of infested leaves	Percentage of infestation	life or death of adult ♂	life or death of adult ♀	
							%				%			
16	Barley	Sapporo Rokkaku	18/VI	9	19	2	10.5	9	20	6	30.0	—	+	2
17	Naked barley	Marumi No. 16	"	9	21	0	0	9	21	0	0	—	±	1[1]
18	Wheat	Sapporo Haru-komugi No. 9	"	7	14	5	35.7	7	14	8	57.1	—	—	5[2]
19	Rye	Old variety	"	9	22	5	22.7	9	22	6	27.3	—	±	5
20	Oats	Victory No. 1	"	8	16	0	0	8	16	0	0	—	—	15[2]

Note: 1) Besides the deposition on the plants, five eggs were deposited on the interior surface of a glass-cylinder and four eggs on the Victoria lawn.

2) Greater parts of eggs deposited were hatched during the experiments, but no injuries by the larva to the crops were observed.

From the data obtained, the following several points are concluded in regard to the feeding habits of adult.

1. The rice-plant is the only and most favourite food-plant for this leaf-beetle among the cereals and grasses cultivated in Hokkaido.

2. When the adult-beetle is prevented to feed the rice-leaves, it has a habit to find some nutriment in any cereals or grasses.

In this case, however, the feeding is very slow, consequently the percentage of infestation is low compared to that of the rice-plant.

3. When the adult-beetle can not take the nutriment from the rice-plant, its capacity of oviposition reduces very much.

4. The adult has a tendency to shorten its life when the adult can not get the food from the rice-leaves.

By the use of glass-cylinder apparatus as in the foregoing experiments, during July 1 and 24 inclusive in 1930, I tried the following experiment to see the behaviour of the feeding habits and oviposition-capacity.

Table XXIV—*Experiment No. 3 (Interchange of food-plants experimented with the adult)*

Apparatus No.	Previous food-plant	Food-plant adopted in the experiment	Conditions on July 4				Conditions on July 8				Conditions on July 24			
			Feeding	Condition of adult ♂	Condition of adult ♀	oviposition	condition of larva	Feeding	Condition of adult ♂	Condition of adult ♀	Oviposition	Condition of larva	Feeding	Condition of adult ♂	Condition of adult ♀	Oviposition	Condition of larva
1	Rice	Rice	+	+	+	+	Early deposited eggs have hatched. Larvae feed the leaves extensively.	+	+	+	+	Larvae infest the leaves severely.	—	—	—	—	Some of the full-grown larvae have already formed cocoons.
16	Barley	Barley	+	—	+	—		+	—	—	—						
21	Oats (12)	Oats	—	—	+	—		—	—	—	—						
22	Oats (13)	Rice	+	+	+	+ (15 eggs)		+	+	+	+ (47 eggs)		+	+	±	—	
23	Rice (8)	Wheat	+	+	+	—		+	—	+	—		—	—	—	—	
24	Rice (6)	Timothy	+	+	+	—		+	+	+	—		—	—	—	—	
25	Rice (4)	Barley	+	+	+	—		+	+	+	—		+	+	—	—	

Note: 1) Number in the column of previous food-plant is corresponded with the apparatus-number in the Table XXII.

2) Marks in the column of the condition of adult have the same meaning with those in the Tables XXII and XXIII. Mark "+" in the feeding of adult and oviposition means that the feeding and oviposition are observed, and mark "—" means the contrary.

3) The female in the Apparatus No. 22 deposited sixty-two eggs during the life.

In this experiment we may recognize the following points:

1. If the rice-plant is substituted with the other Gramineous plant, the appetite of the adult diminishes, consequently the capacity of oviposition reduces remarkably, also the life of adult is shortened.

2. On the contrary, when the cereal unsuitable for the food-plant is substituted with the rice-plant, the beetle increases its appetite and prolongs its life, so the capacity of oviposition is recovered.

3. The longer the duration to take the nutriment by the adult in an unsuitable plant the more the life of adult is shortened.

B. On the larva The breeding-apparatus used was a wire-screen cylinder, and each contains 10 larvae of various stadia. The results are tabulated as follows:

Table XXV—*Experiment No. 4 (Food-plant selection of the larva)*

Apparatus No.	Food-plant	Variety of food-plant	Beginning date of rearing	After 1 day (6/VII)		After 2 days (7/VII)		After 3 days (8/VII)		After 5 days (10/VII)		Remarks
				Feeding	Condition of larva	Feeding	Condition of larva	Feeding	Condition of larva	Feeding	Condition of larva	
26	Rice	Bodzu No. 5	5/VII	+	+	++	+	++ Some of the leaves were skeletonized	+	++	+ Some of the larvae pupated	Six cocoons were formed. Five adults emerged.
27	Barley	Sapporo Rokkaku	"	—	+	±	+	±	± Only two larvae remain in waste	—	—	
28	Naked barley	Marumi No. 16	"	—	+	—	+	—	—	—	—	
29	Wheat	Sapporo Haru-komugi No. 9	"	—	+	—	+	±	± Larvae grown very weak	—	—	
30	Rye	Old variety	"	—	+	—	+	±	—	—	—	
31	Oats	Victory No. 1	"	—	+	—	+	—	—	—	—	
32	Timothy	—	"	—	+	±	+	±	± Larvae grown very weak	—	—	
33	Orchard grass	—	"	—	+	—	+	±	—	—	—	

Note: 1) Meaning of marks in the column of feeding is as follows:
++ Fed ravenously, the leaves being partly skeletonized.
+ Fed freely.
± Only a trace of feeding on one or two leaves.
— No feeding at all.
2) Meaning of marks in the column of the condition of larva are as follows:
+ Healthy.
± Some of the larvae died, the remainings being in waste.
— Died.

As is seen in the above table, when the larva was reared on the cereals or grasses other than the rice-plant, it became very weak within three days, sloughing the excreta on the back, and could not feed at all or at best effected only a few traces of feedings on the leaves, and in from three to five days almost of all larvae died.

According to the repeated experiments mentioned above, this insect can live only on the rice-plant, and apparently there are no other substitute food-plant at present. In regard to this phase, the present insect has a different habit from *L. melanopa*.

7. Destructiveness and Economic Aspects

As stated before, this insect, during both its adult and larval stages, does a harm to the rice-plant by gnawing out longitudinal stripes from the leaves. In severely infested case, a stretch of the infested rice-field loses a lively green colour and presents the appearance as if burned by fire as far as the eye could see. In such an occasion it is not rare that one rice-plant contains several dozens of the larvae and adults. The plant severely infested, of course, can not escape death. Although in the case of slight infestation the plant must repeatedly spear new leaves and consequently it is unavoidable to delay its growth. This influence is recognizable more conspicuously in the northern parts in which the duration of the growth of rice-plant is shortened. From the month of August onward, even though the plants were infested in spring, they come to luxuriate the leaves and appear as if recovering their vitality. Nevertheless, if the rice-plants are once affected by this leaf-beetle, they can not avoid the reduction of weight and yield as well as the fall of the value of grains on account of the delay of ripening period.

However, an exact estimation of the damage is impossible, since it varies according to localities where the climatic and many other conditions differ; it is not also constant from year to year even in the same

locality. J. OKADA *(69)* stated that there is from 5 to 20 per cent damage yearly to the rice-crop at the Abu district in Yamaguchi Prefecture. J. MURATA and others *(61)* stated on the conditions in Nagano Prefecture that the yields on the infested rice-fields are 1.5 Koku[1] and 1.4 Koku per Tan[2] each at Kashiwabara in the Kamiminochi district and Taira in the Kita-adzumi district against 2.1 Koku and 1.9 Koku on the healthy rice-fields in the same localities respectively. According to his many experiments conducted in Shimane Prefecture, R. NODZU *(67)* stated that, in 1923 the controlled sections produced an increase of 0.64 Koku per Tan on the average yield against the uncontrolled section, and also in 1925 the controlled sections in two series produced each an increase of 0.536 and 0.2163 Koku against the uncontrolled ones. Now, in Hokkaido, the Hokkaido-Government investigated the rate of damage thoroughly in 1929 on some infested localities in the Province of Ishikari, and attended the result that on the average the yield of controlled field was 2.256 Koku per Tan against to 1.750 Koku of the uncontrolled one. That is, the damage in this case amounts over 22.4 per cent of the whole harvest. Speaking generally, the damages in the infested localities by this pest amount to 5 per cent to 10 per cent of the whole harvest where the infestation is slight, and 20 per cent to 30 per cent where the infestation is severe.

VI. TAXONOMIC CONSIDERATION

1. Systematic Description of the Adult

Lema oryzae KUWAYAMA (1931)

Lema oryzae KUWAYAMA, Kontyû, III, p. 193 (1929) (nom. nudum); KUWAYAMA, Ins. Matsum., V, p. 155 (1931).

Lema melanopa (nec. LINNÉ), SONAN, Taiwan-Nôji-hô, 236, p. 573 (1926); YUASA, Kontyû, I, p. 95 (1926); YUASA, Kontyû, II, p. 61 (1927); MURATA, T., Beibaku. Gaichû. Yobôkujo, p. 343 (1927); MURATA, J. & SEKIYA, Byôchû. Zasshi, XV, p. 146 (1928); TAKAHASHI, Sakumotsu Gaichû Ron, p. 143 (1928); SONAN, Trans. Nat. Hist. Soc. Formosa, XIX, p. 66 (1929); YUASA, Kontyû, III, p. 199 (1929); MATSUMURA, Nô-Konchûgaku, p. 337 (1930).

Lema melanopus (nec LINNÉ) KUWAYAMA, Hokkaido Agr. Exp. Sta., Bul. 47, p. 54 (1928).

Lema tristis (nec HERBST), MATSUMURA, Dainippon Gaichû Zensho, II, p. 121 (1915); MATSUMURA, Konchû Bunruigaku, II, p. 74 (1915); SASAKI, Komaba. Sakumotsu Gaichûhen, p. 82 (1919); MURATA, J. & IKEDA, Byochû. Zasshi, XIII, p. 9 (1926).

Lema flavipes (nec SUFFRIAN) MATSUMURA, Gaichû Kujo Zensho, p. 262 (1897); MATSUMURA, Nippon Konchûgaku, p. 186 (1898); MATSUMURA, Nippon Gaichûhen, p. 283 (1899); ISHI-

1) 1 Koku = 180.4 litres.

2) 1 Tan = 991.7 square meters.

KAWA, Nôgyô Dôbutsu., p. 220 (1906); MATSUMURA, Thous. Ins. Jap., IV, p. 33 (1907); HORI & SHIRAKI, Agr. Exp. Sta., Formosa, Sp. Rep. I, p. 206 (1910); SHIRAKI, Cat. Ins. Nox. Formos., p. 59 (1911); NAWA, Ins. World, XVII, p. 18 (1913); OKADA, Yamaguchi Agr. Exp. Sta., Sp. Rep. III, p. 1 (1913); SHIRAKI, Agr. Exp. Sta., Formosa, Sp. Rep. VIII, p. 597 (1913); NAWA, Ins. World, XVIII, p. 152 (1914); MURATA, T., Beibaku. Gaichû. Yobôkujo, p. 209 (1915); TAKAHASHI, Futûsakumotsu. Gaichû, p. 157 (1916); TAKAHASHI, Nôgyô Konchû., p. 162 (1923); SHIMOYAMA, Shimane Agr. Exp. Sta., Sp. Rep. 32, p. 134 (1926); YOKOYAMA, Fig. Jap. Best., p. 779 (1927).

Lema flaviceps (nec SUFFRIAN) SASAKI, Nippon Nôsaku. Gaichû., p. 113 (1899); TANAKA, Tor., Niigata Agr. Exp. Sta., Month. Rep. 23, p. 53 (1901); ONUKI, Jitsuyô Konchû., p. 136 (1903); KUWANA, Nôyô Konchû. Kôgi, p. 178 (1918); TANAKA, Tom., Tochigi Agr. Exp. Sta., Sp. Rep. IV, p. 125 (1924); MACHIDA & AOYAMA, Chosen Gaichû., p. 86 (1928); NAKAYAMA, Ann. Agr. Exp. Sta., Gov.-Gen. Chosen, IV, p. 264 (1929).

Diagnosis: ♂ ♀. Body oblong, somewhat depressed, subparallel-sided, rounded at the apex, narrowed in front. General colour blackish, with the prothorax bright yellowish brown to reddish brown and the elytra cyaneous or metallic deep blue; eyes black; antennae black, with grayish yellow pubescence densely, exepting two basal joints which are dark brown and scarcely pubescent; scutellum black; legs bright brownish yellow, with blackish coxae and dark brownish tarsi, the tibia being darkened at the apex; the abdominal sternites somewhat darker than the upper side, and with dense grayish yellow pubescence.

Head as wide as the prothorax, punctured roughly, and bearing a few yellowish white pubescence on the face. Eyes prominent, raised hemispherically. Antenna shorter than the length of elytron, but longer than the length of the head and pronotum taken together; first segment large and grobular, the second small, the third somewhat longer than the second, the fifth and terminal the longest, followed by the sixth to the tenth; from the proximal flagellum to the tenth gradually broadened, eleventh bluntly pointed. Prothorax as long as wide, slightly narrowed anteriorly and posteriorly, transversely sulcate at the base, polish and roughly punctate. Scutellum small, subtrigonate, and with moderate coarse punctures and pubescence. Elytra elongate, at the base much broader than the prothorax, strongly punctate-striate, the striae of each represented by eleven rows, the shoulders well marked, and slightly depressed from about the middle to the base. Legs similar in three pairs, rather long; femora incrassate, but as long as the tibia; covered all over with dense pubescence. Underside with close and fine punctures, and covered with fine pubescence.

Measurements: Average length of body 4.23 mm. in the male and 4.76 mm. in the female.

Remarks: Described from 27 male and 25 female specimens. The

cotypes are deposited now with the collection of the Hokkaido Agricultural Experiment Station.

In form and colouration this species closely resembles *Lema melanopa* LINNÉ, and hitherto wrongly identified as the latter species. However, it entirely differs in the colourations of the basal two joints of antennae, the venter of abdomen, trochanter, tarsi and the apices of tibiae, and also the condition of punctures and pubescence on the abdominal sternites The shape and colour of the male genitalia, or penis, are also quite different in both species. These differences are discussed in detail in a later chapter.

2. Comparison of the Adult with the Other *Lema*-Species in Japan

(1) Synopsis of the Japanese Species of *Lema*

Family **Chrysomelidae** LEACH (1819)

[Division **Eupodes** CHAPUIS (1874)]

Subfamily **Criocerinae** LACORDAIRE (1845)

Genus ***Lema*** FABRICIUS (1798)

Lema FABRICIUS, Ent. Syst. Suppl., p. 90 (1798); LACORDAIRE, Mém. Soc. Roy. Sci. Liége, III- 1, p. 303 (1845); CHAPUIS, Gen. Col., X, p. 72 (1874); WEISE, Naturg. Ins. Deutsch., I Abt., VI, p. 59 (1881); FOWLER, Col. Brit. Isl., IV, p. 281 (1890); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 5 (1904); JACOBY, Fauna Brit. Ind., Col. II, Chrys. I, p. 15 (1908); REITTER, Fauna Germ., IV, p. 81 (1912); CLAVAREAU, Col. Cat., LI, p. 52 (1913); KUHNT, Illust. Best.-Tab. Käfer Deutsch., p. 817 (1913); SCHAUFUSS, Calw. Käferb., II, p. 901 (1916).

Of the genus *Lema* of Japan, from Karafuto in the north to Taiwan in the south, including Chosen, more than twenty species have hitherto been described. However, my careful examination of the material at hand reveals not only some reduction of the number of species on account of synonyms, but also one species and three varieties new to science; and we can enumerate nineteen species and three varieties at present in our faunal region. I wish to make use of this occasion to tabulate and describe them in the following pages. The material used is of three collections in the Entomological Museum, Faculty of Agriculture, Hokkaido Imperial University, in the Entomological Laboratory, Department of Agriculture, Kyushu Imperial University and in the Hokkaido Agricultural Experiment Station.

1. *Lema puncticollis* CURTIS

Crioceris puncticollis CURTIS, Brit. Ent., VII, Pl. 323 (1830).

Lema puncticollis BALY, Trans. Ent. Soc. Lond., 1873, p. 74 (1873); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., p. 752 (1885); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 6 (1904); REITTER, Fauna Germ., IV, p. 81 (1912); KUHNT, Illust. Best.-Tab. Käfer Deutsch., p. 817 (1913); SCHAUFUSS, Calw. Käferb., II, p. 903 (1916).

Lema cyanella (nec LINNÉ) WEISE, Naturg. Ins. Deutsch., I Abt., VI, p. 61 (1881); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); FOWLER, Col. Brit. Isl., IV, p. 281 (1890); CLAVAREAU, Col. Cat., LI, p. 60 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1231 (1929).

Lema rugicollis SUFFRIAN, Stett. Ent. Zeit., A. 1841, p. 97 (1841); LACORDAIRE, Mém. Soc. Roy. Sci. Liége, III-1, p. 362 (1845).

Local Distribution: Sapporo (June 12, 1916, May 31, 1918, leg. S. MATSUMURA), Atsubetsu, Prov. Ishikari (May 28, leg. S. MATSUMURA), Iwate, Prov. Rikuchû (September 8, 1912, leg. T. OGASAWARA), Chûzenji, Prov. Shimotsuke (June 3–6, 1911, leg. S. MATSUMURA; July 21–31, 1914, July 8–17, 1916, September 25, 1916, leg. E. GALLOIS), Tokyo (July, 1903, leg. S. MATSUMURA), Chichibu, Prov. Musashi (June 10, 1913, leg. H. TAKABAYASHI), Mt. Takao, Prov. Musashi (May 6, 1912, leg. H. TAKABAYASHI; May 18, 1913, leg. E. GALLOIS), Kôyadaira, Prov. Awa (August 4–6, 1913, leg. E. GALLOIS), Nagasaki (July 8, 1913, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Hokkaido, Honshu, Shikoku, Kyushu; Mongolia; Europe.

Japanese Name: Ruri-kubiboso-hamushi.

Remarks: This species does not seem to be very rare from Hokkaido to Kyushu. J. S. BALY (*3*) first recorded this species from our faunal region on a single specimen taken by G. LEWIS at Nagasaki.

2. *Lema cyanella sapporensis* MATSUMURA

Lema sapporensis MATSUMURA, Jour. Coll. Agr., Tohoku Imp. Univ., IV, p. 140 (1911) YOKOYAMA & KANO, Dôbutsu. Zasshi, XXXIX, p. 24 (1927).

Lema pygmaea (KRAATZ in part) WINKLER, Cat. Col. reg. Palaearc., X, e. 1231 (1929).

Local Distribution: Ôdomari, Karafuto (June 30, 1919, leg. E. IZAWA) [in the collection of the Hokkaido Agr. Exp. Sta.]; Toyohara, Karafuto (August 24, 1914, leg. J. ADACHI & S. ISSIKI), Sapporo (May 16, 1904, leg. S. MATSUMURA), Jôzankei, Prov. Ishikari (July 12, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Tonnaitcha (after S. MATSUMURA).

General Distribution: Karafuto, Hokkaido.

Japanese Name: Hime-ruri-kubiboso-hamushi.

Remarks: S. MATSUMURA (*25*) in his original description states that *L. sapporensis* may be distinguished from *L. cyanella* by the character of the punctures on the pronotum and the size. A. WINKLER (*39*) treated recently this species as a synonym of *L. pygmaea*, which was originally described from the Amur. Nevertheless, in examining the specimens of *L. cyanella* taken in Finkenkrug near Berlin and Göttingen, Germany, by T. ESAKI, and the type specimens of *L. sapporensis*, I have come to conclusion that the difference between the two forms can not be adopt as a specific character, while *L. sapporensis* should be taken for a local form, or subspecies, of *L. cyanella*. The typical *L. cyanella* is distributed in Europe and Siberia. In the collection of the Hokkaido Agricultural Experiment Station, I found one more specimen taken at Konuma, Karafuto, in July, 1930, by K. TAMANUKI. It is entirely blackish in colour dorsad, while the other characters agree with this species. I presume that it is a melanic aberration to be referred to ab. *obscura* STEPHENS, well known as a common form in Europe.

3a. *Lema concinnipennis* BALY

Lema concinnipennis BALY, Ann. Mag. Nat. Hist., (3), XVI, p. 157 (1865); BALY, Trans. Ent. Soc. Lond., 1873, p. 70 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3252 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 6 (1904); CLAVAREAU, Col. Cat., LI, p. 59 (1913); DOI, Dôbutsu. Zasshi, XXXIX, p. 326 (1927); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Lema Kiotoensis PIC, Mél. Exot. Ent., XLI, p. 12 (1924).

Local Distribution: Kyoto (July 5, 1913, leg. S. HIRAYAMA), Kôyadaira, Prov. Awa (August 4-6, 1913, leg. E. GALLOIS), Keijô (June 8, 1919, leg. E. GALLOIS), Taiyudong, Chosen (leg. E. GALLOIS), Tojinmen, Chosen (leg. K. DOI) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mt. Kibune, Prov. Yamashiro (June 25, 1919, leg. M. SUZUKI), Fukuoka (April 23, 1929, leg. T. MATSUO) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Hyôgo, Prov. Settsu (after J. S. BALY); Nagasaki (after J. S. BALY).

General Distribution: Honshu, Shikoku, Kyushu, Chosen; North China; Turkestan (Coast of Tartary).

Japanese Name: Kibara-kubiboso-hamushi.

Remarks: J. S. BALY (*3*) noted that this species was found on the Chrysanthemum.

3b. *Lema concinnipennis* BALY var. *ventralis* nov. var.

Diagnosis: This varietal form is very similar structurally to the typical

species, but differs in the following respects:

1) Abdominal sternites concolorously blackish.

2) Size rather smaller throughout.

3) Scutellum more or less densely clothed with adpressed sericeous hairs.

Measurements: Length of body 4.5–5.0 mm; width of body 2.0 mm.

Local Distribution: Kôyadaira, Prov. Awa (July 27–August 11, 1913, leg. E. GALLOIS), Chosen (leg. H. OKAMOTO) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]

General Distribution: Shikoku, Chosen.

Japanese Name: Ruribara-kubiboso-hamushi.

Remarks: J. S. BALY *(2)* already recognized a variety, of which abdomen is entirely black, in 1865, when he described from the specimens brought from the North China, and then he *(3)* noted in 1873 that "in the majority of the larger specimens from Japan the abdomen is entirely black; but I possess others, equally large, from the coast of Tartary, in which the apex of the abdomen is testaceous: I presume, therefore, that this is normal colouring, the black apex being only a variety". He gave, however, no name on this variety, and I take this opportunity to adopt new name on this distinct variety.

4. *Lema coronata* BALY

Lema coronata BALY, Trans. Ent. Soc. Lond., 1873, p. 72 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3252 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); JACOBY & CLAVAREAU, Gen. Ins. XXIII, p. 6 (1904); CLAVAREAU, Col. Cat., LI, p. 60 (1913); WINKLER, Cat. Col. reg. Paraearc., X, e. 1232 (1929).

Local Distribution: Kumamoto (September 14, 1907, leg. H. KAWAMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mizoro-Ike, Prov. Yamashiro (June 21, 1918, leg. M. SUZUKI), Fukuoka (June 11, 1929, leg. M. FUJINO) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Honshu, Kyushu.

Japanese Name: Akazu-kubiboso-hamushi.

Remarks: J. S. BALY *(3)* reported that the type specimens of this species were captured on the Chrysanthemum. As far as I am aware of, this is rather a rare species in our faunal region.

5. *Lema dilecta* BALY

Lema dilecta BALY, Trans. Ent. Soc. Lond., 1873, p. 74 (1873); GEMMINGER & HAROLD,

Cat. Col., XI, p. 3253 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 194 & p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); CLAVAREAU, Col. Cat., LI, p. 62 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: Nakano, Prov. Musashi (July 17, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Maruyama, Prov. Ishikari (July 29, 1918, leg. M. SUZUKI) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Hyôgo, Prov. Settsu (after J. S. BALY); Ogura Lake, Prov. Yamashiro (after M. JACOBY); Kyoto (after M. JACOBY).

