Interspecific relations among three hymenopterous egg parasites of the pine moth, Dendrolirnus spectabilis Butler (Lepidoptera : Lasiocampidae) in the Japanese blackpine forest. I. : Methods of the study and general sketches of the biology of the host and parasites

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Methods of the study and general sketches of the biology of the host and parasites[1]

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Abstract

This is a preliminary report presented prior to the publication of serial reports on interspecific relations among *Trichogramma dendrolimi* Matsumura (Trichogrammatidae), *Telenomus dendrolimi* (Matsumura) (Scelionidae) and *Anastatus japonicus* Ashmead (Eupelmidae), hymenopterous egg parasites of the pine moth, *Dendrolimus spectabilis* Butler in the Japanese black pine forest on the coast near Fukuoka. Methods of study and a sketch of the biology of the host and its parasites were described.

Introduction

It is well known that the synchronous attack by two or more parasite species on a host population consisting of one developmental stage often causes a serious competition among them. In such a case, multiple parasitism usually occurs as a form of interspecific competition. From the viewpoint of both biological control and similar ecology, it is very interesting to throw light on such interspecific relations in a given parasite complex under field conditions. The present field study

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was designed to gain some information on this subject especially in the case of the egg parasite complex of the pine moth, *Dendrolimus spectabilis* Butler which is one of the most important pests of pine trees in Japan.

In the Japanese black pine forest on the coast near Fukuoka, the egg parasite complex of the pine moth consists of six hymenopterous parasites (Hirose, 1964). Of the six species, *Trichogramma dendrolimi* Matsumura[1] (Trichogrammatidae), *Telenomus dendrolimi* (Matsumura)[2] (Scelionidae) and *Anastatus japonicus* Ashmead[3] (Eupelmidae) are the principal parasites. In the present and following papers in this series the authors will report the result of their studies on the interspecific relations among these three egg parasites of the pine moth in this area.

Methods of the study

An open stand of Japanese black pine (Pl. 5, Figs. A and B) at Hanami about fifteen kilometers north of Fukuoka was chosen for this study. The test plot used was about 100 m from the sea shore and was sheltered from the sea by another stand of pine. These pine stands formed a part of the Japanese black pine forest skirting the coast in the Fukuoka district.

The stand covered an area of 3 ha and consisted ot about 1,100 trees planted for erosion control. The trees were about 15 years old, but the tree height varied from 0.7 m to 4.5 m or more probably because of the difference in the soil condition. The soil was a very well drained, leached sand. The undergrowth in this stand was sparse, consisting mostly of *Imperata cylindrica*, but also *Fimbristylis sericea*, *Eragrostis minor*, and other species.

The sampling plot in the first host generation was a block of 30 m by 22.5 m in this stand, later an area of 30 m by 7.5 m was added to the plot of the first host generation to form the sampling plot used in the second host generation. The former plot consisted of 278 trees, and

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1 This species was not included in Quednau's (1960) comprehensive work on the taxonomy of *Trichogramma*. In his key to species of *Trichogramma* this species appears to run to *Trichogramma minutum* Riley. *Tr. dendrolimi* may be a synonym of *Tr. minutum*. The senior author, however, believes that further more detailed examination is necessary for this problem.

2 *Telenomus dendrolimusi* Chu in China is a synonym of this species, which was described by Matsumura (1925) as *Holcaerus* (?) *dendrolimi* from Saghalien.

3 This species has been recorded as *Anastatus bifasciatus* (Fonscolombe) by Japanese authors. It is true that the latter is found not in Japan but in Europe. According to Tachikawa (1965), *Anastatus disparis* Ruschka is a synonym of *Anastatus japonicus* Ashmead.

the latter plot contained 374 trees. As a rule the trees in these areas were planted 1.5 m apart.

In 1963 the census was carried out on these plots. Preliminary surveys on the egg parasitism of the pine moth in the Japanese black pine forest have been made since 1960 in several stands including this stand.

Collections of material in the field

A thorough search was made of every tree in the sampling plot. All egg masses found were marked with vynil tapes stuck to the pine needles near them. About ten days after marking, the egg masses were brought into the laboratory for examination. It was found that after ten days' exposure in the field the host larvae had hatched and most of the parasites had already emerged so that both host and parasite populations were least affected by removing material, and the best estimate of parasitism might be obtained. In the first host generation, searching and marking was done on June 23, July 2, and July 12. These three census dates corresponded to the biginning, middle and end of the host oviposition period, respectively. Overlooked egg masses were checked in the following census. For the second host generation, the census was made on September 29. This census date corresponded to the end of the host oviposition period, so that the sample material covered a much greater part of host egg population of the second generation.

Examination of material in the laboratory

Field-collected egg masses were examined in the laboratory to determine the number of eggs per egg mass. Out of the unparasitized eggs, the number of eggs that had already hatched can be readily counted on the basis of each egg shell, a greater part of which had

Table 1. Characters in the pine moth eggs parasitized by three hymenopterous egg parasites.

Parasite species	Color	Exit hole		Meconia of mature parasite larvae within the host egg	
		No. per host egg	Size (diameter in mm.)	Shape	Color
Tr. dendrolimi	blackish brown	1-3	0.16-0.27	reticulate	blackish brown
Tel. dendrolimi	pale pink	1-2	0.31-0.41	massive	greenish brown
An. japonicus	pale pink	1	0.71-0.82	massive	blackish green

been eaten by the newly hatched larva. The eggs parasitized by the three egg parasites are easily distinguished from each other by the characters shown in Table 1. Of these characters, the size of exit hole is the most useful (Pl. 5, Figs. D, F and H). The eggs which produced neither adult parasites nor host larvae were dissected to determine whether they were parasitized or not.

General sketches of the biology of host and parasites

Host

Pine moth eggs are available twice a year in this region. The adult moth lays its eggs in groups of 2 to 600 or more on the pine needles or twigs from mid June to early July. The eggs hatch in a week or so. Most larvae feed on needles till autumn, then they pass the winter in this stage. However, some of larvae begin to pupate in mid August. The pupa of this generation is much smaller than that of the preceding generation, so that in September a smaller adult moth emerges and in turn deposits smaller egg masses. The abundance of eggs in autumn varies greatly from year to year, but the egg population density in the second generation is always much lower than that in the first generation.

In this region, there are two remarkable size differences of egg masses regardless of year or generation (Hirose, 1967). These two types of egg masses, viz. small-type and large-type, were distinguished from each other in size for convenience as follows:

Small-type ones consist of less than 20 eggs, usually 3 to 6 eggs on an average; large-type ones comprise 21 to 600 or more eggs, with the range 100 to 200 or more on an average.

Parasites

The three egg parasites of the pine moth are more or less polyphagous. They may have hosts other than the pine moth not only inside the Japanese black pine forest but also outside it. They may also originate from other places and fly to the pine forest. It is, therefore, difficult to trace their seasonal histories in the Japanese black pine forest.

The following statements are chiefly based on field surveys carried on since 1960. The field placement of cultured pine moth eggs was carried out in this stand in August in both 1961 and 1962. The object of this experiment was to determine whether egg parasites occur during the period when the pine moth eggs are absent in the Japanese black pine forest.

1. *Trichogramma dendrolimi* Matsumura

This parasite is very minute and is the smallest of the three egg parasites of the pine moth (Pl. 5, Fig. C). It is gregarious in the pine moth egg ; a single host egg produces 20-30 adult parasites on an average.

This species is an extremely polyphagous parasites of Lepidoptera. According to Yasumatsu and Watanabe (1964), 26 species in 11 families are known to be hosts of this species in Japan. There is, however, no evidence that this species has alternate hosts in the Japanese black pine forest.