General Distribution: Hokkaido, Honshu.

Japanese Name: Maeboshi-kubiboso-hamushi.

Remarks: The specimen at my disposal, caught at Maruyama near Sapporo, has blackish legs, with the exception of fulvous basal halves of tibiae, and dark brownish raised spot at the middle between the upper portion of the eyes, but no other difference could be found. This species seems to be a rare one.

6. *Lema tristis* HERBST

Crioceris tristis HERBST, in Fuessly, Arch. Ins., VII, p. 165 (1786).

Lema tristis WEISE, Arch. f. Naturg., LXVI, p. 267 (1900); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 6 & p. 8 (1904); REITTER, Fauna Germ., IV, p. 81, Pl. 141-fig. 18 (1912); CLAVAREAU, Col. Cat., LI, p. 81 (1913); KUHNT, Illust. Best.-Tab. Käfer Deutsch., p. 817 (1913); SCHAUFUSS, Calw. Käferb., II, p. 903 (1916); YUASA, Kontyû, I, p. 96 (1926); WINKLER, Cat. Col. reg. Palaearc., X, e. 1231 (1929).

Lema flavipes SUFFRIAN, Stett. Ent. Zeit., II, p. 100 (1841); LACORDAIRE, Mém. Soc. Roy. Sci. Liége, III-1, p. 367 (1845); BALY, Trans. Ent. Soc. Lond., p. 75 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3254 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); WEISE, Naturg. Ins. Deutsch., VI, p. 65 (1882); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887).

Local Distribution: Nagara, Prov. Mino (July 19, 1919, leg. M. SUZUKI) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Tokyo (after Hiro. YUASA); Nagasaki (after J. S. BALY); Tsushima (after J. S. BALY).

General Distribution: Honshu, Tsushima, Kyushu; Siberia; Mongolia; South Europe.

Japanese Name: Kiashi-kubiboso-hamushi.

Remarks: In Japan it seems to be a rare species. J. S. BALY *(3)* regarded his Nagasaki and Tsushima specimens as a variety of European form on account of their infuscated tibia and tarsi. Hiro. YUASA *(42)*, however, recorded that the legs of his reared specimen are only darkened on the tarsi, while the Nagara specimen at my disposal has brownish legs,

only darkened at the last tarsal joint. From this I shall have to look upon the specimen having darkened legs as merely a form of individual variation.

7. *Lema melanopa* LINNÉ

Chrysomela melanopa LINNÉ, Syst. Nat., ed. X, 1, p. 376 (1758).

Crioceris melanopa FABRICIUS, Syst. Ent., p. 121 (1775); CURTIS, Farm. Ins., p. 307, Fig. 43 (1883).

Lema melanopa FABRICIUS, Syst. Eleuth., I, p. 476 (1801); SUFFRIAN, Stett. Ent. Zeit., 1841, p. 101 (1841); LACORDAIRE, Mém. Soc. Roy. Sci. Liége, III-1, p. 393 (1845); GEMMINGER & HAROLD, Cat. Col., XI, p. 3257 (1874); WEISE, Naturg. Ins. Deutsch., VI, p. 65 (1882); JACOBY, Proc. Zool. Soc. Lond., 1888, p. 351 (1888); FOWLER, Col. Brit. Isl., IV, p. 232 (1890); LEWIS, Entomologist, XXVI, p. 153 (1893); NAWA, Konchû Sekai, VIII, p. 343 (1904); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 5 & p. 7 (1904); REITTER, Fauna Germ., IV, p. 82, Pl. 142-fig. 1 (1912); CLAVAREAU, Col. Cat., LI, p. 70 (1913); KUHNT, Illust. Best.-Tab. Käfer Deutsch., p. 817 (1913); HODSON, Bul. Ent. Res., XX, p. 5, Pls. I-II (1929); WINKLER, Cat. Col. reg. Palaearc., X, e. 1231 (1929).

Lema melanopus SCHAUFUSS, Calw. Käferb., II, p. 903, Pl. XXXIII-fig. 13 (1916).

Local Distribution: Niigata (after G. LEWIS); Shiojiri-toge, Prov. Shinano (after G. LEWIS); Yoshiki district, Prov. Hida (after NAWA).

General Distribution: Honshu; Siberia; Madeira; North Africa; Europe.

Japanese Name: Kubiaka-kubiboso-hamushi.

Remarks: To supplement his catalogue of the Japanese Phytophaga published in 1885, M. JACOBY *(10)* noted in 1888 that "*Lema melanopa* is left out, the species is, I believe, found in Japan". G. LEWIS *(21)* also says in 1893 in regard to this species—"This Eurasian species is scarce in Japan; I found it at Niigata, and I swept five examples on the Shiwojiri-toge in July, 1881". Unfortunately I have not yet met with any specimen to be determined as *L. melanopa*, and I personally give rein to my imagination that M. JACOBY, G. LEWIS and NAWA might have wrongly identified the rice leaf-beetle, *L. oryzae*, as this species. Anyhow, the occurrence of this species in our faunal region is doubtful.

8. *Lema oryzae* KUWAYAMA

Lema oryzae KUWAYAMA, Ins. Matsum., V, p. 155 (1931).

Local Distribution: Kotoni, Prov. Ishikari (June 10–July 5, 1930, leg. S. KUWAYAMA), Kuroishi, Prov. Mutsu (June 9, 1930, leg. S. ASAHARA), Junisho, Prov. Ugo (May 21, 1930, leg. R. TAKEDA), Yamagata (June 9, 1930, leg. D. TOYOTA), Suyoshi, Prov. Echigo (June 13, 1930, leg. N. TAKAHASHI), Horikawa, Prov. Etchû (July 4, 1930, leg. S. IWAYAMA),

Minma, Prov. Kaga (June 20, 1930, leg. K. KATSUMATA), Kawagishi, Prov. Shinano (leg. T. ASANUMA), Hotaru, Prov. Kai (June 19, 1930, leg. T. KANZAWA), Mt. Kurama, Prov. Yamashiro (July 6, 1915, leg. M. SUZUKI), Tokusa, Prov. Nagato (July 5, 1930, leg. Tokusa Agr. Soc.), Tokusen, Heiannando (July 3, 1930, leg. S. MURAMATSU), Taihoku (April 13, 1930, leg. J. SONAN) [in the collection of the Hokkaido Agr. Exp. Sta.]; Kameda, Prov. Oshima (June 7, 1898, leg. S. MATSUMURA), Kashiwazaki, Prov. Echigo (leg. M. NAKAMURA), Gunma, Prov. Kôzuke (August 7, 1913, leg. S. MATSUMURA), Gifu (leg. Y. NAWA), Taihoku (April, 1915, leg. S. INAMURA; May 8, 1925, leg. R. TAKAHASHI) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mt. Kurama, Prov. Yamashiro (May 25, 1919, leg. M. SUZUKI); Kotoni, Prov. Ishikari (July 5, 1930, leg. S. KUWAYAMA) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]

General Distribution: Hokkaido, Honshu, Shikoku[1], Kyushu[2], Chosen, Taiwan.

Japanese Name: Ine-(doro)-kubiboso-hamushi.

Remarks: This species has been identified as *L. tristis* HERBST or *L. melanopa* LINNÉ, but it is not right. So far as my studies go, it is an undescribed species, and the above-mentioned name was given in 1931.

9. *Lema honorata* BALY

Lema honorata BALY, Trans. Ent. Soc. Lond., 1873, p. 73 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3255 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 175 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 66 (1913); TAKAHASHI, Jour. Pl. Protect. (Byôchûgai Zasshi), III, p. 277, 1 fig. (1916); TAKAHASHI, Sosai Gaichû Kakuron, p. 121, Figs. 69–70 (1928); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: Prov. Hyûga (April 29, 1909, leg. M. KURISAKI) [in the collection of the Hokkaido Agr. Exp. Sta.]; Iwate, Prov. Rikuchû (August 20, 1912, leg. T. OGASAWARA), Morioka (leg. S. MATSUMURA), Tokyo (July, 1903, leg. S. MATSUMURA), Mt. Takao, Prov. Musashi (May 6, 1912, leg. H. TAKABAYASHI), Komaba, Prov. Musashi (July 30, 1913, leg. H. TAKABAYASHI), Shizuoka (August 24, 1912, leg. H. TAKABAYASHI), Mt. Iwawaki, Prov. Kawachi (July 18, 1913, leg. S. ISSIKI), Nara (August 2, 1910, leg. S. MATSUMURA), Prov. Ise (leg. S. MATSUMURA), Mt. Kinkwa,

1) According to the communication from the Tokushima and Kagawa Agricultural Experiment Stations.

2) According to the "Surveys on the distribution of diseases and injurious insects. Part II" (Mimeograph), published in 1929 by the Board of Agriculture, Department of Agriculture and Forestry of Japan.

Prov. Mino (June 22, 1910, leg. T. ÔTSUKA), Takasago, Prov. Harima (July, leg. S. MATSUMURA), Hagi, Prov. Nagato (August 9, 1904, leg. S. MATSUMURA), Prov. Iyo (June 4, 1914, leg. S. ARAKAWA), Kôyadaira, Prov. Awa (July 25–August 11, 1913, leg. E. GALLOIS) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mizoro-Ike, Prov. Yamashiro (June 21, 1918, leg. M. SUZUKI), Wakasugiyama, Prov. Chikuzen (August 26, 1929, leg. T. ESAKI, H. HORI & M. FUJINO), Hikosan, Prov. Buzen (July 17, 1929, leg. T. ESAKI & M. FUJINO) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Honshu, Shikoku, Kyushu.

Japanese Name: Yamanoimo-kubiboso-hamushi.

Remarks: This species is very common in different localities, and as had already been reported by J. S. BALY (*3*) in 1873, this insect has a habit to feed on *Dioscorea japonica* ("Yamanoimo"). According to S. TAKAHASHI (*35*, *36*), this widely distributed species injures "Yamanoimo", like *Crioceris rugata* BALY, especially in Miye, Niigata, Saitama, Fukui, Ishikawa and Fukushima Prefectures, and produces one generation annually, hibernating in the adult-stage. TAKAHASHI stated also that the adult appears during the months of June and July and deposits her eggs singly on the young leaves or buds of the food-plant; the larva remains coverd with excreta during the greater part of its active life and skeletonizes the under surface of leaves, the cocoon is formed of a white quick hardening secretion on the under surface of leaves.

10. *Lema fortunei* BALY

Lema Fortunei BALY, Trans. Ent. Soc. Lond., (n. s.), V, p. 148 (1859); BALY, Trans. Ent. Soc. Lond., 1873, p. 74 (1873); GEMMINGER & HAROLD, Cat. Col., IX, p. 3254 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 175 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 64 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Lema postrema BATES, Proc. Zool. Soc. Lond., 1866, p. 353 (1866); GEMMINGER & HAROLD, Cat. Col., XI, p. 3259 (1874); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 74 (1913).

Local Distribution: Shôka, Taiwan (July 20, 1906, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Kyushu, Taiwan; North China.

Japanese Name: Taiwan-kubiboso-hamushi.

Remarks: So far as my investigations go, *L. postrema* BATES could hardly be distinguished from *L. fortunei* BALY, which was described much

earlier than the BATES' species, and so I treated in this paper *L. postrema* as the synonym of *L. fortunei*. In 1873, J. S. BALY (*3*) gave Nagasaki, Kyushu, as a locality of this species. I did not find, however, any specimens from that region.

11. *Lema lewisii* BALY

Lema Lewisii BALY, Trans. Ent. Soc. Lond., 1873, p. 72 (1873); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 175 (1887).

Lema Lewisi GEMMINGER & HAROLD, Cat. Col., XI, p. 3256 (1874); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 68 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: Prov. Hyûga (May 5, 1909, leg. M. KURISAKI) [in the collection of the Hokkaido Agr. Exp. Sta.]; Tamagawa, Prov. Musashi (May 21, 1914, leg. H. TAKABAYASHI), Mt. Kinugasa, Prov. Yamashiro (August 18, 1913, leg. S. HIRAYAMA), Kôyadaira, Prov. Awa (July 25–August 11, 1913, leg. E. GALLOIS), Prov. Iyo (May 1, 1914, leg. S. ARAKAWA), Kumamoto (April 12, 1907, August 27, 1907, leg. H. KAWAMURA), Beppu, Prov. Hyûga (July 10, 1916, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Hanazono, Prov. Yamashiro (July 6, 1921, leg. M. SUZUKI), Shimonoseki, Prov. Nagato (August 22, 1930, leg. K. YASUMATSU), Hikosan, Prov. Buzen (August 2, 1930, leg. K. YASUMATSU) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Honshu, Shikoku, Kyushu.

Japanese Name: Lewis-kubiboso-hamushi.

Remarks: This species is not rare in the southern parts of Japan.

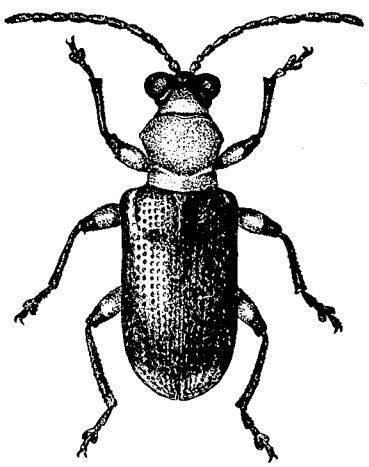
12. *Lema formosana* sp. nov. [Text-fig. II]

Diagnosis: Head metallic dark blue, with the vertex rufous; the lower portion of the face sparingly clothed with yellowish pubescence; eyes blackish; labrum and palpi nearly black; antenna long and slender, entirely black; the third joint one half longer than the second but shorter than the fourth; the fourth, the fifth and the sixth joints being equal; all joints shining, scarcely pubescent. Prothorax rufous and polish; sternites of the meso- and meta-thorax black, with dense yellowish pubescence.

Scutellum brownish black. Elytra metallic deep blue, margined with a flavous colour on the apical portions. Legs nearly black, except the basal halves of femora rufous; abdomen fulvous or flavous.

Head constricted posteriorly, vertex finely punctured and with a short

longitudinal groove in the middle; eyes large, deeply notched, the surrounding space rugose. Prothorax subquadrate, not longer than broad, rather deeply constricted just behind the middle at the sides; basal sulcus deep and sinuate; at the sides minutely and remotely punctured; rest of the surface impunctate. Scutellum broader than long, truncate at the apex, smooth. Elytra parallel-sided, with a distinct sutural depression below the base, regularly and rather deeply punctate-striate; the punctures larger within the depression, much finer and more apart posteriorly, where the interstices are convex. Underside clothed with fine pubescence.



Text-fig. II
Lema formosana sp. nov.
(Ca × 8)

Measurements: Length of body 5.5 mm.; width of body 2.0 mm.

Local Distribution: Taichû, Taiwan (May 4, 1907, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]

General Distribution: Taiwan.

Japanese Name: Tsumaki-kubiboso-hamushi.

Remarks: The cotypes are three specimens of the same locality and labelled as a pest of sugar-cane. The general appearance of this species is that of *L. lewisii* BALY, but by the colour of abdomen and femora, the character of the vertex and scutellum easily distinguish both species.

13. *Lema delicatula* BALY

Lema delicatula BALY, Trans. Ent. Soc. Lond., 1873, p. 75 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3253 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 753 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 61 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: Gifu (July 14, 1903, leg. Y. NAWA), Kôyadaira, Prov. Awa (August 9, 1913, leg. E. GALLOIS) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mt. Yatsugatake, Prov. Shinano (August 20, 1918, leg. M. SUZUKI), Hikosan, Prov. Buzen (August 2, 1930, leg. K. YASUMATSU) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Honshu, Shikoku, Kyushu.

Japanese Name: Kiobi-kubiboso-hamushi.

Remarks: This handsome species is rare but widely distributed in the southern Japan.

14. *Lema scutellaris* KRAATZ

Crioceris scutellaris KRAATZ, Deutsch. Ent. Zeitschr., XXIII, p. 130, Pl. II-fig. 4 (1879); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 28 (1904).

Lema scutellaris JAKOBSON, Rev. Russe d'Ent., VII, p. 26 (1907); CLAVAREAU, Col. Cat., LI, p. 77 (1913); DOI, Dōbutsu. Zasshi, XXXIX, p. 327, 1 fig. (1927); WINKLER, Cat. Col. reg. Palaearc., X, e. 1231 (1929).

Local Distribution: Kotoni, Prov. Ishikari (September 11, 1930, leg. S. KUWAYAMA; September 16, 1931, leg. M. TAKIZAWA) [in the collection of the Hokkaido Agr. Exp. Sta.]; Iwate, Prov. Rikuchû (May 16, 1912, leg. T. OGASAWARA), Mt. Takao, Prov. Musashi (May 24, 1912, leg. S. HIRAYAMA), Chosen (July, 1922, leg. T. UCHIDA & S. TAKANO) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mizoro-Ike, Prov. Yamashiro (June 21, 1918, leg. M. SUZUKI), Osaka (April 4, 1917, leg. T. ESAKI) [in the collection of the Ent. Lab., Dept., Agr., Kyushu Imp. Univ.]

General Distribution: Hokkaido, Honshu, Chosen; Siberia.

Japanese Name: Seaka-kubiboso-hamushi.

Remarks: This species seems to be rare, but widely distributed in the northern part of Japan as well as in Chosen, the type-locality being in the Amur. This species was newly added to the fauna of Hokkaido in this paper.

15. *Lema adamsii* BALY

Lema Adamsii BALY, Ann. Mag. Nat. Hist., (3), XVI, p. 156 (1865); BALY, Trans. Ent. Soc. Lond., 1873, p. 75 (1873); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 753 (1885).

Lema Adamsi GEMMINGER & HAROLD, Cat. Col., XI, p. 3250 (1874); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 194 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 6 (1904); CLAVAREAU, Col. Cat., LI, p. 53 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Lema quadripunctata SWARTZ, in Schönh. Syn. Ins., (1), II, p. 281 (1808); LACORDAIRE, Mém. Soc. Roy. Sci. Liége, III-1, p. 544 (1845).

Lema Swartzi CLARK, Cat. Phyt., p. 25 (1866).

Local Distribution: Honshu[1] (June 4, 1908, leg. KOJIMA), Hachijo-jima (August 18, leg. S. MATSUMURA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Yuyama (after M. JACOBY); Nagasaki

1) Locality is uncertain.

(after J. S. BALY); "Korea" (after H. CLAVAREAU).

General Distribution: Honshu, Kyushu, Chosen; China.

Japanese Name: Kiberi-kubiboso-hamushi.

Remarks: As had already been mentioned by J. S. BALY *(3)* and M. JACOBY *(9)*, the colouration, especially the markings on the elytra, of this species varies considerably among the individuals. For instance, one of the two specimens at my disposal has two bluish black spots on each elytron as originally described by J. S. BALY *(2)*, and the other has a bluish black longitudinal broad band, by the connection of the elytral spots, as noted by M. JACOBY *(9)*.

16a. *Lema diversa* BALY

Lema diversa BALY, Trans. Ent. Soc. Lond., 1873, p. 71 (1873); GEMMINGER & HAROLD, Cat. Col., XI, p. 3253 (1874); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 62 (1913); DOI, Dôbutsu. Zasshi, XXXIX, p. 326 (1927); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: Kyoto (leg. M. SUZUKI; leg. S. HIRAYAMA), Nagasaki (1924, leg. T. ISHII), Genzan (August 2, 1919, leg. E. GALLOIS), Keijo (September 12, 1918, leg. E. GALLOIS), Tojinmen, Chosen (July, leg. K. DOI) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Hanazono, Prov. Yamashiro (June 16, 1921, leg. M. SUZUKI) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]; Nagasaki (after J. S. BALY).

General Distribution: Honshu, Kyushu, Chosen; China.

Japanese Name: Aka-kubiboso-hamushi.

Remarks: J. S. BALY *(3)* reported that this species was captured on the Chrysanthemum at Nagasaki.

16b. *Lema diversa* BALY var. *doii* nov. var. [Text-fig. III]

Diagnosis: Differs from the typical species in the following points:

1) Each elytron with a bluish black longitudinal band along the side. This band sometimes is broadened apically, and covers the distal half of elytron, leaving only the sutural and lateral margins of the ground colour.

2) The sutural depression below the base of elytra is rather shallower than that of the typical species.

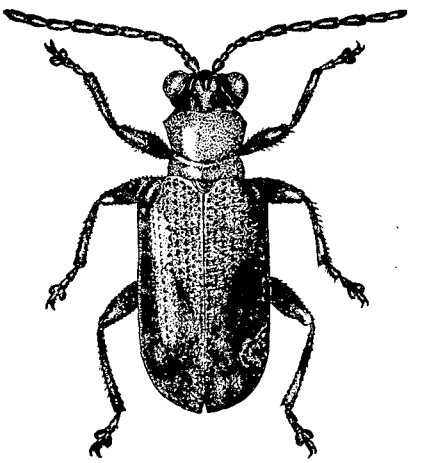
Measurements: Length of body, 5.5 mm., width of body, 2.2 mm.

Local Distribution: Kyoto (leg. S. HIRAYAMA) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]

General Distribution: Honshu.

Japanese Name: Kurosuji-kubiboso-hamushi.

Remarks: Two specimens of this variety are placed at my disposal. Dedicated this variety to K. DOI who studied the Chrysomelid-fauna of Japan recently.



Text-fig. III

Lema diversa var. *doii* nov. var. (Ca × 8)

17. *Lema downesii* BALY

Lema Downesii BALY, Ann. Mag. Nat. Hist., (3), XVI, p. 156 (1865); BALY, Trans. Ent. Soc. Lond., 1873, p. 75 (1873); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 752 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887).

Lema Downesi GEMMINGER & HAROLD, Cat. Col., XI, p. 3253 (1874); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); JACOBY, Fauna Brit. Ind., Col. II, Chrys. I, p. 43 (1908); CLAVAREAU, Col. Cat., LI, p. 62 (1913).

Lema nigrosuturalis CLARK, Cat. Phyt., App., p. 37 (1865).

Local Distribution: Nagasaki (after J. S. BALY).

General Distribution: *Kyushu; India.*

Japanese Name: Sesuji-kubiboso-hamushi.

Remarks: Since J. S. BALY *(3)* recorded the occurence of this species at Nagasaki, so far as I am aware of, no one added any locality in our faunal region, due to be quite rare. Also unfortunately no specimen has been available to me for examination.

18. *Lema minutissima* PIC

Lema minutissima PIC, Mél. Exot. Ent., XL, p. 18 (1923); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Local Distribution: "Japon" (after M. PIC).

General Distribution: Japan.

Japanese Name: Hime-kubiboso-hamushi.

Remarks: This species, originally described from Japan without any denotation of detailed locality, seems to be a very rare one in our faunal region, and as far as I am aware of, only the type specimen in PIC's collection is at present known.

19a. *Lema decempunctata japonica* WEISE

Lema decempunctata GEBLER var. *japonica* WEISE, Horae Soc. Ent. Ross., XXIII, p. 562

(1889); JACOBY & CLAVAREAU, Gen. Ins., XXIII, p. 7 (1904); CLAVAREAU, Col. Cat., LI, p. 61 (1913); WINKLER, Cat. Col. reg. Palaearc., X, e. 1232 (1929).

Lema decempunctata (nec GEBLER) BALY, Trans. Ent. Soc. Lond., 1873, p. 76 (1873); LEWIS, Cat. Col. Jap. Arch., p. 27 (1879); JACOBY, Proc. Zool. Soc. Lond., 1885, p. 753 (1885); SCHÖNFELDT, Jahrb. Nass. Ver. Naturk., XL, p. 174 (1887); MATSUMURA, Thous. Ins. Jap., IV, p. 32, Pl. LVIII-fig. 21 (1907); NAWA, Konchû Sekai, XII, p. 363, Pl. XI-fig. 1 (1908); DOI, Dôbutsu. Zasshi, XXXIX, p. 327 (1927).

Local Distribution: Nakano, Prov. Musashi (June 12, 1912, leg. H. TAKABAYASHI), Komaba, Prov. Musashi (May 14, 1912, leg. H. TAKABAYASHI), Gifu (June 9, 1893, leg. Y. NAWA), Takasago, Prov. Harima (May, 1903, leg. S. MATSUMURA), Hyôgo, Prov. Settsu (April 14, 1914, leg. S. HIRAYAMA), Keijo (June 5, 1922, leg. G. TAKAGI) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mizoro-Ike, Prov. Yamashiro (June 21, 1918, leg. M. SUZUKI), Kagoshima (May 12, 1912, leg. T. ESAKI), Toso, Prov. Satsuma (April 23, 1916, leg. T. ESAKI) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.]

General Distribution: Honshu, Kyushu, Chosen.

Japanese Name: Tohoshi-kubiboso-hamushi.

Remarks: J. WEISE *(38)* separated the Japanese form as a variety from the typical species which occurs in the central Mongolia and Siberia, by a darker colouration and more conspicuous punctation. On closer examination of many specimens from many localities of our faunal region, I should like to regard WEISE's diagnosis of var. *japonica* as a rather constant character of local form or subspecies. According to J. S. BALY *(3)*, the typical species is distributed also in the North China. BALY also noted that in Japan this species occurs commonly along the coast-regions, where it is found on the tea-plant. On the other hand, U. NAWA *(29)* reported that this is common in the vicinity of Gifu and defoliates the leaves of *Lycium chinense* ("Kuko"). According to NAWA, the adult of this insect deposits dull yellowish eggs in a mass of about five or six to fifteen, and the larvae, covered with a mucous secretion, eat the leaves, sometimes devouring them altogether.

19b. *Lema decempunctata japonica* WEISE

var. ***brunneipennis*** MATSUMURA (MS.), nov. var. [Text-fig. IV]

Diagnosis: This variety differs from the typical form in having the complete evanescence of the steel-blackish spots on the elytra, and also in having the entirely blackish legs.

Measurements: Length of body, 5.0 mm.; width of body 2.3 mm.

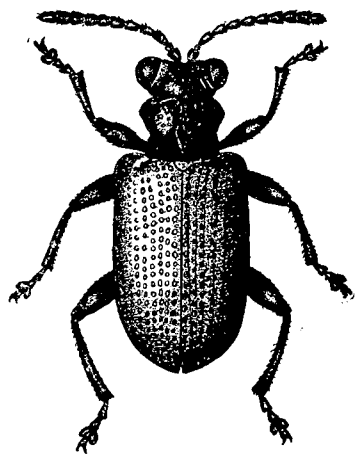
Local Distribution: Kameoka, Prov. Tamba (May 7, 1915, leg. M.

SUZUKI) [in the collection of the Hokkaido Agr. Exp. Sta.]; Nakano, Prov. Musashi (June 12, 1912, leg. H. TAKABAYASHI), Tokyo (May, 1914, leg. M. GALLOIS) [in the collection of the Ent. Mus., Facul. Agr., Hokkaido Imp. Univ.]; Mizoro-Ike, Prov. Yamashiro (June 21, 1918, leg. M. SUZUKI) [in the collection of the Ent. Lab., Dept. Agr., Kyushu Imp. Univ.].

General Distribution: Honshu.

Japanese Name: Mumon-kubiboso-hamushi.

Remarks: *Lema decempunctata japonica* is, as mentioned already by J. S. BALY *(3)*, among the most variable examples in the markings. I found in the specimens at my disposal that the number of steel-black spots on the elytra varies from four to ten among the individuals. However, it may be convenient to arrange the form, of which the spots on the elytra are completely obsolete, as a distinct variety.



Text-fig. IV

Lema decempunctata japonica var. *brunneipennis* nov. var. (Ca ×8)

(2) Key to the Japanese Species of *Lema*

As is enumerated in the foregoing pages, we can recognize in Japan nineteen valid species and three varieties of the genus *Lema* at present, and they can be readily distinguished in the following table:

1. Prothorax metallic blue or steel-black. **2**
   Prothorax red or rufous. **10**
2. Elytra testaceous and prothorax steel-black. **3**
   Elytra and prothorax concolorously metallic blue. **4**
3. Elytra with steel-black spots, number of which vary from 4 to 10; legs with the basal halves of femora and the middles of tibiae rufous. ... ... *L. decempunctata japonica*
   Elytra with no steel-black spot; legs entirely black. ... *L. d. japonica* var. *brunneipennis*
4. Head with light coloured markings. **5**
   Head without any marking. **6**
5. Size larger (5.0–5.5 mm.); head with a transverse rufous marking on the vertex; legs concolorously black. ... ... *L. coronata*
   Size smaller (3.0–3.5 mm.); head with an ill-defined but raised fulvous spot at the middle between the upper portion of eyes; legs fuscous excepting the basal halves of femora, apices of tibiae and tarsi which are blackish. ... ... *L. dilecta*
6. Legs testaceous or dark brown. ... ... *L. tristis*

Legs blackish or bluish black. 7

7. Prothorax constricted just before the base; less than 4.5 mm. in the body-length. ... ... *L. cyanella sapporensis*

Prothorax constricted just behind the middle; more than 4.5 mm. in the body-length.... 8

8. Pronotum impressed rather closely with large and strong punctures, being pock-marked.. ... ... *L. puncticollis*

Pronotum impressed with rather small but deep punctures.... 9

9. Last three ventral segments of the abdomen testaceous or dark brown. ... *L. concinnipennis*

Ventral segments of the abdomen entirely blackish. ... ... *L. concinnipennis* var. *ventralis*

10. Pronotum with four quadrately situated blackish spots. ... ... *L. adamsii*

Pronotum without any spot. 11

11. Elytra entirely metallic blue. 12

Elytra rufous, with dark coloured vittate markings, or metallic blue with testaceous markings.... 15

12. Head shiny, black or metallic blue.... 13

Head shiny, rufous. 14

13. Ventral segments of the abdomen blackish; antennae black with the two basal joints dark brownish; the apices of tibiae slightly infuscated; trochanter yellowish brown. ... ... *L. oryzae*

Ventral segments of the abdomen metallic blue; antennae entirely black; trochanter and the apices of tibiae black. ... ... *L. melanopa*

14. Under surface of the body rufous; legs rufous with the tibiae and tarsi black. ... ... *L. fortunei*

Under surface of the body black excepting those of the head and prothorax; legs entirely shiny black. ... ... *L. honorata*

15. Elytra metallic blue in the greater part. 1

Elytra rufous or fulvous, sometimes with vittate markings.... 19

16. Elytra with a broad common transverse fulvous fascia on the middle of third of them. ... ... *L. delicatula*

Elytra without a transverse fulvous fascia. 17

17. Elytra with a rectangular sutural fulvous marking behind the base and a fulvous apical area.... ... ... *L. scutellaris*

Elytra with a fulvous apical portion only. 18

18. Legs entirely black, ventral segments of the abdomen blackish, with last two or three segments fulvous. ... ... *L. lewisii*

Legs blackish with the basal halves of femora rufous; ventral segments of the abdomen fulvous or flavous. ... ... *L. formosana*

19. Elytra entirely rufous. 20

Elytra rufous or fulvous with vittate markings. 21

20. Size larger (5.5-6.0 mm.); legs black. ... ... *L. diversa*

Size smaller (3.0 mm.); legs testaceous. ... ... *L. minutissima*

21. Antennae entirely black; elytra rufous with a bluish black longitudinal band on each; legs black. ... ... *L. diversa* var. *doii*

Antennae fuscous with the fulvous basal joint; elytra pale fulvous with a black sutural band; legs fulvous with fuscous tarsi. ... ... *L. downesii*

3. Comparison with the Hitherto Known *Lema*-Species infesting the Gramineous Plants in the Palaearctic Region

(1) Comparison of the Graminivorous *Lema*-Species in the Palaearctic Region

So far as I am aware of, the following five species of the genus *Lema* have hitherto been known as the feeders of the Gramineous plants in the Palaearctic region, or from Europe to Asia.

1)	*Lema oryzae* KUWAYAMA	In Japan, especially in Hokkaido, Honshu, Chosen and Taiwan.
2)	*Lema melanopa* LINNÉ	In Europe, North Africa and Siberia, especially in England, Hungary, Russia, etc.
3)	*Lema hoffmannseggi* LACORDAIRE	In Europe and North Africa, especially in the south-eastern part of the Continent, such as Portugal and Spain.
4)	*Lema tristis* HERBST	In Europe, Siberia and Japan, especially in France.
5)	*Lema cyanella* LINNÉ	In Europe and Siberia, especially in Germany.

Of the above-mentioned species, we can easily discriminate *L. oryzae* on the adult-stage from others as is shown in the following key:

1. Upper surface of the body entirely metallic blue or cyaneous. 2
   Prothorax bright red or rufous, elytra metallic blue. 3
2. Legs bluish black or blackish. ... ... *L. cyanella*
   Legs testaceous or dark brown. ... ... *L. tristis*
3. Upper surface of the body dark metallic blue, except reddish or ferrugineous pronotum. Legs also dark metallic blue. Elytra deeply punctate-striate. ... *L. hoffmannseggi*
   Upper surface of the body metallic blue or cyaneous, with the pronotum red or ferrugineous. Legs concolorous with the pronotum, except the tarsi and the apices of tibiae darkened. 4
4. Ventral segments of the abdomen metallic blue. Antennae entirely black. Trochanter black. ... ... *L. melanopa*
   Ventral segments of the abdomen blackish. Antennae black with the two basal joints dark brownish. Trochanter brownish yellow. ... ... *L. oryzae*.

As S. HÄNSEL *(46)* stated already, the immature stages of these leaf-beetles are quite alike, and it is very difficult to discriminate one from another during the immature stages, as nowadays there is not much literatures on the detailed morphology and ecology. However, we can observe

some ecological points of agreement and difference between them from the previous records. So far as I am aware of, the following ecological characters can be noticed as special features common to the above mentioned species:

1. Annual number of generation is generally restricted to one. The production of two or more generations is sometimes reported, but it is exceptional and very rare. As the adults live for a long time, so it is liable to be mistaken under natural conditions as if two or more generations were produced in a year or the ovipositions by the newly emerged adult were done.

2. Overwintering form is usually in the adult-stage.

3. The injury to crops is caused by the adults and by the larvae. The feedings by both are similar and are effected by the removal of longitudinal stripes from the leaves, the lower epidermis being left intact.

4. In the temperate zone, the active time, or the duration of feedings by the adult and larva, is in the spring time, and usually continues up to the mid-summer.

5. The larva remains covered with excreta during the greater part of its active life.

6. The pupa is enclosed in a cocoon.

On the contrary, there are some different ecological habits among the species. On the selection of food-plants, W. E. H. HODSON (*47*) stated in regard to *L. melanopa* in the Great Britain that "barley, oats and wheat, in the order named, are the favourite larval food-plants in this country; larvae have been found in the field on Cocksfoot (*Dactylis glomerata*), Timothy (*Phleum pratense*), and Couch (*Agropyron repens*), and have been reared satisfactorily on Canary grass (*Phalaris canariensis*); adults feed freely on any cereal, particularly in the spring and early summer, but their staple food after harvest is Cocksfoot". S. HÄNSEL (*46*) found that the larva of *L. cyanella* in Germany up to mid-June feeds on barley, oats, rye and wheat. J. FEYTAUD (*45*) observed in France on *L. tristis* that Italian millet (*Panicum italicum*) is a preferred food, the common millet in adjoining fields being very little damaged, and the maize not at all. As already stated, the principal food-plant of *L. oryzae* is only the rice-plant. These accounts are enough to distinguish *L. oryzae* from the other related species.

On the pupating habit, S. HÄNSEL (*46*) called attention to the fact that the situation of pupation differs between *L. cyanella* and *L. melanopa*. That is, the cocoon of *L. cyanella* is formed of a white quick hardening

secretion from the mouth, and is usually placed on the upper leaf-surface and very rarely between the ear-awns, while *L. melanopa* pupates in an earthen thin membranous envelope hidden underground. The cocoon of *L. oryzae*, as stated in the preceding pages, is formed of a white secretion, and is usually placed on the upper surface of leaves, but sometimes on the ground and rarely under the ground. In regard to these facts, we can recognize that *L. oryzae* is the mediate between *L. melanopa* and *L. cyanella*, or rather similar to the latter, in spite of more resemblance existing in the adult-characters to *L. melanopa*.

(2) More Detailed Difference between *L. oryzae* and *L. melanopa*

Here I desire to detail my careful observations on the difference between the rice leaf-beetle and the European *Lema melanopa* not only on the morphological characters but also on the ecological characters.

L. oryzae	***L. melanopa***
(On the morphological characters of the adult)	
1. Size smaller. Length of body (♀) 4.76 mm. and the width 1.75 mm. on the average.	1. Size larger. Length of body (♀) 4.95 mm. and the width 1.90 mm. on the average.
2. Antenna blackish, except two basal joints, which are shiny dark brown on the upper and dark yellowish brown on the under surface. The interjoint-membrane brownish. Length-comparison of the joints is as follows: XI> V> VI. VII> VIII> IX> X> IV> I> III> II (♂) Length of antenna (♂) 2.091 mm. on the average. [Pl. I–fig. 1]	2. Antenna blackish, except the basal joint, which is dark cyaneous in colour. The interjoint-membrane blackish. Length-comparison of the joints is as follows: V> VII> XI> VI> VIII> IX> X> IV> III> I> II (♂) Length of antenna (♂) 2.523 mm. on the average. [Pl. I–fig. 4]
3. Elytra thinner. Length and width of elytron (♂) 3.275 mm. and 1.04 mm. on the average. [Pl. I–fig. 7]	3. Elytra thicker. Length and width of elytron (♂) 3.383 mm. and 1.05 mm. on the average. [Pl. I–fig. 8]
4. Legs bright brownish yellow, except the coxae blackish, tarsi dark brown, and the apices of tibiae darkened. Claws comparatively longer. Average lengths of legs including the claws, and those of claws in the male are as follows:	4. Legs bright reddish brown, except the coxae, trochanter, tarsi and the apices of tibiae blackish. Claws comparatively shorter. Average lengths of legs including the claws, and those of claws in the male are as follows:

	Total length of leg	Claw
	mm.	mm.
Fore leg	2.976	0.116

	Total length of leg	Claw
	mm.	mm.
Fore leg	3.306	0.096

Middle leg	3.128	0.132
Hind leg	3.444	0.132

[Pl. I-fig. 14]

5. The abdominal sternites blackish, covered densely with grayish yellow pubescence and closely punctured. The intersternal membrane pale brown, without marking. [Pl. I-figs. 12 & 13; Pl. II-fig. 9]

6. The penis glossy yellow, spatulate in shape, its apex being sharply pointed. At the distal one-third of each lateral fold there is a S-shaped reddish brown marking. The length 0.824 mm., the height 0.243 mm. on the average. [Pl. II-fig.2]

Middle leg	3.387	0.096
Hind leg	3.891	0.107

[Pl. I-fig. 15]

5. The abdominal sternites shiny metallic greenish blue and sparsely punctured, the pubescence being very few. The intersternal membrane brownish, finely reticulated with transverse hexagonal markings all over. [Pl. I-fig. 16a; Pl. II-fig. 10]

6. The penis dark brown, spatulate in shape, but its apex obtuse. No conspicuous marking. The length 0.88 mm., the height 0.39 mm. on the average. [Pl. II-fig. 3]

(On the morphological characters of the egg)

7. Egg elongate ovoid in shape, rounded at the narrow end and somewhat angulated at the broad end. Length 0.807 mm. and the width 0.375 mm. at the middle on the average. [Pl. II-fig. 4a]

7. Egg cylindrical, rounded at ends. Length 1.092 mm. and the width 0.533 mm. on the average. [Pl. II-fig. 4b]

(On the morphological characters of the larva)

8. On the prothoracal shield of the full-grown larva, many dark brownish spots are scattered. [Pl. II-fig. 6]

8. On the prothoracal shield of full-grown larva, a few brownish spots are restricted on the posterior area.

(On the food-plants)

9. Rice-plant is only the food-plant for the larva. Our experiments on many cereals other than the rice-plant have been failures. Adults feed occasionally on *Phragmites communis*, Orchard grass, Timothy, *Zizania latifolia*, *Imperata cylindrica* var. *Koenigii*, etc., especially prior to the growing of rice-plant in spring. According to my repeated experiments, however, the rice-plant is also only the favourite food-plant for the adult among the cereals and grasses cultivated in Hokkaido.

9. Barley, oats and wheat, in the order named, are the favourite larval food-plants. Larva is also found in the field on Orchard grass, Timothy, and Couch (*Agropyron repens*), and it may be reared satisfactorily on Canary grass (*Phalaris canariensis*). Adult feeds freely on any cereal, particularly in spring and in the early summer, but its staple food after harvest is Orchard grass. [After W. E. H. HODSON (47)].

(On the habits of oviposition)

10. The eggs are usually placed on the leaves, adjoining rather roughly each other in a mass. [Pl. II-fig. 5]
The number of eggs in a mass varies from 1 to 46, the majority containing from 3 to 12 eggs. However, single deposition occurs as a rare and an abnormal case.

10. The eggs are laid singly, each on a carefully selected site. It is a quite rare case that two or more eggs are adjoined.

(The construction of cocoon and the pupating place)

11. The cocoon is a whitish fragile chamber constructed by the secretion of the larva, though the cocoon is formed on or under the ground; though attached to some particles of soil, the adherence is not so compact. [Pl. IV–fig. 3]	11. The cocoon is constructed by the secretion of the larva in the soil, and adheres compactly to soil-particles.
12. In the case of ordinary rice-field, the greater part of the cocoon are situated on the upper surface of leaves, and a few are in the soil. In the case of upland rice-field, most of cocoons are formed on the surface of ground, next to this they are formed on the leaves, and a few are in the soil.	12. The larva invariably pupates in the soil.

4. Discussion

So far as my studies go, among many hitherto known species of the genus *Lema* the one most closely related to the rice leaf-beetle is, of course, *Lema melanopa* LINNÉ. However, as already has been mentioned in detail in the foregoing pages, I found many important differences between two species not only on the morphological characters of the adults as well as of the immature stages, but also on the ecological characters. It is very interesting to me that the differences of the morphological characters of the adult between two species are proved substantially by the early descriptions of senior entomologists. On *L. melanopa* J. CURTIS (*44*) recorded the diagnosis in his "Farm Insects" published in 1883, and Toraji TANAKA (*92*) of the Niigata Agricultural Experiment Station published in 1901 a very thorough description on the rice leaf-beetle. Some important portions of these two works are given as follows:

L. oryzae	*L. melanopa*
[After Toraji TANAKA (*92*, pp. 54–55); carefully translated from Japanese]	[After J. CURTIS (*44*, p. 308)]
[Antennae] Antennae are filiform, 2.1 mm. in length, and with eleven joints; basal joint is large but short, the second small, these two joints being yellowish brown, shining, and without pubescence; the following nine joints are blackish brown, each joint being twice as long as the width, the terminal one	[Antennae] "The antennae are twice as long as the thorax, subclavate, black and pubescent, excepting the basal joint, which is green, shining, and globose; second small; third and fourth obovate; the following compressed, broader, and obovate-truncate; apical joint conical."

conical, and densely covered with grayish yellow pubescence, having four long hairs on each apical margin of the joints.	
[Abdomen] Abdomen is of seven segments; yellowish brown dorsad, deep black ventrad and with grayish pubescence densely.	[Abdomen] "The under side is deep blue and punctured."
[Legs] "The six legs are pale yellowish brown, except the coxae blackish; the femora are stout; the third joints of the tarsi bilobed, and hide the fourth and a part of the fifth; each joint of tarsi provided with grayish yellow pubescence, except the fourth.	[Legs] "The six legs are bright and deep ochreous: the trochanters black; the thighs are stout: the tips of the tibia are dusky, and the tarsi are black and pubescent: they are four-jointed, and cushioned beneath; the two basal joints are elongated, third bilobed, fourth the longest, slender, clavate, and furnished with two simple claws."

The above comparison fully agrees with the result of my studies as already mentioned.

In naming the rice leaf-beetle as *L. oryzae*, I should say a few words. It is an explanation in regard to the name *L. flaviceps*. In his excellent work "Nippon Nôsakumotsu Gaichû Hen" published in 1899, C. SASAKI (*79*) recorded this species under the name of "*Lema flaviceps* Suff.", and this name was followed by some entomologists and agriculturists in Japan up to the present time. Since E. SUFFRIAN never named "*flaviceps*" at least in the genus *Lema*, and at the same time the name "*flaviceps*" has its own meaning, it appears to have the rights of priority. However, C. SASAKI (*79*) wrote "Suff." as the author-name, and in 1919 he (*80*) adopted "*Lema tristis* Hbst.", admitting the synonym of *L. flavipes*. In fact, it is apparently possible to cause an illusion that the pronotum of the rice leaf-beetle is bright yellowish brown to reddish brown colour. From these facts, "*flaviceps*" should be admitted as an error of transcription for "*flavipes*." So I proposed another name "*oryzae*" to the rice leaf-beetle, in accordance to the Nineteenth Article of the International Rules of Zoological Nomenclature, revised in 1927.

VII. DISTRIBUTION AND ORIGINAL HOME

It is difficult to determine the exact distribution of the insect in Japan as there is not much literature on the subject. However, as I said before, this insect occurs all over Hokkaido, Honshu, Shikoku, Kyushu, Chosen

and Taiwan; that is, the distribution is extended from about 22.°5 to about 44° in the north latitude and within about 121° and 144° in the east longitude at present.

In Hokkaido, though this beetle was already known before 1898, its distribution was limited only to the Oshima Peninsula until 1913. The bad harvest of that island in 1913, caused insufficiency of seeds in the following year, and in the spring of 1914 some farmers in the Iwanai district of the County of Shiribeshi and the Usu district of the County of Iburi procured the young rice-plants from the Counties of Oshima and Hiyama. Unfortunately this transportation proved to be the cause of distributing the worst beetle to the areas just referred to, and the beetle soon spread over the neighbourhood of these localities. In 1921, the beetle distributed all over the County of Shiribeshi, and in 1926 it covered the fields as far north as Sapporo, and even extended its damages to the County of Urakawa. From 1921 to 1922, the Kamikawa district of the County of Kamikawa, the Uriu district of the County of Sorachi and the Nakagawa district of the County of Kasai became the centres of the infestation of this beetle. From 1926 to 1927 we found the centres of infestation in the Mashike district of the County of Rumoe and the Tokoro district of the County of Abashiri. The infestations gradually grew from these centres to the neighbourhood, especially so in the northern part of the Counties of Kamikawa and Sorachi. According to the inquiry of the Hokkaido-Government in 1929, the infested area by this leaf-beetle ran up to 62143 Chôbu,[1] it being about one-third of the total rice-field in Hokkaido. It is noticeable also that the infestation by the leaf-beetle is severer and more widely extended in the western half, bounded by the Hitaka and Kitami Mountain-ranges, than that in the eastern half.

In Honshu, the rice leaf-beetle is widely distributed from Aomori Prefecture in the north to Yamaguchi Prefecture in the south. The Board of Agriculture of the Department of Agriculture and Forestry of Japan (93), recorded in 1929 twenty-two prefectures as infested localities by this beetle. According to their surveys, the infestations in Aomori, Niigata, Toyama, Ishikawa, Nagano, Kyoto, Hyogo (the Province of Tajima only), Tottori, Shimane, Okayama (the mountain districts only) and Yamaguchi Prefectures are severer than those in Iwate, Miyagi, Akita, Ibaragi, Tochigi, Saitama, Fukui, Yamanashi, Gifu, Shizuoka and Aichi Prefectures. However, as far as I am aware of, besides the prefectures mentioned above, this beetle is also distributed in Yamagata, Fukushima,

1) 1 Chôbu=0.992 hectare.

Gunma and Hiroshima (the mountain districts only) Prefectures, and the severe infestations in the former two are heretofore known. In view of this fact, the infestation by this beetle is severer along the coast of the Sea of Japan than in the Pacific sea-board of Honshu. Moreover, this leaf-beetle has proved also to be harmful to the rice-field in the Islands of Sado and Oki.

In Shikoku, according to the official communications from four Prefectural Agricultural Experiment Stations, this beetle occurs rarely in Tokushima and Kagawa Prefectures, and the infestations are very slight.

In Kyushu, the mountain district in Ôita Prefecture is only the known habitat of this beetle, and according to the official communication from the Ôita Agricultural Experiment Station this beetle gives a slight injury, and does not seem to be an important pest.

In Chosen, according to S. NAKAYAMA (*64*), this leaf-beetle occurs abundantly in the mountain districts of Kankyô-Nandô, Kankyô-Hokudô, Heian-Hokudô, Kôgendô and Keishô-Nandô. The Kankyô-Hokudô Agricultural Experimental Farm (*100*) also reported a severe injury by this leaf-beetle in that prefecture in 1924. It may be recognized that this beetle has a tendency to distribute to the eastern half of the Peninsula.

In Taiwan, according to J. SONAN (*86*, *87*), this leaf-beetle is one of the most important noxious pests to the rice-culture, and its occurrence is limited to the submontane districts. This species is now extending towards the southern parts; about ten years ago its distribution was only limited to Taihoku and Shinchiku Prefectures, and the Daiankei Valley which forms a boundary between Shinchiku and Taichû Prefectures was the boundary of the distribution of this pest, but recently it was found in the Tôsei, Toyohara and Nôkô districts of Taichû Prefecture in the west and in the submontane districts along the coast of the Karenkô and Taitô Prefectures in the east as well as in the Kashôtô Island (Samasana). It seems as though this leaf-beetle in Taiwan has a tendency to distribute gradually from the north to the south.

Generally speaking, though it is widely distributed in Japan, the rice leaf-beetle occurs abundantly around the coast of the Sea of Japan with the exception of Taiwan; therefore the infestation is more serious in these localities than in the Pacific sea-board of Japan.

It is important to determine the actual locality, where this beetle is indigenous, and whence it spreaded to other localities. In Hokkaido and Taiwan, as stated above, the infested districts are yet limited, and the infestation now only gradually broadens to the north or the south, so that

these localities do not seem to be the original home of this species. Also Shikoku and Kyushu are not probable the original homes of this insect.

Most likely the original home may be found along the coast of the Sea of Japan in Honshu, especially in the region from Yamagata to Ishikawa Prefectures. However, as it is rather difficult to determine it at once, I shall discuss this matter later on.

VIII. NATURAL ENEMIES

There are some records on the parasites of the rice leaf-beetle but none on the predaceans. Birds, frogs and spiders may, to a certain extent, take part in destroying the leaf-beetle in its various stages, although I have no positive evidence to prove that such is the case. In this paper, however, I shall touch on the parasitic and predaceous insects only.

(1) Parasitic Insects

In 1901, T. TANAKA (*92*) described a Chalcid-fly under the name "Doromushi-midori-kobachi", which bred on the pupa of the rice leaf-beetle in Niigata Prefecture. As far as I am aware of, this is the first record on the parasites of the beetle referred to, and it is probably identical with *Trichomalopsis shirakii* CRAWFORD. In the year following, the Niigata Agricultural Experiment Station (*122*) recorded one more parasite, which belongs to the Ichneumonidae and named as "Doromushi-kuro-himebachi". According to the exact coloured plate annexed, it is no doubt that this Ichneumon-fly is referred to *Bathythrix kuwanae*, of which H. L. VIERECK (*121*) described in 1912 on the specimens bred on the larva of the rice leaf-beetle by S. I. KUWANA. In 1913, J. OKADA (*69*) reported his ecological observations on the parasites. According to him, one species of *Anaphes*, two Ichneumon-flies, one of which may be referred to as *Bathythrix* sp., and one Pteromalid-fly inhabit in Yamaguchi Prefecture. The percentage of parasitism of the egg-parasite attained about 63 per cent and that of parasites on the larva about 33 per cent on the average. In the same year, J. C. CRAWFORD (*107*) described a new genus and species under the name of *Trichomalopsis shirakii* based on the specimens bred on the pupa of the rice leaf-beetle by T. SHIRAKI.

In 1915, S. INAMURA (*111*) reported on the status of the parasites of the rice leaf-beetle in Taiwan. According to him, *Trichomalopsis shirakii* is a very beneficial Pteromalid-fly that devours this leaf-beetle; the percen-

tage of parasitism in Shinchiku Prefecture attained 75.9 per cent on the surveys carried out in May, 1914. Besides this species, one egg-parasite and one Ichneumon-flies on the larva, both undetermined, were reported in this paper. In 1922, the Hokkaido Agricultural Experiment Station (*96*) reported the occurrence of two species of parasites from the cocoons of the rice leaf-beetle, which are identical with the species reported from Niigata Prefecture. In 1928, T. UCHIDA (*119*) recorded "*Lema tristis*" as the host of *Nesopimpla naranyae* ASHMEAD besides *Naranga aenescens*. In the same year, I (*54*) also reported on the status of the parasites of the rice leaf-beetle in Hokkaido, enumarating one egg-parasite, *Polynema* sp., and three species of parasites on the larva and pupa, *Anilastus* sp., *Nesopimpla naranyae* ASHMEAD and *Pteromalus* ? sp.

In 1930, J. SONAN (*116*, *117*), furnished two papers concerning the Ichneumon-flies bred on the rice leaf-beetle. The species enumerated is as follows:

Anilasta japonica SONAN
Pezomachus lemae SONAN
Bathythrix kuwanae VIERECK
Habrocryptus ruficoxatus SONAN
Batithrix kuwanae var. *nigrans* SONAN
Batithrix rufus SONAN
Melcha lemae SONAN

By these works the following nine species and one variety parasitic on the rice leaf-beetle may now be known.

Mymaridae	Mymarinae	(1) *Anaphes nipponicus* KUWAYAMA (sp. nov.) (=*Anaphes* sp. =*Polynema* sp.)
Pteromalidae	Pteromalinae	(2) *Trichomalopsis shirakii* CRAWFORD
Ichneumonidae	Ophioninae	(3) *Anilastus japonicus* SONAN (=*Anilasta japonica* SONAN)
"	Pimplinae	(4) *Nesopimpla naranyae* ASHMEAD
"	Cryptinae	(5) *Melcha lemae* SONAN
"	"	(6) *Habrocryptus ruficoxatus* SONAN
"	"	(7) *Pezomachus lemae* SONAN
"	"	(8a) *Bathythrix kuwanae* VIERECK (=*Hemiteles narangae* UCHIDA)
"	"	(8b) *B. kuwanae* var. *nigrans* SONAN
"	"	(9) *B. rufus* SONAN (=*Batithrix rufus* SONAN)

As far as it is known, however, the members of the genera *Pezomachus* and *Bathythrix* are mostly secondary parasites, and it is probable that *P. lemae*, *B. kuwanae*, *B. kuwanae* var. *nigrans* and *B. rufus* may be also the secondary parasites to the rice leaf-beetle for the reasons to be discussed later on, though their exact host relationships are not yet clear enough.

A. Primary Parasites

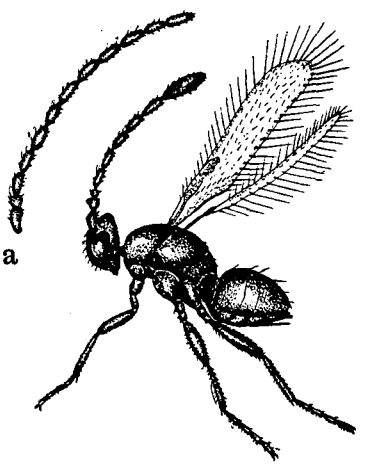
1. *Anaphes nipponicus* sp. nov. [Text-figs. V & VI]

(Doromushi-mukuge-tamagobachi)

Anaphes sp., OKADA, Yamaguchi Agr. Exp. Sta., Ex. Rep. 3, p. 9, Pl. II-fig. 1 (1913).
Polynema sp., KUWAYAMA, Hokkaido Agr. Exp. Sta., Bul. 47, p. 68 (1928).

This fairy fly belonging to the tribe Anaphini, subfamily Mymarinae, family Mymaridae of superfamily Chalcidoidea, is distributed in Japan through Hokkaido and Honshu, and acts as an important natural enemy, parasitic on the eggs of the rice leaf-beetle.

Morphological Characters of the Adult: [Female] General colour shiny black uniformly, with sparse whitish gray hairs. Scape and pedicel dark yellow, remaining antennal joints dark brown, all covered with moderate whitish gray hairs. Eyes mat black. Legs clay-yellow, with moderate concolorous pubescence, except the middle and hind coxae which are concolorous with the body. Wings hyaline, iridescent, fumate especially on the margins and bases, with brownish fringes and discal cilia; venation of fore wing dusky, inconspicuous.



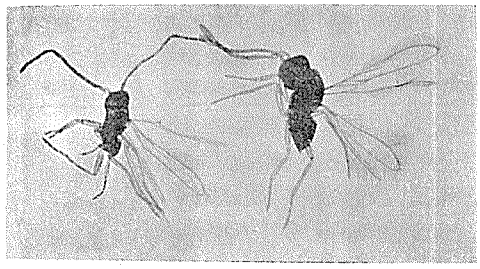
Text-fig. V

Anaphes nipponicus sp. nov. Female (Ca ×65)
a. Antenna of the male.

Body apparently impunctate. Head somewhat wider than the thorax and flexed obliquely downwards; face flattened; vertex produced acutely, with three ocelli; eyes large, ovoidal; mandibles acute and sharply curved. Antennae rather shorter than the body, 0.525 mm. in length, nine-jointed; scape cylindrical, somewhat dilated below, more than thrice as long as wide; pedicel much dilated apically, a little shorter than a half of the scape and about twice as long as wide at the apex; funicle-joints much longer than wide, slightly widening distad; first joint the shortest, much shorter than a half of the pedicel or the second funicle-joint, a little shorter than twice as long as wide; second funicle as long as the pedicel, while as wide as the first funicle; third to sixth funicle-joints subequal in shape, cylindrical, a little more than thrice as long as wide; the last joint or club the longest, somewhat spindle-shaped, a little shorter than the last two funicle-joints combined, its width being a little slenderer than twice as wide as the last funicle-joint. From the third to

sixth funicle-joints with each a sensorium as a long paler furrow visible from one side, and the club with four sensoria as paler furrows.

Thorax nearly as long as the abdomen, well developed, but not arched. Fore wings long and narrow, 0.66 mm. in length and 0.10 mm. in width, slightly curved at the apical fourth, narrower at the base in normal, somewhat rounded at the apical margin; discal cilia arranged in from 6 to 9 longitudinal lines, uniform, but the lines not at all in regular rows; an oblique proximo-caudal line of discal cilia running back from the marginal vein, containing about 13 cilia. The neuration reaches nearly to one-third of the wing-length, marginal nervure lengthened and slightly indented at the distal half, bluntly ended, with 9 to 10 bristles. The marginal cilia or fringe very long, of which the longest is measured 0.144 mm., being about one and a half times as long as the greatest width of the wing, and at the distal posterior angle. Hind wings a little shorter than the fore wings, slender and sharpened at the apex, and petiolate at the base, 0.58 mm. in length and 0.03 mm. in width. The longest of the marginal cilia is about six times as long as the width of the wing, measuring 0.18 mm. Discal ciliation is very sparse, the second row being just in advance of the mid-line. The apex of petiole terminated with several curved bristles or hamuli.



Text-fig. VI

The female and male of *Anaphes nipponicus* (Photograph of the mounted cotype-specimens.)

Legs slender, with four tarsal joints. Fore leg 0.61 mm. in length; first trochanter longer than the second; femur slightly shorter but broader than the tibia, provided with two curved spines near the apex; tarsus as long as or slightly longer than the tibia; the first tarsal joint with about 10 lateral ventral spines and as long as the fourth; the second and third being of the same length and shorter than the other. Middle leg 0.61 mm. in length and similar in shape to others, but the apical ventral spines weak and hardly visible. Hind leg a little longer than others, being 0.66 mm. in length; structure similar to that of the fore leg.

Abdomen subsessile and not petiolate, conic ovate in shape, the dark yellowish ovipositor slightly protruding.

[Male] Similar to the female. Antennae with twelve-joints, much

longer than that of the opposite sex, one and a half times as long as the body, 0.752 mm. in length; scape cylindrical, thrice as long as wide; pedicel much dilated apically, about a half length of the scape; funicle-joints cylindrical, with sensoria which are visible from side as a paler furrow longitudinally on each joint; first and ninth funicle-joints subequal, rather shorter than all the others; the remaining joints, including the club, almost equal in length; club bluntly pointed. Abdomen rather slender.

[Measurements] Average length of body, 0.608 mm. in the female, 0.496 mm. in the male.

Remarks on the Type-Specimens: Described from many cotype-specimens mounted in balsam and "Euparal", as well as preserved in dry and alcoholic conditions, from Kagura, Kamikawa district, County of Kamikawa and Ôno, Kameda district, County of Oshima. Cotypes are preserved in the collection of the Hokkaido Agricultural Experiment Station.

Remarks on the Parasitism: Although the number of generations in one year is not yet fully ascertained, it is probably more than five. The adults, as in the cases of other egg-parasites, seem to dislike the dark place, and are always prowling about their host on the surface of the rice-leaves, resting their wings on the back. When the female finds the egg-mass of the rice leaf-beetle, she mounts the egg-mass and lays her egg inside the egg by means of her sharp ovipositor. According to my observations the longevity of adult, confined in a glass-tube and fed with diluted honey, was about five days; so it is probable that the adults of this fairy fly live at least over a week in nature. At present, no host other than the egg of the rice leaf-beetle is known. According to the observations by J. OKADA (*69*) in Yamaguchi Prefecture during 1911 to 1912, the average percentage of the egg of the rice leaf-beetle parasitised by this fairy fly is 62.96 per cent, being 25.64 per cent during the period of the early to the middle part in June, 66.56 per cent during the end of June, and 96.67 per cent during the early part in July. In Hokkaido, my observations show that the occurrence of *Anaphes nipponicus* is limited to the southern part of of the island. To illustrate, the records of my observations in 1928 are given as follows:

Table XXVI—*Number of the adults of Anaphes nipponicus emerged from the eggs of the rice leaf-beetle in the Province of Ishikari, Hokkaido (1928)*

Locality collected	Date of collection	Number of the egg-masses of *L. oryzae*	Number of the adults of *A. nipponicus* emerged
Kotoni, Sapporo district	July 9	105	98
Itchan, Uriu district	July 13	49	0
Fukagawa, Uriu district	"	59	0
Nagayama, Kamikawa district	July 11	138	0
Higashi-Asahigawa, Kamikawa district	"	75	0
Kagura, Kamikawa district	July 12	171	0
Kamui, Kamikawa district	"	101	0

Based on these observations and the fact of the rapid propagation of the rice leaf-beetle in the recent year in the Counties of Kamikawa and Sorachi, an experiment on the transplantation of this egg-parasite from the Counties of Oshima and Shiribeshi to the above-named Counties, was attempted by our Experiment Station. At first, during June 26 and 27 about one thousand egg-masses of the rice leaf-beetle were gathered at Ôno, Kameda district, County of Oshima, Maeda and Kozawa, both in the Iwanai district, County of Shiribeshi, and about five hundred egg-masses were transported each to Itchan, Uriu district, County of Sorachi and Kagura, County of Kamikawa respectively, then they were put into each two Miye-type and Kagawa-type of the apparatus used for protecting the emergence of egg-parasites. For the second attempt, during July 14 and 16 inclusive about four thousand egg-masses were collected at Ôno, Kameda district and about one thousand and three hundred egg-masses were transported, and were preserved respectively in the same protecting apparatus at the same localities of Itchan and Kagura. From time to time we collected about 80 to 200 egg-masses, or 528 to 1802 eggs of the leaf-beetle in the rice-field and calculated the percentage of the emerged adults of the egg-

parasite against the total number of the eggs of the rice leaf-beetle. The data obtained are tabulated as follows:

Table XXVII—*Percentage of the emerged fairy fly, Anaphes nipponicus, against the total number of eggs of the rice leaf-beetle (1929)*

Date of the collection of egg-masses / Locality	June 25–26	July 2–3	July 11–17	July 22–27	August 2
Ôno, Kameda district, County of Oshima	% 0.78	—	% 14.33	—	—
Kozawa, Iwanai district, County of Shiribeshi	9.40	—	—	—	—
Maeda, Iwanai district, County of Shiribeshi	0.56	—	—	—	—
Itchan, Uriu district, County of Sorachi (breeding place)	—	% 0	1.17	% 3.56	—
Same (about 2 kilometers apart from the breeding place)	—	—	—	0	—
Kagura, Kamikawa district, County of Kamikawa (breeding place)	—	0	0.38	7.11	% 0.57
Same (about 2 kilometers apart from the breeding place)	—	—	—	51.53	39.01
Same (about 6 kilometers apart from the breeding place)	—	—	—	—	13.32
Nagayama, Kamikawa district, County of Kamikawa	—	—	—	4.27	38.38

As is seen in the above table, when the parasitised egg-masses were transported and protected by the use of the egg-parasite-protecting apparatus, this egg-parasite was able to settle easily in the locality where had not been any trace of this insect, as in the case at Itchan and Kagura. We examined in 1930 the collected egg-masses of the leaf-beetle from the

identical places, where the protecting apparatus were set up the previous year at Itchan and Kagura, and noticed that when once settled this egg-parasite easily hibernates and propagates in the succeeding year. The data obtained are as follows:

Table XXVIII—*Percentage of the emerged fairy fly, Anaphes nipponicus, against the total number of eggs of the rice leaf-beetle (1930)*

Date of the collection of egg-masses / Locality	July 14	July 24
Itchan, Uriu district, County of Sorachi	% 19.65	% 34.71
Kagura, Kamikawa district, County of Kamikawa	12.15	35.92

According to the survey of the Tokachi Branch, Hokkaido Agricultural Experiment Station, none of the emerged egg-parasites was observed from 358 egg-masses of the rice leaf-beetle, which were collected at Ikeda, Nakagawa district, County of Kasai, on July 19, 1930.

From the data obtained in 1929 and 1930, it may be inferred that the distribution of *Anaphes nipponicus* is localised in certain districts at present, though many other districts in Hokkaido also seem to be adapted to its habitation by the climatic and other environmental conditions.

The application or artificial multiplication of this natural enemy has much room for future studies, as it is very doubtful whether a proportionate reward by the practice of this method could be gained by the labour entailed or not. However, from the above it may be concluded that the collection of the egg-masses of the leaf-beetle and the protection of its natural enemy on the rice-field in the localities where *Anaphes nipponicus* is distributed are of course very desirable as one of the most effective controlling measures.

2. ***Trichomalopsis shirakii*** CRAWFORD [Text-fig. VII]

(Doromushi-midori-kobachi)

Trichomalopsis shirakii CRAWFORD, Proc. U. S. Nat. Mus., XLV, p. 252 (1913); INAMURA, Taiwan Nôjihô, 99, p. 163 (1915).

Gn. ? sp. ?, TANAKA, Niigata Agr. Exp. Sta., Month. Rep. 23, p. 57 (1901); Anonymous, Hokkaido Agr. Exp. Sta., Cir. 20, p. 8, fig. 7 (1922).

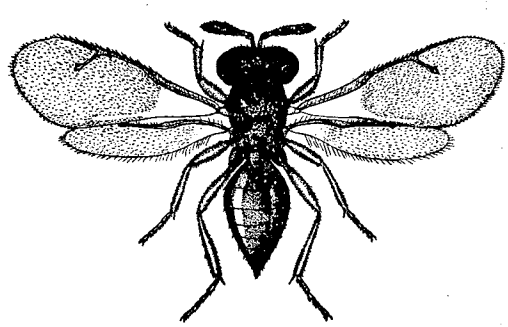
Pteromalid sp., OKADA, Yamaguchi Agr. Exp. Sta., Ex. Rep. 3, p. 9, Pl. II-fig. 3 (1913).

Pteromalus sp. ?, KUWAYAMA, Hokkaido Agr. Exp. Sta., Bul. 47, p. 69 (1928).

This species belongs to the tribe Rhaphitelini, subfamily Pteromalinae, family Pteromalidae, superfamily Chalcidoidea. This species is common in the rice-field of Hokkaido. According to the previous records, this is also known from Niigata and Yamaguchi Prefectures of Honshu and from Taihoku, Taiwan.

Morphological Characters of the Adult: [Female] General colour of the body metallic green, shining, the abdomen much darker, with a brownish tint, nitid. Body is covered with fine whitish hairs sparsely. Eyes indian-red in colour; ocelli dark yellow to reddish brown; scape and pedicel testaceous, rest of the antennae brown to dark brown, with whitish pubescence densely; mouth-part dark yellow, with reddish brown apices of mandibles. Wings hyaline, iridescent, nervures pale yellowish. Legs testaceous, except coxae which are concolorous with the body-colour, the tibiae and tarsi more whitish, apices of the terminal tarsal joints and claws darkened, provided with whitish fine hairs moderately.

Head transverse, slightly wider than the thorax, placed rather perpendicularly; occipital foraminal depression margined; the surface covered closely with thimble-like punctures; face below the antennal insertion engraved with many fine striae converging towards the mouth-part. Eyes ovate, not much raised. Ocelli with moderate distance each other, forming an obtuse isosceles triangle at the middle of vertex. Antennae rather thick, geniculate as usual, thirteen-jointed including two ring-joints (annelli); 0.96 mm. in length; basal joint very short, nearly globular; scape very long, more than one-fourth as long as the whole length of the antenna, slightly curved inwards, reaching nearly to the vertex; pedicel about one-third as long as the scape, dilated at the apex, shorter than the first funicle-joint; first ring-joint shorter than the second, both very short and narrow; each funicle-joint a little longer



Text-fig. VII

Trichomalopsis shirakii CRAWFORD
Female (Ca ×12.5)

than the width, while gradually broadened towards the distal joints, with 7 to 9 long sensoria on each; the terminal or club three-jointed, the ratio of the length being 4 : 4 : 3, each with 8 to 10 sensoria, bluntly pointed at the apex. Mandibles broad and stout, the right mandible quadridentate, the left tridentate, the teeth deeply separated, the inner one being especially sharpened.

Thorax, including propodeum, mesopleurae and metapleurae, engraved with thimble-like punctures closely as in the head, being narrower than in the head. Pronotum narrow, transverse. Metanotum wide and large; parapsidal furrows or Notauli not so much complete but distinct anteriorly and traceable backwards to nearly one-half of the notum; scutellum comparatively large, at the posterior margin nearly rounded, at the two-thirds backwards with an indistinct transverse line due to the difference in punctures; propodeum with a distinct neck, the lateral fold indistinct, due to the sculpture; median carina indistinct; propodeal spiracles small, elongate.

Fore wings broad and large, as long as the thorax and abdomen combined, 2.25 mm. in length, 0.95 mm. in width; broadened apically and rounded at the outer margin, hyaline; the fringe or marginal cilia rather short and discal ciliation very dense, without bristles on the subcostal (submarginal), marginal, radius (stigmae) and postmarginal nervures approximately 19 : 7 : 5 : 7 in ratio; radius as broad as the marginal, and much broader than the postmarginal; the radial knob thrice as broad as the radius; about 15 long bristles on the subcostal nervure; subcostal as long as a half of the wing-length and the postmarginal three-fourths. Hind wings much shorter and narrower than the fore wings, 1.55 mm. in length, 0.35 mm. in width; apex rather pointed; costal margin dented at the one-third from the base; both the costal and inner margins slightly curved basad; discal cilia rather close, inner marginal cilia very long; nervure reaching as far as two-fifths of the wing-length, with many bristles along it, and near the apex of nervure at margin with three curved bristles or hamuli.

In the fore leg, coxa with coarse raised reticulation, as twice as the trochanter; femur much shorter than the tibia, which is as long as the tarsal joints and claws combined; near the apex of tibia the spur is a little shorter than the first tarsal joint; tarsal joints 6 : 4 : 3 : 2 : 5 in length-ratio. Middle leg similar to the fore leg; femur is as long as the tibia; tarsal joints 8 : 5 : 3 : 2 : 5 in length-ratio. In the hind leg, coxa much larger than that of the other legs; femur much shorter than the tibia; only one apical spur of the tibia as a half as long as the first tarsal joint; tarsal joints 10 : 6 : 5 : 2 : 7 in length-ratio.

Abdomen smooth, shining, a little shorter than the head and thorax taken together, spindle-shaped, sharply pointed at the apex, rather flattened dorsad, subsessile, petiole not extending beyond the neck of propodeum; ovipositor slightly projecting beyond the apex.

[Male] Closely allied to the opposite sex, but much smaller. Abdomen a little shorter than the thorax, rather ovoidal.

[Measurements] Length of body; the female, 2.35–2.7 mm., and 2.5 mm. on the average; the male, 1.75–2.25 mm., and 2.0 mm. on the average.

Remarks on the Parasitism: The complete life-cycle has not yet been studied. In Hokkaido, emergence of the adult under natural conditions occurs at the end of July and continues throughout August. The earliest date of emergence under an observation in 1930 at Sapporo was July 22. The adult always flies out from the cocoon of the rice leaf-beetle. According to INAMURA's report (*111*), the percentage of the parasitism of this Chalcid-fly ran up to 75.9 per cent in Shinchiku Prefecture, Taiwan, in 1914. The Oshima Branch of the Hokkaido Agricultural Experiment Station investigated the conditions of this parasite from 1916 to 1920, and according to their investigations the average percentage of the parasitism of this Chalcid-fly to the rice leaf-beetle is 11.26 per cent in the Oshima Peninsula. The data obtained are as follows:

Table XXIX—*Percentage of the cocoons of the rice leaf-beetle which were parasitised by Trichomalopsis shirakii in the Oshima Peninsula*

Year / Percentage / Locality	1916		1917		1918		1919		1920	
	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined
Ôno, Kameda district	% 32.0	200	% 1.7	115	% 14.0	100	% 15.0	100	% 6.0	100
Nanaii, Kameda district	2.6	38	3.0	33	—	—	1.5	200	—	—
Kameda, Kameda district	9.5	200	12.1	58	—	—	5.8	138	9.6	73
Yunokawa, Kameda district	17.0	100	3.4	58	3.7	161	2.0	100	8.5	118

Year / Percentage / Locality	1916		1917		1918		1919		1920	
	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined
Kamiiso, Kamiiso district	% 14.0	100	% 3.8	133	% 24.2	120	% 9.0	100	% 4.9	102
Kikonai, Kamiiso district	22.0	200	13.8	80	18.0	100	9.0	100	2.2	45
Shiriuchi, Kamiiso district	—	—	—	—	—	—	2.9	68	9.5	21
Tomari, Hiyama district	—	—	—	—	—	—	12.8	86	3.3	92
Kaminokuni, Hiyama district	23.0	100	9.6	156	14.0	100	14.0	93	1.8	113
Assabe, Hiyama district	35.5	200	7.5	146	—	—	1.8	113	—	—
Otobe, Nishi district	—	—	—	—	25.0	100	8.0	100	0	100
Average	22.23		6.93		15.57		6.84		4.71	

3. *Anilastus japonicus* SONAN[1] [Text-fig. VIII]

(Doromushi-yadori-amebachi)

Anilasta japonica SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 269,, 1 fig. (1930).
Anilastus sp., KUWAYAMA, Hokkaido Agr. Exp. Sta., Bul. 47, p. 69 (1928).

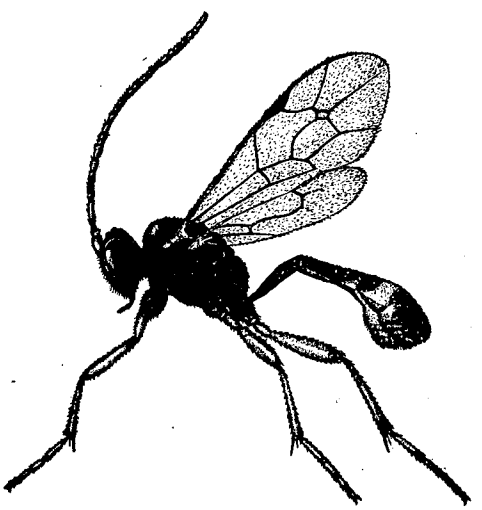
This species is a member of the tribe Campoplegini, subfamily Ophioninae, family Ichneumonidae of the superfamily Ichneumonoidea. This species is widely distributed in Hokkaido and Honshu. SONAN (*116*) recorded Hakodate, Fukushima and Nagano as the habitats; I also collected a number of the specimens at Kamishibetsu, Province of Teshio, in August, 1929.

Morphological Characters of the Adult: [Female] General colour of the body black. Eyes brownish black; ocelli dark yellow. Antennae brownish black, with the scape and pedicel yellowish brown. Mouth-part, including palpi, light yellow, with reddish brown apices of mandibles. Wings hyaline, slightly fumate, iridescent; pterostigma and nervures dark brown. Legs brownish; fore coxae, trochanters and tibial spurs of all

1) I followed the generic name after ASHMEAD's classification (*104*) and also the opinion of T. UCHIDA.

legs light yellow; hind coxae concolorous with the body; apices of the hind tibiae and of each hind tarsal joints dark brown. In the abdomen, apical halves of the second and third tergites, the lower side of the third, and the fourth segment, and sometimes the lower side of the fifth to sixth tergites brown; colouration of the abdomen considerably variable among individuals; beneath yellowish brown.

Head slightly wider than the thorax, with close and fine punctures; apparently shagreened and provided with a white pubescence rather densely; rather transverse dorsad and quadrate anteriorly; the posterior margin nearly straight. Ocellar isosceles triangle is obtuse on the vertex; a median carina from the anterior ocellus reaching almost to the space between antennal fossae; genae as long as the width of mandibles; clypeus anteriorly truncate, with rather conspicuous grooved lines on both sides. Eyes bare, large, oval, hemispherically raised. Antennae filiform, about 3.5 mm. in length, 26-jointed, densely pubescent; basal joint short and globose, scape large and elliptical, nearly twice as long as the width; pedicel short, subequal in length and width, one-third as long as the scape; annellus very short, ring-shaped; funicle-joints gradually tapering distad; first funicle-joint slender, cylindrical, four times as long as the width; terminal joint as long as the width. Mouth-part as usual; labrum small, triangular in shape; mandibles rectangular, parallel-sided, with white hairs moderately on the outer sides, bidentate, the teeth being very sharp and unequal in length; palpi very long and slender, with dense white pubescence.



Text-fig. VIII

Anilastus japonicus SONAN
Male (Ca × 10)

Thorax immaculate, closely punctate, with moderately dense pubescence; mesonotum wide, without parapsidal furrows; scutellum distinctly convex; propodeum with distinct carinae, area basalis very small, areola which is formed by a connection of the area supero-media and area petiolaris very large, elongate and apically opened; costula distinct; spiracles

small. Fore wings elongate, 3.25 mm. in length, 1.15 mm. in width, with rather dense discal ciliation; pterostigma long and narrow, 0.45 mm. in length and 0.13 mm. in height; recurrent nervure received by the areolet far beyond the middle; areolet small, rhomboidal, with a short petiole; radius distinctly and angularly curved. Hind wings rather short. Legs with dense, uniform and fine pubescence, tibial spurs 1–2–2, unequal in length, longer spur being as long as a half of the first tarsal joint; last joint of the hind tarsi very slightly shorter than the third.

Abdomen not much compressed, but gradually fusiformly thickened towards the apex, with dense pubescence; petiole long; first abdominal segment without a sharp carina and its spiracles not prominent; spiracles of the second abdominal segment at far before the middle; terebra stout, densely pubescent, only slightly projecting beyond the tip of the abdomen.

[Male] Similar to the opposite sex; abdomen rather strongly compressed behind the second segment than that of the female, truncated at the tip.

[Measurements] Length of body 4.0–4.6 mm. in the female, 4.2–5.0 mm. in the male.

Remarks on the Parasitism: The life-history is still unknown, though this species is one of the most common and important larval parasites of the rice leaf-beetle. The adult-fly gets out the cocoon of the host during July and August. According to the surveys of the Oshima Branch of the Hokkaido Agricultural Experiment Station, during 1916 to 1920, the percentage of the cocoons of the rice leaf-beetle from which this parasite appeared, was recorded 11.65 per cent on the average. The details of the data are as follows:

Table XXX—*Percentage of the cocoons of the rice leaf-beetle from which Anilastus japonicus appeared in the Oshima Peninsula*[1]

Year / Percentage / Locality	1916		1917		1918		1919		1920	
	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined
	%		%		%		%		%	
Ôno, Kameda district	2.5	200	52.2	115	4.0	100	12.0	100	14.0	100
Nanaii, Kameda district	0	38	12.1	33	—	—	10.0	200	—	—
Kameda, Kameda district	0	200	51.7	58	—	—	16.7	138	6.8	73
Yunokawa, Kameda district	0	100	10.3	58	6.8	161	6.0	100	10.2	118
Kamiiso, Kamiiso district	0	100	5.3	133	6.7	120	12.0	100	13.7	102
Kikonai, Kamiiso district	0	200	27.5	80	7.0	100	25.0	100	0	45
Shiriuchi, Kamiiso district	—	—	—	—	—	—	30.9	68	14.3	21
Tomari, Hiyama district	—	—	—	—	—	—	5.8	86	9.8	92
Kaminokuni, Hiyama district	0	100	16.7	156	14.0	100	12.9	93	0.9	113
Assabe, Hiyama district	0	200	38.4	146	—	—	12.4	113	—	—
Otobe, Nishi district	—	—	—	—	3.0	100	16.0	100	18.0	100
Average	0.44		27.09		6.90		13.86		9.95	

4. *Nesopimpla naranyae* ASHMEAD [Text-fig, IX]

(Aomushi-hirata-himebachi)

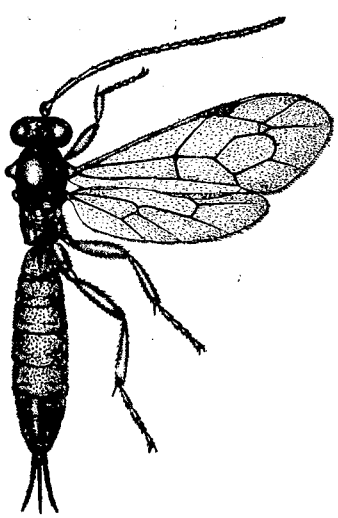
Nesopimpla naranyae ASHMEAD, Proc. U. S. Nat. Mus., XXX, p. 180, Pl. XIII-fig. 3 (1906); MATSUMURA, Cat. Benef. Ins. Jap., p. 110 (1908); UCHIDA, Jour. Facul. Agr., Hokkaido Imp. Univ., XXV, p. 48 (1928).

1) On account of wrong identification, a few other species are included in the data.

This species belonging to the tribe Pimplini, subfamily Pimplinae, family Ichneumonidae, is commonly distributed in Japan throughout Hokkaido, Honshu, Shikoku, Kyushu, Okinawa, Taiwan and Chosen.

Morphological Characters of the Adult: [Female] Head and thorax pitchy black. Eyes and ocelli blackish brown; antennae brownish, with narrow blackish annulations, except the blackish scape; palpi yellowish white. Wings hyaline, iridescent; pterostigma black except a yellowish white spot at the base, internal nervures black, costal nervure to the stigma dark yellow. Legs pale yellow; hind coxae behind, middle and hind femora and the apical half of the hind tibia pale ferrugineous; apex of the hind femora, both extremes of the hind tibia, apices of the hind tarsal joints and claws of all legs black. Abdomen pale ferrugineous except apical two segments and the dorsal part of the sixth segment which are black; ovipositor dark red, terebra black.

Head transverse, nearly as wide as the thorax, with fine punctures closely and provided with dense silverly white pubescence; eyes large, elongate, hemispherically raised, with a depression at the inner side; ocelli prominent but rather small, situated nearly in an equilateral triangle. Antennae slender, filiform, slightly longer than the length of the fore wing, about 6.0 mm. in length, 25-jointed, with dense and fine pubescence; basal joint small; scape large, elliptical in shape, one and a half times as long as the width, at the outer side being deeply clefted; pedicel stout, of which length-ratio is 3 : 1 in the outer and inner sides; annellus very short, ring-shaped; funicle-joints provided with many slit-like sensoria, gradually shortening towards the distal joints; first funicle-joint slender, cylindrical, 5.5 times as long as the width; the penultimate nearly equal in length and width; the terminal rather long, twice as long as the width, roundly ended, with 11 short obtuse spines of yellowish colour at the apex. Clypeus rather narrow, anteriorly concave; labrum wide; mouth-part slightly protruded; mandibles somewhat narrow, two-dentated, palpi very slender, with dense white pubescence.



Text-fig. IX
Nesopimpla naranyae ASHMEAD
Female (Ca ×6)

Thorax immaculate, closely punctated, with moderate dense pubescence,

especially on the sides; mesonotum longer than the width, scutellum roundly ended; propodeum with two distinct longitudinal carinae that diverge posteriorly and end just over the insertion of the hind coxae, and without costula; metathoracic spiracles round, sometimes oval. Fore wings elongate, as long as the abdomen and ovipositor combined, with rather dense discal ciliation; pterostigma narrow; areolet large, irregularly pentagonal in shape; recurrent nervure curved and received by the areolet at the middle; nervulus connected with the basal nervure directly at the cubitus. Hind wings rather long. Legs with dense pubescence; hind leg stout and much longer than the fore leg; tibial spurs 1 – 2 – 2, subequal in length, rather short; claws simple and curved, without tooth; first tarsal joint the longest, followed by the fifth and then the second, the fourth being the shortest.

Abdomen subsessile, elongate, depressed, suddenly tapering at the apex; first segment nearly straight, with the spiracles placed before the middle; apices of the second to sixth segments tumid; the third to sixth with each a transverse impression a little behind the middle, impression on the second being distinct only laterally, and interrupted at the middle, lateral impressed lines appeared at the second to fifth segments; all segments strongly punctured and with dense pubescence. Ovipositor and terebra subequal in length, rather short, straight, a little longer than the terminal three segments; ovipositor pointed sharply, terebra with concolorous hairs densely.

[Male] Essentially the same with the female except the secondary sexual characters; the body in general much smaller than in the female.

[Measurements] This species is considerably variable in dimensions. Length of body, 8–10 mm. including ovipositor in the female, 5–6 mm. in the male.

Remarks on the Parasitism: This is a well-known species as an important parasite of the rice leaf-caterpillar (*Naranga aenescens*), and the adult may be frequently seen in the rice-field from June to October. I once caught this Ichneumon-fly emerged from the cocoon of the rice leaf-beetle in the County of Kasai. The fly issued was very small, measuring only 5 mm. in body-length, but it was without doubt this species. From this fact, it may be concluded that *Nesopimpla naranyae* has a habit to attack the rice leaf-beetle from time to time.

5. *Melcha lemae* SONAN

(Taiwan-doromushi-himebachi)

Melcha lemae SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 359 (1930).

This Ichneumon-fly belongs to the tribe Mesostenini, subfamily Cryptinae, family Ichneumonidae, and was described by one male specimen which was reared from a cocoon of the rice leaf-beetle at Shirin, near Taihoku, Taiwan. The genus *Melcha* is closely related to the genus *Goryphus*. I have not yet examined this species personally.

6. *Habrocryptus ruficoxatus* SONAN

(Doromushi-onaga-himebachi)

Habrocryptus ruficoxatus SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 357 (1930).

This species belongs to the tribe Cryptini, subfamily Cryptinae, family Ichneumonidae. J. SONAN (*117*) described this species on one female specimen reared from a cocoon of the rice leaf-beetle which was collected in Yamaguchi Prefecture by T. SHIRAKI. This seems to be quite rare.

B. Secondary Parasites

1. *Pezomachus lemae* SONAN

(Doromushi-arigata-himebachi)

Pezomachus lemae SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 271 (1930).

This Ichneumon-fly belongs to the tribe Pezomachini, subfamily Cryptinae, family Ichneumonidae, and seems to be rare, being only known in Nagano Prefecture at present. As is well known, the members of the tribe Pezomachini are almost secondary parasites. In Japan, T. UCHIDA (*120*) regarded *Pezomachus dendrolimi* MATSUMURA as a secondary parasite of *Dendrolimus albolineatus*, and U. NAWA reported *P. apantelicida* VIERECK[1] as a parasite of "Samurai-yadori" (*Apanteles japonicus*) and a Braconid parasitic on *Dendrolimus spectabilis*. It is also probable that *P. lemae* is a secondary parasite of *Lema oryzae*.

2. *Bathythrix kuwanae* VIERECK [Text-fi X]

(Doromushi-kuro-himebachi)

Bathythrix kuwanae VIERECK, Proc. U. S. Nat. Mus., XLIII, p. 584 (1912); SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 271 (1930).

Batithrix kuwanae SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 358 (1930).

Batithrix kuwanae var. *nigrans* SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 358 (1930).

Bathythrix sp., OKADA, Yamaguchi Agr. Exp. Sta., Ex. Rep. 3, p. 9, Pl. II-fig. 2 (1913).

Gn. ? sp. ?, Anonymous, Niigata Agr. Exp. Sta., Gaichû Kenkyû Seiseki Hôkoku (Rep. Res. Injur. Ins.), 2, p. 45, Pl. IV (1902); Anonymous, Hokkaido Agr. Exp. Sta, Cir. 20, p. 7, Fig. 6 (1922).

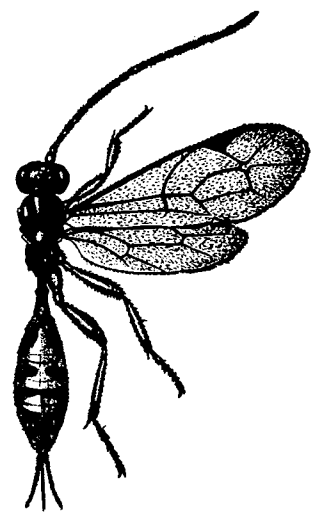
1) According to NAWA, this species is not fully determined. See "Konchû Sekai" (Ins. World), XVIII, p. 94 (1914).

Hemiteles narangae UCHIDA, Jour. Facul. Agr., Hokkaido Imp. Univ., XXV, p. 342 (1930).

This species belongs to the tribe Hemitelini, subfamily Cryptinae, family Ichneumonidae. This is very common throughout Hokkaido, Honshu and Chosen. According to J. SONAN (*116*, *117*), this species was captured at Hakodate, Aomori, Akita, Fukushima, Yamanashi, Nagano, Niigata, Ishikawa, Tottori, Shimane, Hiroshima, Yamaguchi and Ryusei (Chosen). T. UCHIDA (*120*) described this species on the specimens from Sapporo.

SONAN (*117*) separated a variety of which the abdomen black and apical margins of the second and third tergites reddish brown, under the name of *nigrans*. As already mentioned by H. L. VIERECK (*121*), this species is closely related to the member of the genus *Hemiteles*.

Morphological Characters of the Adult: [Female] Head and thorax shiny black, covered with silverly white pubescence; eyes blackish brown, ocelli dark yellow; antennae yellowish brown, gradually darkened towards the distal part; mandibles reddish brown, palpi light yellow. Wings hyaline, iridescent; pterostigma and nervures in the distal two-thirds brown, basal parts of the nervures yellowish brown. Fore and middle legs light yellow; hind legs yellowish brown, except light yellowish coxae and trochanters, darkened at the apices of the tibiae and each tarsal joints. The first segment of the abdomen black, shiny; the second and third segments stramineous yellow, each with two black markings on the dorso-lateral side; the fourth blackish at the base; the rest of the abdomen stramineous yellow to light brown, often varying to brownish black; ovipositor light yellow, terebra dark brown.



Text-fig. X
Bathythrix kuwanae VIERECK
Female (Ca ×9)

Head transverse, wider than the thorax, narrowed behind the eyes, polished and shining, with rather dense and long pubescence except at the occipital region; clypeus somewhat square in shape, slightly convex, well defined by the deep clypeal suture; anterior margin straight. Eyes large, elliptical in shape, raised convexedly, bare; ocelli far from the eyes, projected, situated in a small equilateral triangle at the vertex; antennae filiform, slender, a little shorter than the body-length excluding ovipositor, 3 mm. in length, 24-jointed, approached at the base, with rather

dense concolorous pubescence; basal joint almost polished, concolorous with the head; scape large, ovoidal, a little longer than the width; pedicel about two-thirds of the scape, shorter than the width; annellus very short, as wide as the funicle-joints, ring-shaped; funicle-joints cylindrical, gradually tapering towards the terminal joints, with 2 bristles at each apical part except the terminal joint, and provided with many slit-like sensoria; first funicle-joint four times as long as the width; penultimate joint one and a half times as long as the width; terminal joint obtuse conical, a little shorter than three times of the width at its base. Mouth-part not so much protruded; mandibles rather slender, polished; palpi slender, with dense concolorous pubescence.

Thorax longer than wide, polished and shining, with whitish dense pubescence; pronotum narrow; mesonotum with two distinct parallel parapsidal furrows, thus dividing the mesoscutum into three subequal rectangular portions; scutellum rather narrow, subacute at the apex; metathoracic spiracle round; propodeum with distinct carinae; area basalis long and rather narrow; area superomedia large, longer than wide, with a longitudinal carina; area petiolaris pentagonal in shape, rather wide; costula rather long, far beyond the middle. Fore wings hyaline, rather wide, with fine discal ciliation, pterostigma large, triangular in shape; areolet pentagonal, but open behind, the basal nervure not strongly curved inwardly; ramellus vanished, radius acutely curved, the recurrent nervure rather straight, broken at the middle. Hind wings rather short and narrow; nervullus broken at the middle. Legs slender; hind leg larger than the others; tibial spurs 1–2–2, short, the spur of the fore leg being flattened; the hind coxae large, globose, situated far behind the metathorax; the first tarsal joint very large, especially the hind one being a little shorter than the rest of the tarsal joints; claws simple, sharp and curved.

Abdomen petiolate, slender, depressed and broadened distally; postpetiole as long as the petiole, slightly widened posteriorly, with distinct longitudinal carinae, shining, without pubescence, punctured roughly, rest of the abdomen smooth with dense whitish pubescence. Ovipositor rather long, little shorter than a half length of the abdomen, straight, very sharply pointed; terebra nearly as long as the ovipositor, with dense and fine pubescence.

[Male] Resembles the female, but differs in the following points:

Antennae brownish to dark brown; the distal half of the hind femur, the hind tibia, the middle and hind tarsi dark brown; the apical halves of the second and fourth segments coloured triangularly with yellow; the

third yellow with two blackish markings; the rest of the abdomen blackish; colouration of the abdomen considerably variable.

[Measurements] Length of body 4 mm. (or 5 mm. including the ovipositor) in the female, and 4.5 mm. in the male.

Remarks on the Parasitism: As already stated, this species has been found from many localities of Hokkaido, Honshu and Chosen, even where other parasites are not yet discovered, and it is known as one of the most important primary parasites of the rice leaf-beetle. However, the majority of the members of the tribe Hemitelini, at least of the genus *Bathythrix*, were proved as secondary parasites. For example, in his well known paper "A study in Insect Parasitism", L. O. HOWARD (*110*) reported his observations on the parasites of the white marked tussock moth (*Orgyia leucostigma*), and regarded *Bathythrix meteori* as a parasite of *Meteorus communis*, which is a common Braconid parasitic on *Orgyia leucostigma*, and also *Bathythrix pimplae* as a parasite of *Pimpla inquisitor*, which is one of the most important and wide spread parasites of the lepidopterous larvae in the United States; in other words, these two *Bathythrix*-species are the secondary parasites of *Orgyia leucostigma*. Of *B. meteori* he recorded that one specimen issued from a cocoon of *M. communis*, and the other specimens, thirteen in number, issued from a mass of 624 cocoons of the *Orgyia*; he also pointed out the remarkable fact that even a single specimen of *Meteorus* did not emerge from this lot of cocoons.

Now, in the case of *Bathythrix kuwanae*, though its exact host relationships are not yet fully investigated, it may probably be a parasite of Ichneumon-flies, such as *Anilastus japonicus*, parasitic on the rice leaf-beetle. Disposing the same material in the surveys of *Anilastus japonicus* and *Trichomalopsis shirakii* during 1916 to 1920, the Oshima Branch of the Hokkaido Agricultural Experiment Station examined the percentage of the cocoons of the rice leaf-beetle from which *B. kuwanae* issued. Its percentage was 9.75 per cent on the average of five years, being 1.9 per cent lower than that of *A. japonicus*. The data are detailed below:

Table XXXI—*Percentage of the cocoons of the rice leaf-beetle from which Bathythrix kuwanae issued in the Oshima Peninsula*

Year / Percentage / Locality	1916		1917		1918		1919		1920	
	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined	Percentage of parasitised cocoons	Number of cocoons examined
	%		%		%		%		%	
Ôno, Kameda district	8.0	200	0	115	15.0	100	7.0	100	6.0	100
Nanaii, Kameda district	2.6	38	9.1	33	—	—	16.0	200	—	—
Kameda, Kameda district	3.5	200	5.2	58	—	—	3.6	138	8.2	73
Yunokawa, Kameda district	3.0	100	32.8	58	23.0	161	17.0	100	0.8	118
Kamiiso, Kamiiso district	4.0	100	15.0	133	10.0	120	12.0	100	12.7	102
Kikonai, Kamiiso district	8.5	200	35.0	80	25.0	100	11.0	100	4.4	45
Shiriuchi, Kamiiso district	—	—	—	—	—	—	4.4	68	0	21
Tomari, Hiyama district	—	—	—	—	—	—	1.2	86	4.3	92
Kaminokuni, Hiyama district	4.0	100	13.5	156	12.0	100	2.2	93	2.7	113
Assabe, Hiyama district	8.5	200	10.3	146	—	—	6.2	113	—	—
Otobe, Nishi district	—	—	—	—	0	100	3.0	100	7.0	100
Average	6.06		13.99		14.83		8.35		5.50	

Taking into my consideration HOWARD's studies as well as my own observations, I have come to conclusion that *Bathythrix kuwanae* is a secondary parasite of the rice leaf-beetle. T. UCHIDA (*120*) described this species as a secondary parasite of the rice leaf-caterpillar (*Naranga aenescens*).

3. ***Bathythrix rufus*** SONAN

(Doromushi-kibara-himebachi)

Batithrix rufus SONAN, Trans. Nat. Hist. Soc. Formosa, XX, p. 358 (1930).

This species was described recently by J. SONAN (*117*) based on a female specimen from Niigata Prefecture, and it differs from *Bathythrix kuwanae* only in its yellowish brown tergites of first to third. This species seems to be rare. Since I have not yet examined this species personally, I cannot express my own view. However, it is probable that this is also a secondary parasite of the rice leaf-beetle as in the case of *B. kuwanae*.

(2) Predaceous Insects

The rice leaf-beetle is, as in the case of other insects, devoured by a number of predaceous insects belonging to the orders Coleoptera, Diptera, etc. However, I will only discuss on two species of Coleoptera, which occur commonly in the rice-field and attack the leaf-beetle.

1. *Hippodamia tredecimpunctata* LINNÉ [Text-fig. XI]

(Jûsanhoshi-tentô)

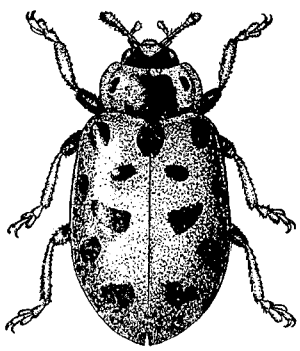
Coccinella tredecimpunctata LINNÉ, Syst. Nat., ed. X, p. 366 (1758).

Hippodamia tredecimpunctata MULSANT, Hist. Nat. Col. Fr. Sécurip., p. 31 (1846); GANGLBAUER, Käfer v. Mitteleur., III, p. 1020 (1899); MATSUMURA, Thous. Ins. Jap., IV, p. 56, Pl. LIX-fig. 31 (1907); OKAMOTO, Hokkaido Agr. Exp. Sta., Bul. 9, p. 9, Pl. II-fig. 7 (1909); TAKIZAWA, Konchû Sekai, XXI, p. 494, 2 figs. (1917); OKAMOTO, Hokkaido Agr. Exp. Sta., Rep. 12, p. 69, Pl. IV-fig. 2 (1921).

This lady-bird belonging to the tribe Coccinellini, subfamily Coccinellinae, family Coccinellidae, is a well known species widely distributed throughout the Northern and Central Europe, Siberia and North America. It occurs abundantly on water-plants. In Japan, this species is known in Hokkaido and Honshu, and devours some kind of aphis, such as *Rhopalosiphum prunifoliae* and *Rhop. nymphaeae* on the rice-plants and arrowhead (*Sagittaria trifolia* var. *sinensis* f. *caerulea*), and also *Macrosiphum granarium*, *Mac. pisi*, *Aphis glycines* and *A. laburni* on the field crops. Nevertheless, as far as I am aware of, predatory habit of this species on the rice leaf-beetle has not yet been reported.

Morphological Characters: [Adult] Oblong, slightly convex, shining; head black except yellowish frons and yellowish brown clypeus, with many fine shallow punctures and sparse whitish pubescence; mouth-part yellowish brown; eyes blackish; antennae yellowish brown, darkened towards the apex, with sparse brownish hairs. Pronotum yellowish, with a broad longitudinal black band and a black spot on each side, punctured as in the head; scutellum blackish, triangular and small, with a few fine punctures;

elytra orange-yellow or yellowish red, with thirteen black spots of various sizes, the arrangement of the spots being $1\frac{1}{2}+2+2+1$, roughly but densely punctured. Sternum black, with a whitish yellow patch on each posterior edge of the meso- and meta-sternum; legs black, but the tibia and tarsi reddish brown with dense pubescence; the ventral side of abdomen black, both sides of each segment, except the terminal one, being orange-red.



Text-fig. XI

Hippodamia tredecimpunctata LINNÉ Adult (Ca ×8)

Length of body 5.8–6.0 mm. in the female, and 4.8–5.9 mm. in the male.

[Egg] Glossy light yellow, spindle-shaped. Length 1.3 mm. and width 0.6 mm. on the average.

[Larva] Elongate, gradually tapering anteriorly and posteriorly, dark reddish green in the ground-colour. Head dark brown, with sparse brownish hairs; frons, clypeus and mouth-part greenish. Pronotum with four blackish longitudinal stripes; meso- and meta-notum each provided with two large blackish patches and a papilla-like blackish projection on each lateral side, the projection having numerous fine processes, whence some short brownish hairs grow; at the middle of notum tinged longitudinally with a yellowish red colour. Legs greenish brown, with dense brownish short hairs; the apical half of femur, the apex of tibia, and the claws blackish. From the first to eighth segments of abdomen it is found six blackish projections transversely arranged on each, and with yellowish green or yellowish brown subdorsal lines; the projection again putting out several small processes which grow a brownish short hair; the first and fourth terga tinged with orange-red colour; the terminal segment fuscous with sparse brownish hairs. Length of the full-grown larva 7.5–8.0 mm.

[Pupa] Ovoidal, yellowish green just after pupating, and changes gradually to brownish colour. Head dark brown, with a greenish longitudinal line; pronotum with two large triangular dark brown spots along the anterior margin and four round concolorous spots along the posterior margin, two dorsal ones of which are smaller than the outer; meso- and meta-notum with two large blackish patches, the wing-portions being dark brown. Abdomen with orange-yellow dorsal and lateral lines, provided with two small black spots on the first tergite, which is almost orange-yellowish coloured; the second and third tergites dark brown. Usually

attached to the larval exuvia. Length of body 6.5 mm.

Life-History and Habits: According to our observations, this lady-bird has two or three generations in one year, and in the adult-stage it passes the winter in shrubs, weeds, crevices of woods, around the house, etc. The adults appear as early as the end of April, accelerating in appearance during June, and they lay their eggs vertically in mass which contains three to thirty on the stems or leaves. The eggs hatch in a week, and the larvae complete their developments within about three to four weeks, and the adults of the next generation appear in August after the pupal stage of five to seven days. Under normal summer-condition the life-cycle from egg to adult is accomplished within a period of approximately a month, and the last emergence takes place at the middle of October. The longevity of the adult is rather long, and during its life it preys upon a great number of aphis and other small insects. According to the feeding records of the adult carried out during 21 days from June 16 to July 6, 1922, the total number of the aphis, *Hyalopterus arundinis*, eaten by one adult was 387, thus giving a daily average of 18.4. I found out also that this lady-bird often devours the onion-thrips (*Thrips tabaci*).

In the rice-field, during June and July, it is very common that the hibernated adult and the larva of the first-generation devour the egg and young larva of the rice leaf-beetle on the rice-plant. Although we have not yet any numerical record, a large number of eggs of the leaf-beetle is fed by them. This lady-bird is by far the most important member as regards the control of the rice leaf-beetle by natural means.

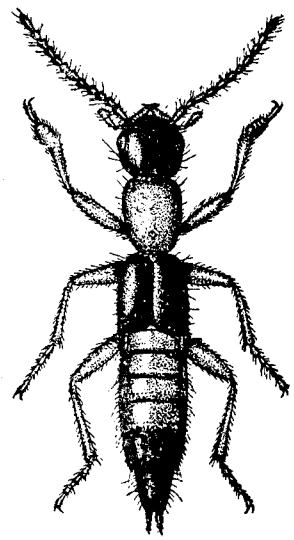
2. *Paederus idae* LEWIS [Text-fig. XII]

(Aoba-arigata-hanekakushi)

Paederus idae LEWIS, Trans. Ent. Soc. Lond., 1874, p. 75 (1874); MATSUMURA, Thous. Ins. Jap., III, p. 34, Pl. XL-fig. 19 (1906); SHIRAKI, Agr. Exp. Sta., Gov. Formosa, Sp. Rep. 15, p. 158, Pl. XI-fig. 6 (1917).

This beetle belongs to the tribe Paederini, subfamily Paederinae, family Staphylinidae, and is distributed in Hokkaido, Honshu, Kyushu and Taiwan. According to SHIRAKI (*115*), it extends also to China.

Morphological Characters: [Adult] Slender, sowewhat flat, and shiny. Head black, as long as wide, with sparse long brownish hairs, and punctured deeply but sparingly; mouth-part yellowish brown to reddish brown, well developed; clypeus sparsely furnished with long brownish setal hairs; eyes brownish black; antennae slender, prominently jointed, brownish except four basal joints which are yellowish brown, sparsely pubescent, and with a



Text-fig. XII

Paederus idae LEWIS
Adult (Ca ×8.5)

few setae near the apex of each joint. Pronotum ovate, as broad as the head, reddish, with sparse hairs, punctured distinctly but sparingly; scutellum very small, yellowish brown, somewhat roundish. Elytra cyaneous or metallic dark blue, short but distinctly longer than the pronotum, rectangular, with dense and deep punctures, furnished with sparse hairs. Legs reddish, with dense concolorous pubescence, darkened at each apex of the femora and tarsal joints. Abdomen not concealed under elytra, reddish in colour and sparsely pilose, except two terminal segments which are blackish and with dense hairs; the punctation distinct but sparse; pygidium long. Length of body 6.0–7.0 mm.

Life-History and Habits: This small beetle was reported by T. SHIRAKI (*115*) as an important predacean to the rice borer (*Schoenobius incertellus*) in Taiwan, since the adult had been repeatedly observed feeding on the larvae of *Schoenobius incertellus* in all stages. In Hokkaido, this beetle is especially abundant around the rice-fields in spring from May to June; it often crawls on the stem of rice-plant. This species is also found under stones or fallen trees or rubbish in the foot-path between rice-fields. I often observed the adult of this beetle preying upon the larvae or eggs of the rice leaf-beetle on the rice-plant. This beetle is probably one of the most effective predaceous enemies against the rice leaf-beetle. Since this beetle resembles the rice leaf-beetle in appearance, farmers often confound these beetles. The complete life-history is not yet fully known.

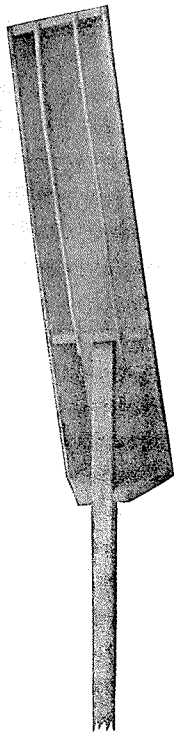
IX. SUGGESTIONS ON THE CONTROLLING MEASURES

Discussion on the controlling measures may not be proper for this paper. However, I wish to make a suggestion from my own personal studies. For a long time various controlling measures against the rice leaf-beetle have been devised and tried in the field. It is the same now as in old times, that, when the ravages by this leaf-beetle are great, many ignorant farmers resort to an amulet against the calamities, but only in vain. As stated before, as this leaf-beetle hibernates in the places other

than in the rice-field, it is very difficult to control it thoroughly. And we are only left to do our best in controlling the leaf-beetle during its activity in the rice-field.

As this leaf-beetle habitually deposits the eggs in mass on the upper surface of the rice-leaves, the collection of the egg-masses will be one of the controlling measures that can be put into practice. When the egg-parasites are found, their protection should jealously be done by the use of the so-called protecting apparatus of natural enemies, as in the case of the rice borers, namely *Chilo simplex* and *Schoenobius incertellus*. On the other hand, application of the poisons such as nicotine, rotenone, pyrethrins, etc., to prevent the hatching of the eggs, is another problem to be solved in the near future.

The habit of the adults and larvae to feed on the upper surface of the leaves makes it convenient to practice the controlling measures. For many years, the method to brush this pest off the rice-plant immediately after the use of some kind of oils has been recommended. Recently the brushing off with a net has also been recommended. For example, a boat-shaped net originally designed by a member of our Experiment Station is generally used by the farmers in Hokkaido [see Text-fig. XIII]. Though this apparatus is still open to improvement, the use of this net is less expensive than the methods such as the use of oils, etc. From the ecological point of view the brushing by net in the early morning may be most effective, as on account of dew-drops the adults are inactive and the larvae are more easily stick to net.



Text-fig. XIII

A boat-shaped net used in Hokkaido for the brushing off the rice leaf-beetle. (Ca × 1/14)

Sprayings are also recommended. The contact poisons or stomach-poisons have not yet been fully determined. However, the application of stomach-poisons retards sometimes the growth of the rice-plant, though the degree of injury varies greatly according to the poisons used and the time of the growth of the plant. From the ecological habits of larva we may reasonably expect an effective result by the application of contact poisons, such as pyrethrum-soap-solution, naphtha-pyrethrum-emulsion, nicotine-sulphate-soap-solution, derris-soap-solution, Neoton-soap-solution, etc. In Hokkaido the pyrethrum-

soap-solution is mostly used by the farmers on account of its easy application as well as its lower cost. There is, however, much room for future research on the insecticides against the rice leaf-beetle. Though some farmers still use simple and incomplete sprayers at present, a more improved machinery such as the compressed air sprayers or knapsack sprayers, are desirable for the purpose of more effective spraying.

No treatment against the pupal stage can be recommended at the present time, especially in view of the protection of the natural enemies discussed in the foregoing chapter.

In closing this chapter, I should like to state, based on the ecological experiments discussed in the foregoing pages, that the food-plant of the rice leaf-beetle is limited absolutely to the rice-plant, so that this leaf-beetle does not seem to make any sudden alteration of the host-plants from the rice-plant to the other cereals, such as wheat, barley, oats, etc., even though the artificial eradication against this leaf-beetle is boldly attempted in the rice-field.

X. SUMMARY

1. The rice leaf-beetle, or "Doro-oi-mushi", "Ine-doro-hamushi", etc. in the Japanese vernacular, is one of the most serious pests among one hundred and seventy species of the injurious insects to the rice-culture.

2. Since N. ÔKURA recorded this pest briefly as early as 1826, intensive studies have been done for many years by various students, but much room has been left for research, especially on its identification, its generations, its ecological habits, its natural enemies, its distribution, etc. So I have made a thorough study of this pest since 1922, and in the present paper I have endeavoured to report the results of my investigations on the external morphology, some phases of ecology, taxonomy, distribution, natural enemies, etc.

3. The rice leaf-beetle has hitherto been referred to as *Lema melanopa* LINNÉ, and formerly known as *L. tristis* HERBST (=*L. flavipes* SUFFRIAN). After my studies, however, I have found out that it is not only distinct from these related species, but also even undescribed. To that I gave the name *Lema oryzae* and described it briefly in March, 1931.

4. A brief diagnosis of the adult is as follows: General colour of the body blackish, with the pronotum bright yellowish brown and the elytra metallic blue. Antennae black and with dense grayish pubescence, except two basal joints, which are dark brown and scarcely pubescent.

Legs bright brownish yellow, with blackish coxae and dark brownish tarsi, the tibiae being darkened at the apices; abdominal sternites deep black, with close and fine punctures, covered with dense grayish yellow pubescence. The average length of body 4.23 mm. in the male and 4.76 mm. in the female.

5. In form and colouration of the adult, this species can easily be separated from *Lema tristis* HERBST by the prothorax bright yellowish brown, and from *L. melanopa* LINNÉ by the size smaller, basal two joints of antennae dark brownish, the trochanters brownish yellow, the tarsi and apices of tibiae dark brownish, the abdominal sternites blackish, and also by the close punctures and dense pubescence of the abdominal sternites and the longer claws of legs.

In detail, the thickness of elytra, the colour of the interjoint-membrane of antennae and the intersternal membrane of abdominal sternites, as well as the colour and the shape of the male genitalia (penis) are also stable features to separate *L. oryzae* from *L. melanopa*.

6. The egg of this leaf-beetle is elongate ovoid in shape, measuring 0.807 mm. in length. It differs very much from the egg of *L. melanopa* which is cylindrical and measured 1.092 mm. in length. The full-grown larva of this beetle has the prothoracal shield scattered with many dark brownish spots, while that of *L. melanopa* has the prothoracal shield provided with a few brownish spots which restricted along the posterior area.

7. According to my measurements the lengths and widths of the adult, egg, larva, pupa and cocoon vary considerably among individuals, and the range between the maximum and minimum is quite wide. The size of the female is much larger than that of the opposite sex. The secondary sexual character in the dimensions appears by the pupal stage, the pupa to be transferred into the female being much larger and more elongate than that into the male.

8. A survey of the literature indicates that the life-history differs in various localities in Japan. However, according to my researches, the annual generation of this leaf-beetle is apparently constant in any locality where climatic complexes differ, from Hokkaido in the north to Taiwan in the south, as well as in Chosen. By my observations, the life-cycle of this leaf-beetle is briefly as follows: There is only one generation per year, and over-wintering takes place in the adult-stage. The adult-beetle leaves the hibernated place as early as the latter part of May, and it mates and commences to oviposit early in June. Oviposition continues long towards the end of July. The adults sprung from the earlier oviposition,

commence to emerge from the end of July and continue to do so until the end of August. Then the adults bury themselves in the debris at the adjacent mountain-bush, under the roots of grasses in the wind-break, etc. In Taiwan, the life-cycle is advanced by about three months than the above-mentioned conditions.

9. The life of adult is a long one. It lives for one year or more; the newly emerged beetle feeds freely on the rice-plant before its hibernation; then it rests for a long time through three quarters of a year, from summer to winter. This phenomenon may be owing to the fact that the sexual glands of this beetle require a longer time for ripening or to proceed to an efficient copulation after emergence. A male and a female copulate repeatedly during their life in spring. The female deposits her eggs in mass especially on the upper surface of the rice-leaves, representing over 95 per cent in our case. On my observations, one female in confinement deposited about fifty eggs, distributing in about ten egg-masses, during the oviposition-period of fifteen days on an average.

10. The higher temperature has a tendency to help the acceleration of the incubation-period of egg. According to my experiments, under 21.°5 C the incubation-period lasts 5 days, while under 16.°1 C it is prolonged to 11 days. Number of eggs in one egg-mass varies considerably among the masses, being ranged from 1 to 46 eggs, mostly from 3 to 12 eggs, in our case. According to my examinations on 2000 egg-masses in 1929 and 439 egg-masses in 1930, the variation represents an asymmetrical curve of moderately distributed type, the maximum frequency being attained at the 7 eggs-class.

11. One of the most remarkable habits of the larva is to cover the body dorsad with dark greenish excreta during the greater part of its active life. The larva in this condition is at a glance mistaken as if a piece of mud had stuck to the rice-leaf. The larva occupies for its growth thirteen to nineteen days under natural conditions. During its growth, the larva has invariably three moults making four instars. The average width of the head of the fourth instar is about 2.5 times of that of the first, while the average body-length of the fourth instar is about 4.2 times of that of the first.

12. This leaf-beetle pupates usually on the rice-leaves, while it puptes also on or under the ground. The latter frequently occurs in the case of upland rice-field. According to my own experiments in this latter case, the cocoons are mostly formed on the surface of ground; about a half of total individuals is formed on the surface of ground, while about one-third

on the leaves. When the cocoons are formed in the soil, the majority of them domicile at the depth less than 3 cm. The cocoon of the rice leaf-beetle is whitish, ellipsoidal, compact though fragile in texture. Even in the case of the cocoons formed on or under the ground, they are not always constructed with soil-particles. The formation of the cocoon of *Lema oryzae* is entirely different from those of *L. melanopa*, but it has a great resemblance to that of *L. cyanella*.

13. The feedings by both the adult and larva are similarly effected by the removal of parallel longitudinal stripes from the leaves, leaving the sclerenchyma around the vascular bundle, the epidermis of lower surface being left intact.

14. As far as is known at present, the rice-plant (*Oryza sativa*) is the only representative staple food-plant of the rice leaf-beetle. While, the resurgent adult in spring occasionally finds some nutriments in certain Gramineous plants other than the rice-plant, especially when the rice-plant has not yet come to growth. However, there is no such a food-plant for the larva. According to my repeated and careful feeding experiments with the rice-plant, oats, barley, naked barley, wheat, rye, Orchard grass and Timothy, the first mentioned plant is the only favourite food-plant for the adult and larva of this leaf-beetle. When the adult is prevented to feed on the rice-leaves, it can find some nutriments in any cereal and grass above mentioned, but the larva in the similar case can not find any nutriment at all, and within from three to five days it starves to death. When the adult is forced to feed on the Gramineous plants other than the rice-plant, its life is shortened and the oviposition-capacity is much reduced. In regard to this phase, the rice leaf-beetle has a different habit from *Lema melanopa*.

15. The rice-plant infested severely withers at no time, and even in the case of slight infestation the rice-plant is doomed to the slow growth. This evil is more conspicuous in the northern parts where the duration of the growth of the rice-plant is shorter.

16. For the sake of comparison, I examined the specimens of the genus *Lema* to the number of nineteen valid species and three varieties inhabiting in the whole Empire of Japan including Karafuto, Taiwan and Chosen. Some of the already known species were revised or struck out into synonyms, while one species and three varieties were newly elected and described in this paper. The new species and varieties are as follows:

Lema formosana KUWAYAMA

Lema concinnipennis BALY var. *ventralis* KUWAYAMA

Lema diversa BALY var. *doii* KUWAYAMA

Lema decempunctata japonica WEISE var. *brunneipennis* KUWAYAMA

I also presented a key to distinguish the Japanese species of the genus *Lema*.

17. In the Palaearctic region, as far as I am aware of, five species of the genus *Lema* are known at present as infesting the Gramineous plants. These species have some ecological habits common to all of them. However, the selection of food-plants and the pupating habits of these species are different. We should consider these ecological characters when we make a classification.

18. The rice leaf-beetle is widely distributed in Japan throughout Hokkaido, Honshu, Shikoku, Kyushu, Chosen and Taiwan, extending from about 22°.5 to about 44° in the north latitude and within about 121° and 144° in the east longitude at present. It is noticeable that the infestation by this leaf-beetle is severer around the coast of the Sea of Japan (except Taiwan) than in the Pacific Sea-board of Japan. The original home is not yet fully determined in this paper, but it is supposed to be the coast of the Sea of Japan in Honshu, somewhere in the localities between Yamagata and Ishikawa Prefectures.

19. Up to present, nine species and one variety of parasites of the rice leaf-beetle are known. Among them, a Mymarid-fly heretofore known as *Anaphes* sp. or *Polynema* sp., is an important egg-parasite distributed in Hokkaido and Honshu. According to my studies, it is an apparently undescribed species; so I named it in this paper *Anaphes nipponicus*. As a result of my repeated experiments it may well be said that when the parasitised egg-masses of the leaf-beetle are transported and protected by the use of the egg-parasite-protecting apparatus, this egg-parasite is able to settle easily in the locality heretofore uninhabited by it in Hokkaido. The maximum percentage of the parasitism by this egg-parasite observed in 1929 and 1930, was 51.5 per cent during the end of July at Kagura, County of Kamikawa. The other members are parasitic on the larva of the rice leaf-beetle. However it is probable that *Pezomachus lemae* SONAN, *Bathythrix kuwanae* VIERECK, *B. kuwanae* var. *nigrans* SONAN and *B. rufus* SONAN, all belonging to the Cryptinae of Ichneumonidae, may be the secondary parasites of the rice leaf-beetle. *B. kuwanae* is one of the most common species in Hokkaido, Honshu and Chosen. According to the surveys of the Oshima Branch of the Hokkaido Agricultural Experiment Station, the percentage of the cocoons of the rice

leaf-beetle from which this parasite issued was 9.75 per cent on the average during 1916 to 1920 in the Oshima Peninsula. As the primary parasites, we can enumerate five species, namely *Trichomalopsis shirakii* CRAWFORD of Pteromalidae, *Anilastus japonicus* SONAN, *Nesopimpla naranyae* ASHMEAD, *Melcha lemae* SONAN and *Habrocryptus ruficoxatus* SONAN of Ichneumonidae. *Trichomalopsis shirakii* is a widely distributed species in Hokkaido, Honshu and Taiwan. According to the surveys of the Oshima Branch during 1916 to 1920, the percentage of the parasitism of this Chalcid-fly to the cocoons of the rice leaf-beetle was 11.26 per cent in the Oshima Peninsula. *Anilastus japonicus* is also common in Hokkaido and Honshu. According to the surveys of the Oshima Branch disposed with the same material above mentioned, the percentage of the cocoons of the rice leaf-beetle from which this Ichneumon-fly appeared was 11.65 per cent on an average. *Nesopimpla naranyae*, which is one of the most important parasites of the rice leaf-caterpillar (*Naranga aenescens*), was observed by me to issue from the cocoon of the rice leaf-beetle. Among the predaceous insects, two species of Coleoptera, namely *Hippodamia tredecimpunctata* LINNÉ of Coccinellidae and *Paederus idae* LEWIS of Staphylinidae, are the most important, as the adults of both species habitually devour the egg or young larva of the rice leaf-beetle.

20. Based on the observations stated in the foregoing pages, the following controlling measures are recommended: (a) The collection of adults and larvae in the early morning by sweeping the rice-leaves with boat-shaped net during its active time, (b) a thorough spraying with contact poisons such as pyrethrum-soap-solution, naphtha-soap-solution, etc., (c) the collection of egg-masses and (d) the protection of egg-parasite by the use of the egg-parasite-protecting apparatus.

XI. BIBLIOGRAPHY

[Chiefly for taxonomic studies]

1. BALY, J. S. : Descriptions of New Species of Phytophagous Insects. [Trans. Ent. Soc. London, Vol. V (n. ser.), pp. 146–161] 1859

2. ———— : Descriptions of New Species of Crioceridae. [Ann. Mag. Nat. Hist., Vol. XVI (3 ser.), No. 93, pp. 153–160] 1865

3. ———— : Catalogue of the Phytophagous Coleoptera of Japan, with Descriptions of the Species new to Science. [Trans. Ent. Soc. London, 1873, pp. 69–98] 1873

4. BATES, H. W. : On a Collection of Coleoptera from Formosa, sent Home by R. SWINHOE, Esq., H. B. M. Consul, Formosa. [Proc. Zool. Soc. London, 1866, pp. 339-355] 1866

5. CLAVAREAU, H.: Chrysomelidae: 1. Sagrinae, 2. Donaciinae, 3. Orsodacninae, 4. Criocerinae. [SCHENKLING'S Coleopt. Cat., Pars. 51] 1913

6. DOI, K. : Chosen san Hamushi-kwa, Chrysomelidae, no Kenkyû (Studies on the Chrysomelidae of Chosen). [Dôbutsugaku Zasshi (Zool. Mag.), Vol. XXXIX, pp. 323-339 with 1 fig.] 1927

7. FOWLER, C. : The Coleoptera of the British Islands. Vol. IV. (Reference on pp. 281-282) 1890

8. GEMMINGER, M. and HAROLD, B. de: Catalogus Coleopterorum. Tom. XI. Chrysomelidae (Pars 1) 1874

9. JACOBY, M. : Descriptions of the Phytophagous Coleoptera of Japan obtained by Mr. George LEWIS during his Second Journey, from February 1880 to September 1881. [Proc. Zool. Soc. London, 1885, pp. 190-210, 719-755, Pls. XI & XLVI] 1885

10. ———— : Descriptions of New Species of Phytophagous Coleoptera from Kiukiang (China). [Proc. Zool. Soc. London, 1888, pp. 339-351] 1888

11. ———— : Descriptions of New Species of Phytophagous Coleoptera received by Mr. J. H. LEECH, from Chang-Yang, China. [Entomologist, Vol. XXIII, No. 322, pp. 84-89] 1890

12. ———— : Some New Genera and Species of Phytophagous Coleoptera from India and Ceylon. [Entomologist, Vol. XXXII, No. 430, pp. 67-70] 1899

13. ———— : The Fauna of British India, including Ceylon and Burma. Coleoptera. Vol. II (Chrysomelidae Vol. I) 1908

14. JACOBY, M. and CLAVAREAU, H.: Coleoptera, Phytophaga, Fam. Crioceridae. [WYTSMAN'S Gen. Insect., Fasc. XXIII] 1904

15. KRAATZ, G. : Neue Käfer vom Amur. [Deutsch. Ent. Zeitschr., Jg. XXIII, pp. 121-144] 1879

16. KUHNT, P. : Illustrierte Bestimmungs-Tabellen der Käfer Deutschlands. 1913

17. KUWAYAMA, S.: Doro-oi-mushi no Gakumei (On the Scientific Name of the Rice Leaf-beetle). [Kontyû, Vol. III, pp. 191-193] 1929

18. ———— : *Lema oryzae* sp. nov. [Ins. Matsum., Vol. V, p. 155] 1931

19. LACORDAIRE, M. T.: Monographie des Coléoptères Subpentamères de la Famille des Phytophages. Première Partie. [Mem. Soc. Roy. Sci. Liége, Tom. III] (Reference on pp. 303-546) 1845

20. LEWIS, G. : A Catalogue of Coleoptera from the Japanese Archipelago. 1879

21. ———— : A List of Coleoptera new to the Fauna of Japan, with Notice of

Unrecorded Synonyms. [Entomologist, Vol. XXVI, No. 360, pp. 150–153] 1893

22. MATSUMURA, S.: Gaichû Kujo Zensho (Manual of Insect Control). (Reference on p. 262) 1897

23. ———— : Nippon Konchûgaku (Entomology of Japan). (Reference on p. 186) 1898

24. ———— : Nippon Senchû Zukai (Thousand Insects of Japan). Vol. IV. (Reference on pp. 32–33, Pl. LVIII) 1907

25. ———— : Erster Beitrag zur Insekten-Fauna von Sachalin. [Jour. Coll. Agr., Tohoku Imp. Univ., Vol. IV, Pt. 1, pp. 1–145, Pls. I–II] 1911

26. ———— : Dainippon Gaichû Zensho (Manual of the Injurious Insects in Japan). Vol. II. (Reference on pp. 121–122, Pl. XIV–fig. 3) 1915

27. ———— : Konchû Bunruigaku (Systematic Entomology). Vol. II. (Reference on p. 74) 1915

28. ———— : Nô Konchûgaku (Agricultural Entomology). (Reference on pp. 337–338 with 1 fig.) 1930

29. NAWA, U. : Shôshimoku Kenkyû Shishin (Guide to the Studies on Coleoptera). No. 16. [Konchû Sekai (Insect World), Vol. XII, pp. 361–367, Pl. XI] 1908

30. PIC, M. : Mélanges Exotico-Entomologiques. Fasc. 40. (Reference on p. 18) 1923

31. ———— : Mélanges Exotico-Entomologiques. Fasc. 41. (Reference on p. 12) 1924

32. REITTER, E. : Fauna Germanica (Die Käfer des Deutschen Reiches). Bd. IV. (Reference on pp. 81–82, Pls. 141–142) 1912

33. SCHAUFUSS, C. : CALWER's Käferbuch (Einführung in die Kenntnis der Käfer Europas). 6ste Aufl. 1916

34. SCHÖNFELDT, H. v.: Catalogue der Coleopteren von Japan, mit Angabe der Bezüglichen Beschreibungen und der sicher Bekannten Fundorte. [Jahrb. d. Nass. Ver. f. Naturk., Jg. XL, pp. 31–204]. (Reference on pp. 174–175) 1887

35. TAKAHASHI, S. : Yamanoimo no Gaichû to Yamaimo-hamushi ni tsuite (Insect-Pests of Yam, with Special Reference to the Yam Leaf-beetle). [Byôchûgai Zasshi (Jour. Plant Protect.), Vol. III, pp. 277–280 with 1 fig.] 1916

36. ———— : Sosai Gaichû Kakuron (Vegetable Insects). (Reference on pp. 121–123, figs. 69–70) 1928

37. WEISE, J. : Coleoptera (Naturgesch. d. Ins. Deutschl., Iste Abt., VI Bd.). (Reference on pp. 59–67) 1881

38. WEISE, J. : Insecta, A. Cl. G. N. Potanin in China et in Mongolia Novissime Lecta. VIII. Chrysomelidae et Coccinellidae. [Hor. Soc. Ent. Ross., Vol. XXIII, pp. 560–653] 1889

39. WINKLER, A. : Catalogus Coleopterorum regionis palaearcticae. Pars. 10. 1929

40. YOKOYAMA, K.: Nipppon Dôbutsu Zukan *no uchi* Shôshi-moku (Coleoptera in the "Figuraro de Japanaj Bestoj"). (Reference on p. 779, Fig. 1505) 1927

41. YOKOYAMA, K. and KANO, T.: Minami-Karafuto san Kôchû-rui (Coleoptera from the South Saghalien). [Dôbutsugaku Zasshi (Zool. Mag.), Vol. XXXIX, pp. 1–39] 1927

42. YUASA, Hiroharu: Ine-no-doro-hamushi no Gakume ini tsuite (On the Scientific Name of the Rice Leaf-beetle). [Kontyû, Vol. I, pp. 95–97; Vol. II, pp. 61–62] 1926–1927

43. ———— : Ine-doro-oi-mushi to *Lema melanopa* tono Sai (On the Difference between the Rice Leaf-beetle and *Lema melanopa*). [Kontyû, Vol. III, pp. 199–200] 1929

[Chiefly for ecological studies and distribution]

44. CURTIS, J. : Farm Insects. (Reference on pp. 307–308, Fig. 43) 1883

45. FEYTAUD, J. : Un parasite de la Miliade, *Lema flavipes*, Suffr. [Rev. Zool. agric. & appl., Vol. XXIII, No. 7, pp. 158–161. Abstract in Rev. Appl. Ent., ser. A, Vol. XII, p. 504 (1924)] 1924

46. HÄNSEL, S. : Beitrag zur Kenntnis der Biologie des Getreidehähnchens *Lema cyanella* Lin. [Zeitschr. f. wiss. Ins.-Biologie, Bd. XIX, pp. 27–29 with 7 figs.] 1924

47. HODSON, W. E. H.: The Bionomics of *Lema melanopa*, L. (Criocerinae), in Great Britain. [Bull. Ent. Res., Vol. XX, pp. 5–14, Pls. I–II] 1929

48. HORI, T. and SHIRAKI, T.: Taiwan no Gaichû ni kwansuru Chôsa (Investigations on the Crop Pests in Taiwan). [(Taiwan Sôtokufu) Nôji Shikenjô Tokubetsu Hôkoku (Agr. Exp. Sta., Gov. Formosa, Sp. Report), No. 1] (Reference on pp. 206–208, Pl. XXI) 1910

49. ISHIKAWA, C. : ISHIKAWA Nôgyô Dôbutsugaku (ISHIKAWA's Text-book of Agricultural Zoology). (Reference on pp. 220–221, Fig. 113) 1906

50. KADOCSA, G. : *Crioceris melanopa* (*Lema melanopus*), Injurious to Oats and Barley in Hungary. (Translated title) [Kisérletugyi Kötzlemények, Vol. XVIII, Pt. 1, pp. 108–176, Pls. I–VIII. Abstract in Intern. Rev. Sci. & Pract. of Agr., Vol. VII, pp. 312–314 (1916)] 1915

51. KATÔ, S. : Doro-oi-mushi no Hassei Keikwa oyobi Kujo-yobôhô (On the Life-history of the Rice Leaf-beetle and its Controlling Methods). [Kon-

chû Sekai (Ins. World), Vol. I, pp. 125–126 with 1 fig.] 1897

52. KUWANA, I. : Gaichû to Ekichû (Noxious and Beneficial Insects). (Reference on p. 119) 1905

53. ———— : Nôyô Konchûgaku Kôgi (A Text-book of Agricultural Entomology). (Reference on pp. 178–180, Fig. 44) 1918

54. KUWAYAMA, S. : Hokkaido ni okeru Inasaku Gaichû (The Principal Insect-Pests of the Rice-plant in Hokkaido). [Hokkaido Nôji Shikenjô Ihô (Hokkaido Agr. Exp. Sta., Bulletin) No. 47] (Reference on pp. 54–69, Figs.22–26) 1928

55. MACHIDA, T. and AOYAMA, T. : Chôsen Gaichû Hen, Zenpen (Injurious Insects in Chosen, Vol. I). (Reference on pp. 86–88, Fig. 38) 1928

56. MATSUMURA, S. : Hondô ni okeru Inasaku Gaichû (On the Insect-Pests of the Rice-plant in Hokkaido). [Hokkai no Shokusan (Plant Industry in Hokkaido), Vol. VIII, No. 96, pp. 275–280] 1898

57. ———— : Nippon Gaichû Hen (Injurious Insects in Japan). (Reference on pp. 283–285, Fig. 124) 1899

58. MEGALOV, V. : *Lema melanopa*, L., a Pest of Oats, Barley and other Graminaceous Plants. (In Russsian, with a summary in German. Translated title.) [Saratovsk. Oblastn. S. Kh. Opuitn. Stantz., Ent. Otd. Abstract in Rev. App. Ent., ser. A., Vol. XV, p. 643 (1927)] 1927

59. MURATA, J. and IKEDA, T. : Nagano-ken no Ine-doro-oi-mushi (The Rice Leaf-beetle in Nagano Prefecture). [Byôchûgai Zasshi (Jour. Plant Protect.), Vol. XIII, pp. 9–19] 1926

60. MURATA, J. and SEKIYA, I. : Ine-doro-oi-mushi Kujo Shiken no Kekkwa (Results on the Experiments of the Controlling Methods to the Rice Leaf-beetle). [Byôchûgai Zasshi (Jour. Plant Protect.), Vol. XV, pp. 146–160] 1928

61. MURATA, J., IKEDA, T. and SEKIYA, I : Ine-doro-oi-mushi ni kwansuru Kenkyû (Studies on the Rice Leaf-beetle). [Nagano Agr. Exp. Sta., Nôji Shiken Seiseki Hôkoku (Research Bulletin), No. 3, pp. 37–52] 1929

62. MURATA, T. : Beibaku no Gaichû to Yobôkujo (Cereal Pests and the Controlling Methods). (Reference on pp. 209-212, Fig. 41) 1915

63. ———— : Beibakusaku no Gaichû to Yobôkujo (Cereal Pests and the Controlling Methods. Revis. ed.). (Reference on pp. 343–346, Pl. V. fig. 4) 1927

64. NAKAYAMA, S. : Chosen ni oite Nôgyôkeizai jô Jûyô naru Gaichû Chôsa (A List of More Important Injurious Insects in Chosen). Part II [Chosen Sôtokufu Nôji Shikenjô Ihô (Ann. Agr. Exp. Sta., Gov.-Gen. Chosen), Vol. IV, pp. 261–300] 1929

65. NAWA, U. : Gaichû toshiteno Hamushi-kwa ni tsukite (On the Chrysomelidae in

Economic Importance). [Konchû Sekai (Ins. World), Vol. XVII, pp. 15–19 with 1 fig.) 1913

66. NAWA, U. : Inasaku Gaichû no Shurui Chôsa, I. (An Annotated List of the Injurious Insects to the Rice-culture). [Konchû Sekai (Ins. World), Vol. XVIII, pp. 149–155] 1914

67. NODZU, R. : Ine-doro-oi-mushi ni tsuite (On the Rice Leaf-beetle). [Byôchûgai Zasshi (Jour. Plant Protect.), Vol. XV, pp. 212–218, 274–282] 1928

68. OJIMA, G. : Sakumotsu Byôgai Hen (Hindrance of Crops). (Reference on pp. 208–209) 1892

69. OKADA, J. : Doro-oi-mushi (The Rice Leaf-beetle). [Yamaguchi Agr. Exp. Sta., Rinji-Hôkoku (Extra Report), No. 3] 1913

70. OKAMOTO, H. : Jitsuyô Gaichû Kujo Yobô-hô (Practical Controlling Measures of the Injurious Insects). (Reference on pp. 40–41, Fig. 8) 1909

71. ———— : Hokkaido Gaichû Hen (Injurious Insects in Hokkaido). (Reference on pp. 38–40, Figs. 6–7). 1913

72. ÔKURA, N. : Jokôroku (Controlling Measures of the Rice-Pests). 1826

73. ONO, M. : Jûyô Shokubutsu Gaichû Yôsetsu (Hand-book of the Injurious Insects of Important Crops). (Reference on pp. 48–50) 1891

74. ONUKI, S. : Gaichû Bumpu no Jôkyô (On the Distribution of Injurious Insects). [Dainippon Nôkaihô (Jour. Agr. Soc. Jap.), No. 174, pp. 10–12] 1896

75. ———— : Jitsuyô Konchûgaku (Economic Entomology). (Reference on pp. 136–137, Fig. 96) 1903

76. ———— : Doro-oi-mushi Kujo Shiken oyobi Seiseki (Experiments on the Controlling of the Rice Leaf-beetle). [Nôshômushô Nôji Shikenjô Hôkoku (Agr. Exp. Sta., Dept. of Agr. & Comm., Rep.), No. 30, pp. 59-62] 1904

77. ÔTSUBO, N. : Ine o gaisuru Doromushi Kujohô Jikken (Practical Experience on the Controlling of the Leaf-beetle injurious to the Rice-plant). [Dainippon Nôkai Hôkoku (Jour. Agr. Soc. Jap.), No. 27, p. 17] 1883

78. SASAKI, C. : Doro-oi-mushi (Doro-mushi, Katsugi-mushi, Bero-mushi) ni tsuite (On the Rice Leaf-beetle). [Konchû Sekai (Ins. World), Vol. I, pp. 85–88 with 4 figs.] 1897

79. ———— : Nippon Nôsakumotsu Gaichû Hen (Manual of Crop Pests in Japan). (Reference on pp. 113–116, Fig. 73) 1899

80. ———— : Komaba Sôsho Sakumotsu Gaichû Hen (Komaba Series, Crop Pests). (Reference on pp. 82–86, Fig. 30) 1919

81. SETO, Y. : Ine o gaisuru Doromushi Kujohô Jikken (Practical Experience on the Controlling of the Leaf-beetle injurious to the Rice-plant). [Dainippon Nôkai Hôkoku (Jour. Agr. Soc. Jap.), No. 40, pp. 18-19] 1884

82. SHIMOYAMA, C.: Inasaku no Kairyô to Kenkyû (Studies and Improvement of the Rice-culture). [Shimane Agr. Exp. Sta., Rinji Yôho (Extra Bulletin), No. 32] [Reference on p. 134) 1926

83. SHIRAKI, T. : Taiwan Gaichû Mokuroku (Catalogue Insectorum noxiorum Formosarum). (Reference on p. 56) 1911

84. ———— : Ippan Gaichû ni kwansuru Chôsa (Surveys on the Injurious Insects in Taiwan). [(Taiwan Sôtokufu) Nôji Shikenjô Tokubetsu Hôkoku (Agr. Exp. Sta., Gov. Formosa, Special Report), No. 8] (Reference on pp. 597–598) 1913

85. SONAN, J. : Ichinen 1-kai Hassei no Yôju no Gaichû "Taiwan-ichi-monji-hamushi" ni tsuite (On *Morphosphaera* sp., a Pest of *Ficus retusa*, which Occurs one Generation Yearly). [Taiwan Nôjiho (Agr. Gazette of Taiwan) No. 236, pp. 575–580 with 1 fig.] 1926

86. ———— : Taiwan ni okeru Gaichû no Hassei to Chiri tono Kankei (Relations between the Occurrence of the Injurious Insects and Geography in Taiwan). [Trans. Nat. Hist. Soc. Formosa, Vol. XIX, pp. 63–74] 1929

87. ———— : Ine, Kansho, Cha-ju Gaichû oyobi Kujoyobô (Injurious Insects of Rice-plant, Sweet Potatoes and Tea-plant and their Control. [Sakumotsu Gaichû Hen (Lectures on the Crop Pests), published by the Bur. Plant Indus., Gov. Formosa, pp. 15–115] (Reference on pp. 42–45) 1930

88. TAKAHASHI, S.: Futsû Sakumotsu no Gaichû (Injurious Insects to the Field Crops). (Reference on pp. 157–158, Fig. 68). 1916

89. ———— : Nôgyô Konchûgaku (Agricultural Entomology). (Reference on pp. 162–163). 1923

———— : Sakumotsu Gaichû Ron (Injurious Insects of Crops). (Reference on pp. 143–145, Figs. 26–27) 1928

91. TANAKA, Tomitaro: Suitô (The Rice-plant). [Tochigi Agr. Exp. Sta., Tokubetsu Hôkoku (Special Report), No. 6] (Reference on pp. 125–126) 1924

92. TANAKA, Toraji: Gaichû Kenkyû Seiseki Hôkoku (Report on the Researches of Injurious Insects). No. 1. [Niigata Agr. Exp. Sta., Geppô (Month. Rep.), No. 23]. (Reference on pp. 53–58) 1901

93. Bureau of Agriculture, Department of Agriculture and Foresty of Japan: Byôgaichû Bumpu Chôsa (Surveys on the Distribution of Diseases and Injurious Insects). (Mimeograph-copy). (Reference on pp. 219–224) 1929

94. Akita Agricultural Experiment Station: Gyômu-hôkoku (Annual Report for the Year 1907). No. 13. (Reference on pp. 81–82) 1908

95. ———— : Gyômu-hôkoku (Annual Report for the Year 1908). No. 14. (Reference on pp. 114–115) 1909

96. Hokkaido Agricultural Experiment Station: Suitô no Gaichû Doro-oi-mushi ni kwansuru Chûi (A Caution on the Rice Leaf-beetle, an Important Pest to the Rice-culture). [Hokkaido Agr. Exp. Sta., Jihô (Circular), No. 20] 1922

97. ————: Futatabi Suitô no Gaichû Doro-oi-mushi ni kwansuru Chûi (Second Caution of the Rice Leaf-beetle, an Important Pest to the Rice-culture). [Hokkaido Agr. Exp. Sta., Jihô (Circular), No. 46] 1927

98. Industrial Bureau, Iwate Prefectural Government: Tôden Chûgai no Keikyô (Status of the Injurious Insects in the Rice-fields). [Dainippon Nôkai Hôkoku (Jour. Agr. Soc. Jap.), No. 17, pp, 32–33] 1882

99. Iwate Agricultural Experiment Station: Gaichû Kujoyobô (Control of the Injurious Insects). [Iwate Agr. Exp. Sta., Rinji Hôkoku (Special Bul.), No. 13]. (Reference on pp. 20–21) 1909

100. Kankyô-Hokudô Agricultural Experimental Farm: Shubyô-jô Hôkoku (Annual Report for the Year 1924). (Reference on pp. 22–23 in Appendix) 1925

101. Shimane Agricultural Experiment Station: Gyômu-hôkoku (Annual Report for the Year 1921). (Reference on pp. 141–142) 1922

102. ————: Gyômu-hôkoku (Annual Report for the Year 1922). (Reference on p. 142) 1923

103. Yamagata Agricultural Experiment Station: Gaichû Hôkoku (Report on the Injurious Insects). No. 5. (Reference on pp. 11–16 with 1 pl.) 1905

[Chiefly for the natural enemies]

104. ASHMEAD, W. H.: Classification of the Ichneumon-Flies or the Superfamily Ichneumonoidea. [Proc. U. S. Nat. Mus., Vol. XXIII, pp. 1–220] 1900

105. ————: Classification of the Superfamily Chalcidoidea. [Mem. Carnegie Mus., Vol. I, No. 4, pp. 225–551, Pls. XXXI–XXXIX] 1904

106. ————: Descriptions of New Hymenoptera from Japan. [Proc. U. S. Nat. Mus., Vol. XXX, pp. 169–201, Pls. XII–XV] 1906

107. CRAWFORD, J. C.: Descriptions of New Hymenoptera, No. 6. [Proc. U. S. Nat. Mus., Vol. XLV, pp. 241–260] 1913

108. GANGLBAUER, L.: Die Käfer von Mitteleuropa. Bd. III. (Reference on pp. 1018–1021) 1899

109. GIRAULT, A. A.: Hosts of Insect Egg-parasites in Europe, Asia, Africa and Australasia, with a Supplementary American List. [Zeitschr. f. wiss. Ins.-Biologie, Bd. X. pp. 87–91, 135–139, 175–178] 1914

110. HOWARD, L. O.: A Study in Insect Parasitism. [U. S. Dept. Agr., Div. Ent., Tech. Ser., No. 5] 1897

111. INAMURA, (S) : Doro-oi-mushi no Kiseihô (Parasites of the Rice Leaf-beetle) [Taiwan Nôjihô (Agr. Gazette of Taiwan), No. 99, pp. 163–165] 1915

112. MATSUMURA, S.: Nippon Senchû Zukai (Thousand Insects of Japan). Vol. III. (Reference on p. 34, Pl. XL) 1906

113. OKAMOTO, H.: Gaiekichû Shiiku Shiken Seiseki (Life-histories of Injurious and Beneficial Insects in Hokkaido). [Hokkaido Agr. Exp. Sta., Hôkoku (Report), No. 12]. (Reference on pp. 69–72, Pl. IV–fig. 2) 1921

114. SCHMIEDEKNECHT, O.: Die Hymenopteren Mitteleuropas. 1907

115. SHIRAKI, T. : Paddy Borer, *Schoenobius incertellus* Wlk. [Agr. Exp. Sta., Gov. Formosa, Tokubetsu Hôkoku (Special Report), No. 15] 1917

116. SONAN, J. : A few Host-known Ichneumonidae found in Japan and Formosa (Hym.). [Trans. Nat. Hist. Soc. Formosa, Vol. XX, pp. 268–273] 1930

117. ———— : Some new Species of Hymenoptera in Japanese Empire, with two known Species. [Trans. Nat. Hist. Soc. Formosa, Vol. XX, pp. 355–360] 1930

118. TAKIZAWA, Masumi: Nippon-san Zoku *Hippodamia* ni tsuite (On the Genus *Hippodamia* of Japan). [Konchû Sekai (Ins. World), Vol. XXI, pp. 494–497, 2 figs.] 1917

119. UCHIDA, T. : Dritter Beitrag zur Ichneumoniden-Fauna Japans. [Jour. Facul. Agr., Hokkaido Imp. Univ., Vol. XXV, pp. 1–115, Pls. I–III] 1928

120. ———— : Fünfter Beitrag zur Ichneumoniden-Fauna Japans (Cryptinae). [Jour. Facul. Agr., Hokkaido Imp. Univ., Vol. XXV, pp. 299–347, Pl. VI] 1930

121. VIERECK, H. L.: Contributions to our Knowledge of Bees and Ichneumonflies, including the Descriptions of twenty-one New Genera and fifty-seven New Species of Ichneumonflies. [Proc. U. S. Nat. Mus., Vol. XLIII] 1912

122. Niigata Agricultural Experiment Station: Gaichû Kenkyû Seiseki Hôkoku (Report on the Researches of Injurious Insects). No. 2. (Reference on pp. 45–47, Pl. IV) 1902

Postscript

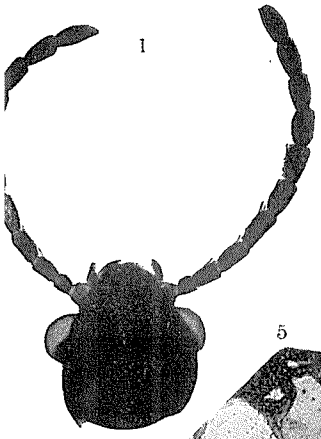
On the eve of publication of my manuscript, I have received from Dr. Y. MIWA his paper entitled "A Systematic Catalogue of Formosan Coleoptera" published under the date of October, 1931. He recognized the following 8 *Lema*-species as occurring in Taiwan.

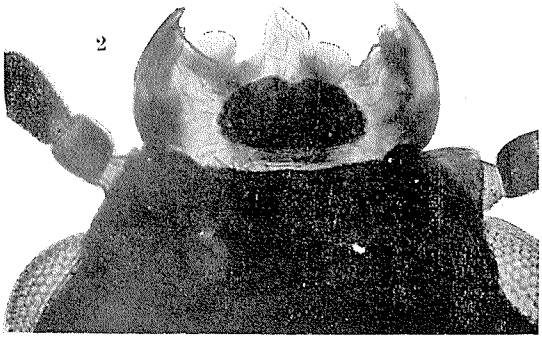
p. 184	*L. rufotestacea* CLARK	Musha, Taitô, Kôshun.
	L. unicolor CLARK	Taihoku, Horisha.
	L. fortunei BALY	Arisan, Kôshun.
	L. oryzae KUWAYAMA	Taihoku.
	L. coronata BALY	Musha, Taitô.
	L. honorata BALY	Nantô, Shôkwa.
p. 185	*L. postrema* BATES	Taihoku.
p. 313	*L. lewisi* BALY	Formosa ?

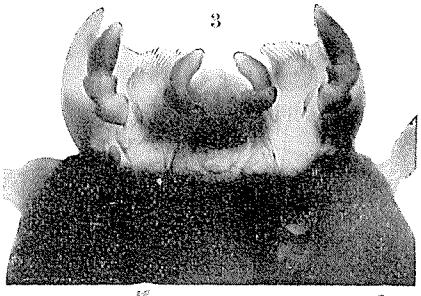
To my regret, no specimens of *L. rufotestacea* and *L. unicolor* have not appeared to my examination. I have not yet examined also any specimen of *L. coronata* and *L. honorata* from Taiwan. *L. postrema* should be, I think, synonymous with *L. fortunei*, and *L. lewisi* which was listed with some doubt, probably be *L. formosana* of mine.

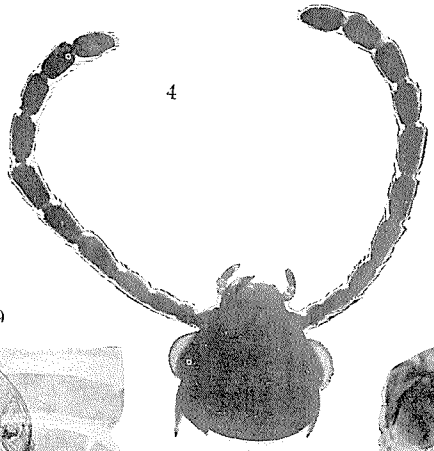
EXPLANATION OF PLATE I

1. Head of *Lema oryzae*, dorsal aspect. [Ca×22]
2. Mouth-part of *Lema oryzae*, dorsal aspect. [Ca×75]
3. Ditto, ventral aspect. [Ca×75]
4. Head of *Lema melanopa*, dorsal aspect. [Ca×22]
5. A part of prothorax and mesoscutellum of *Lema oryzae*. [Ca×22]
6. Metasternum of *Lema oryzae*. [Ca×22]
7. Elytron of *Lema oryzae*. [Ca×22]
8. Elytron of *Lema melanopa*. [Ca×22]
9. Abdominal tergites of *Lema oryzae*. [Ca×22]
10. Metanotum of *Lema oryzae*. [Ca×22]
11. Hind wing of *Lema oryzae*. [Ca×17.5]
12. Abdominal sternites of *Lema oryzae* (male). [Ca×22]
13. Ditto (female). [Ca×21]
14. Middle leg of *Lema oryzae*, lateral aspect. [Ca×21]
15. Middle leg of *Lema melanopa*, lateral aspect. [Ca×21]
16a. Abdominal sternites of *Lema melanopa*.
16b. Abdominal tergites of ditto. } [Ca×21]


1

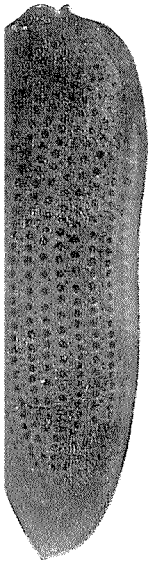

2

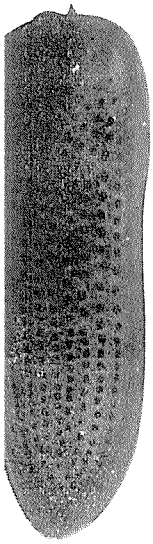

3

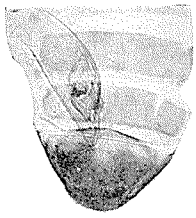

4


5

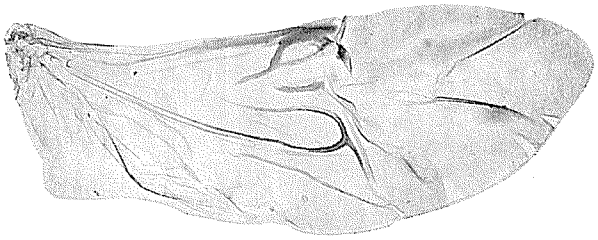

6


7

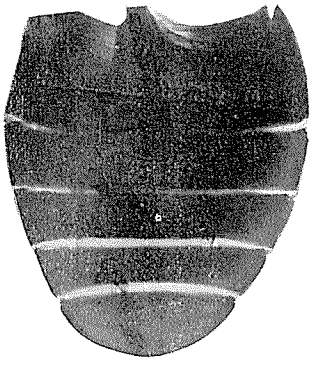

8

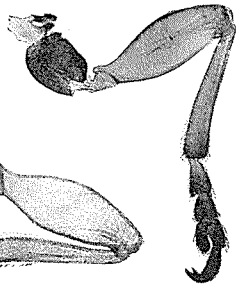

9


10


11


12


13


14

15


16a 16b

S. Kuwayama & K. Fujita photo

EXPLANATION OF PLATE II

1. Female genitalia of *Lema oryzae*, dorsal aspect. [Ca × 22]

2. Male genitalia of *Lema oryzae*, lateral aspect. [Ca × 22]

3. Male genitalia of *Lema melanopa*, lateral aspect. [Ca × 22]

4a. Egg of *Lema oryzae*, lateral aspect.
4b. Egg of *Lema melanopa*, lateral aspect. [Ca × 21]

5. Egg-mass of *Lema oryzae* in situ on the rice-leaf, white stripe on the leaf being the mark by the feeding of adult-beetle. [Ca × 16]

6. Head and thorax of the larva of *Lema oryzae*, lateral aspect. [Ca × 21]

7. Mouth-part of the larva of *Lema oryzae*, ventral aspect. [Ca × 70]

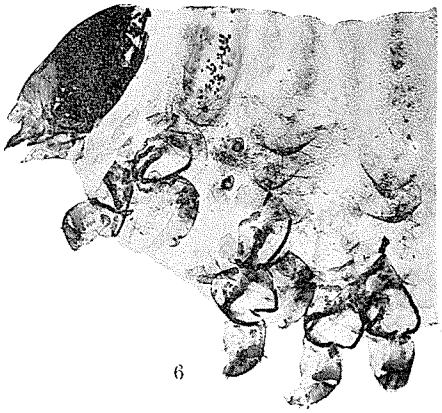
8. Integument of the larva of *Lema oryzae*, showing the spiracles. [Ca × 70]

9. Abdominal sternites and intersternal membrane of *Lema oryzae*. [Ca × 75]

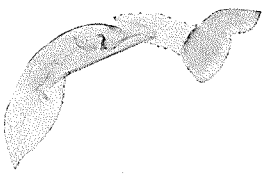
10. Abdominal sternites and intersternal membrane of *Lema melanopa*. [Ca × 75]

1

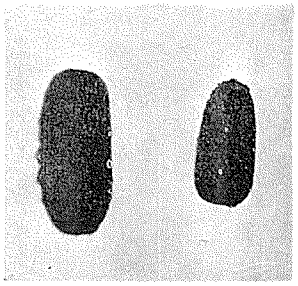
7



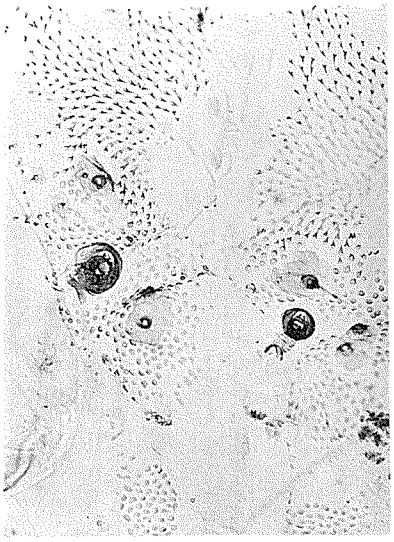
6



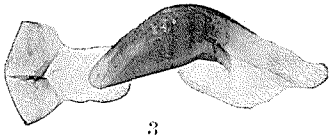
2



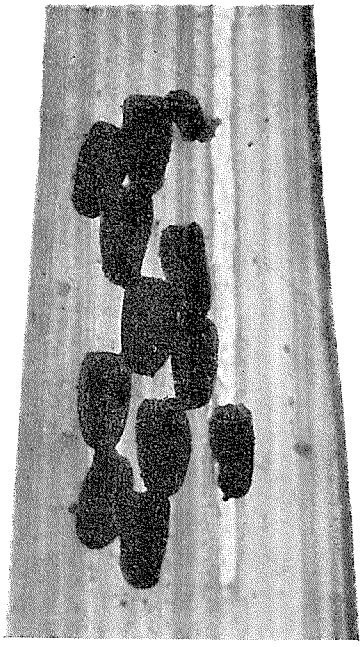
4b 4a



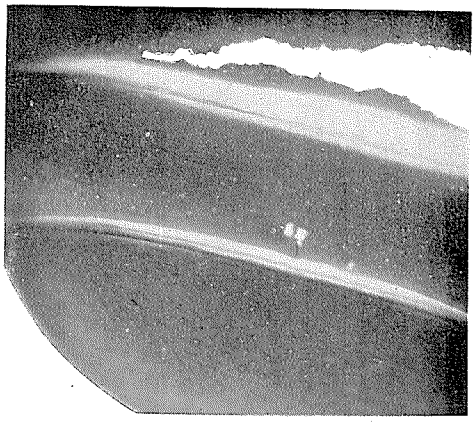
8



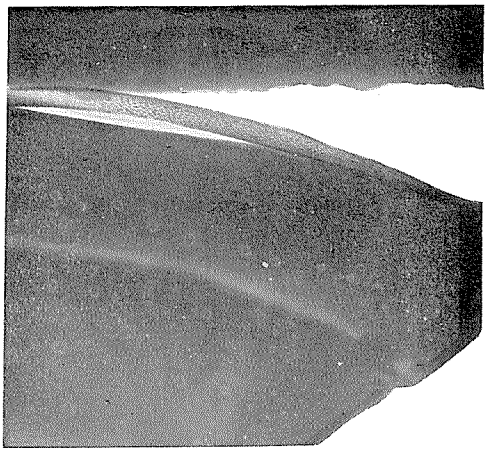
3



5



9



10

EXPLANATION OF PLATE III

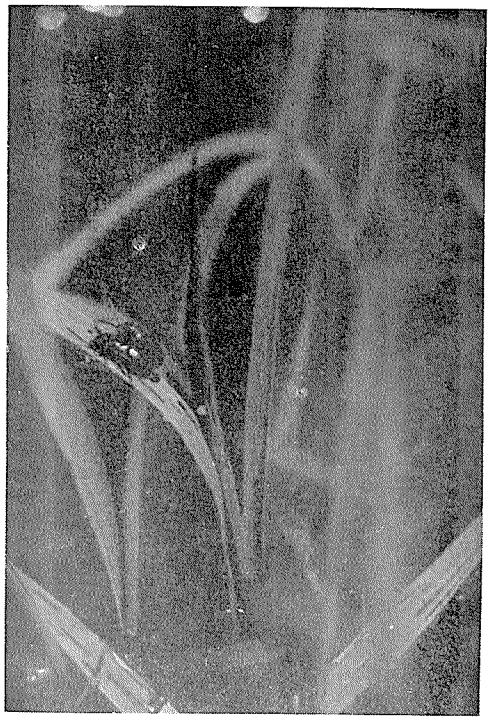
1. Adults of *Lema oryzae* on the rice-leaf, showing their feeding marks. [Ca × 1.8]

2. Mating of the adults of *Lema oryzae* and the egg-masses on the rice-leaf. [Ca × 4.4]

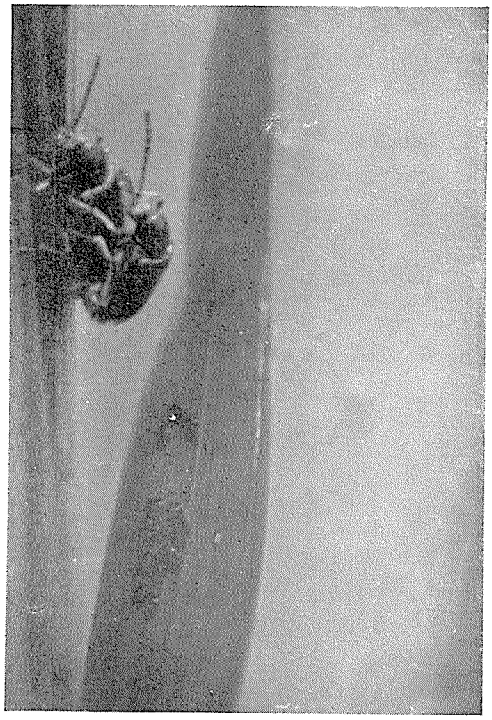
3. Larva of *Lema oryzae* on the rice-leaf, showing their feeding marks. [Ca × 1]

4. Cocoon of *Lema oryzae* on the rice-leaf. [Ca × 3]

Plate III

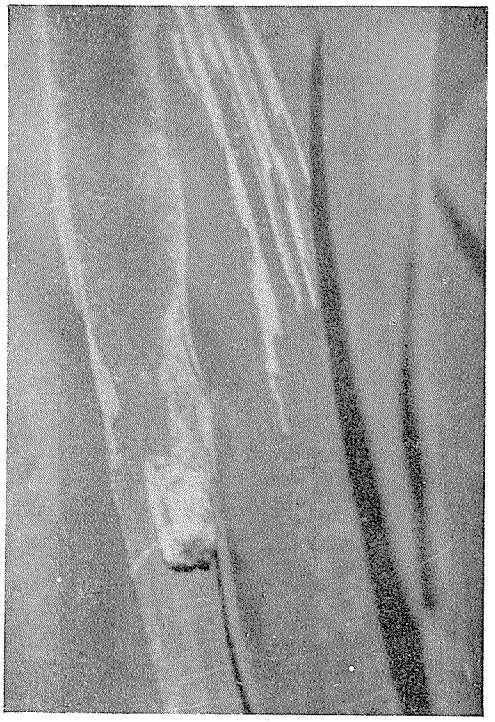


1



2

3



4

S. KUWAYAMA photo

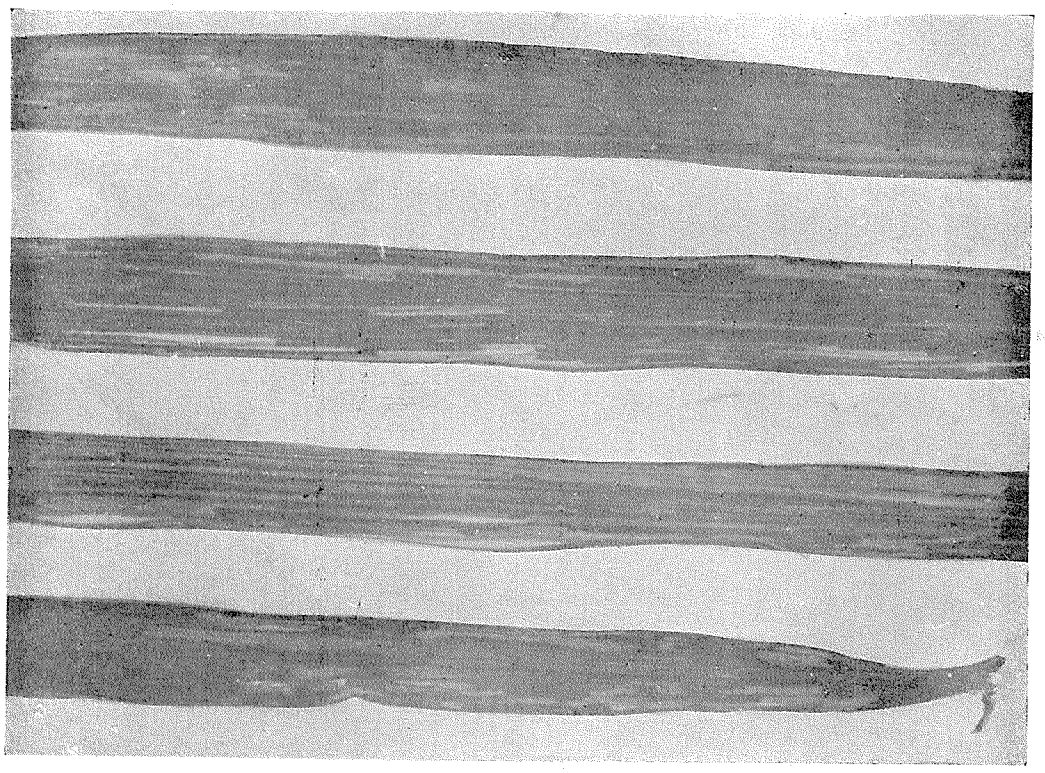
EXPLANATION OF PLATE IV

1. Rice-leaves showing typical injury by the larva of *Lema oryzae*. [Ca × 1.8]

2. Situation of the cocoon of *Lema oryzae* on the ground in the case of upland rice-field. [Ca × 2]

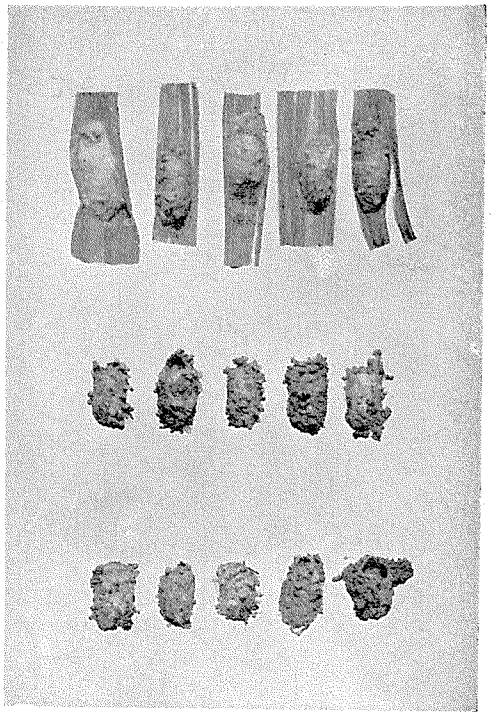
3. Cocoons of *Lema oryzae*. [Ca × 2]

Upper	Cocoons on the rice-leaves.
Middle	Cocoons on the ground.
Lower	Cocoons under the ground.



1

2



3

S. KUWAYAMA photo