Of the three egg parasites of the pine moth, this species is usually the most dominant in the first host generation. In this season its developmental period requires 8-9 days (Hirose, 1964). Hence this parasite may have three generations in the pine moth eggs of the first generation. In mid June, the beginning of the host oviposition period, the percentage parasitism is very low. Thereafter it increases rapidly, and in early July host eggs are often heavily parasitized. In spite of high parasite densities attained in mid July, this species is not found in the Japanese black pine forest in August. Aino and Nobuchi (1960) stated that this parasite disperses and moves out of the pine forest in the event of host shortage. Host eggs in the second generation are rarely parasitized by this species. Probably this species passes the winter within lepidopterous eggs outside the Japanese black pine forest. It is very doubtful that this parasite inhabits the Japanese black pine forest before mid June of each year. The initial parasitization of the first host generation is probably due to the parasites which enter the pine forest from outside areas.

2. *Telenomus dendrolimi* (Matsumura)

When considering the three parasites of the pine moth, this parasite is medium-sized (Pl. 5, Fig. E). It is also gregarious in the pine moth egg ; a single host egg produces about 6-8 on an average.

This species attacks the eggs of *Hyloicus caligineus* Butler, the larva of which feeds on the needles of Japanese black pine (Hirose, 1964). However, this sphingid moth is far too uncommon to be an important alternate host in the Japanese black pine forest.

This species is usually the dominant one next to *Trichogramma* in the first host generation. In this season its developmental period requires 12-13 days (Hirose, loc. cit.). Hence this species may have two generations in the pine moth eggs of the first generation. Like *Trichogramma*, the percentage parasitism is very low in mid June, and at the end of host oviposition period a relatively high percentage parasitism is ob-

served. In contrast with *Trichogramma*, this parasite is found in the Japanese black pine forest in August and, furthermore, the heavy parasitization occurs in the second host generation. The adult emergence from parasitized eggs in autumn continues till late October. According to Lung et al. (1957), in China this parasite passes the winter as an adult at the base of pine needles. In spring the overwintered adults may attack their alternate host, *Hyloicus caligineus*. Undoubtedly this species inhabits the Japanese black pine forest throughout the year.

3. *Anastatus japonicus* Ashmead

This parasite is the largest in size of the three egg parasites of the pine moth (Pl. 5, Fig. G). It is a solitary parasite in the pine moth egg.

Like *Trichogramma*, the host range of this species is very wide[1], but there is no evidence that it has alternate hosts in the Japanese black pine forest.

This species is usually not abundant in the Japanese black pine forest. In summer its developmental period requires at least 20 days (Hirose, 1964) and its preoviposition period requires 1-2 days (Hirose, unpublished data). Evidently this parasite has only one generation in the pine moth eggs of the first generation. The percentage parasitism is always low throughout the first generation host oviposition period. Like *Telenomus*, this species is found in the Japanese black pine forest in August. In autumn its population density seems to be as low as in summer, but sometimes a relatively high percentage parasitism is observed in the pine moth eggs of the second generation. Hibernation takes place as a full-fed larva within the pine moth egg. The overwintered larvae pupate in spring and adult parasites emerge from May to June. Like *Telenomus*, this species inhabits the Japanese black pine forest throughout the year.

Seasonal histories of the pine moth and its three egg parasites in the Japanese black pine forest are summarized in Fig. 1.

Table 2 summarizing the result of the census made in 1963 shows clearly that the pine moth eggs of the first generation are heavily parasitized by *Trichogramma dendrolimi* and *Telenomus dendrolimi* and that

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[1] It is well known that this species is an egg parasite of the gypsy moth, *Lymantria dispar* Linné. Ishii (1951) recorded a nymphalid butterfly, *Sasakia charonda* Hewitson as its host. The senior author reared this parasite from the eggs of *Malacosoma neustria testacea* Motschulsky (Lasiocampidae) and *Philosamia cynthia pryeri* Butler (Saturnidae) (new host record). According to Hokyo et al. (1966), it also attacks the eggs of some pentatomids, such as *Nezara viridula* Linné, *N. antennata* Scott and *Eurydema rugosum* Motschulsky.

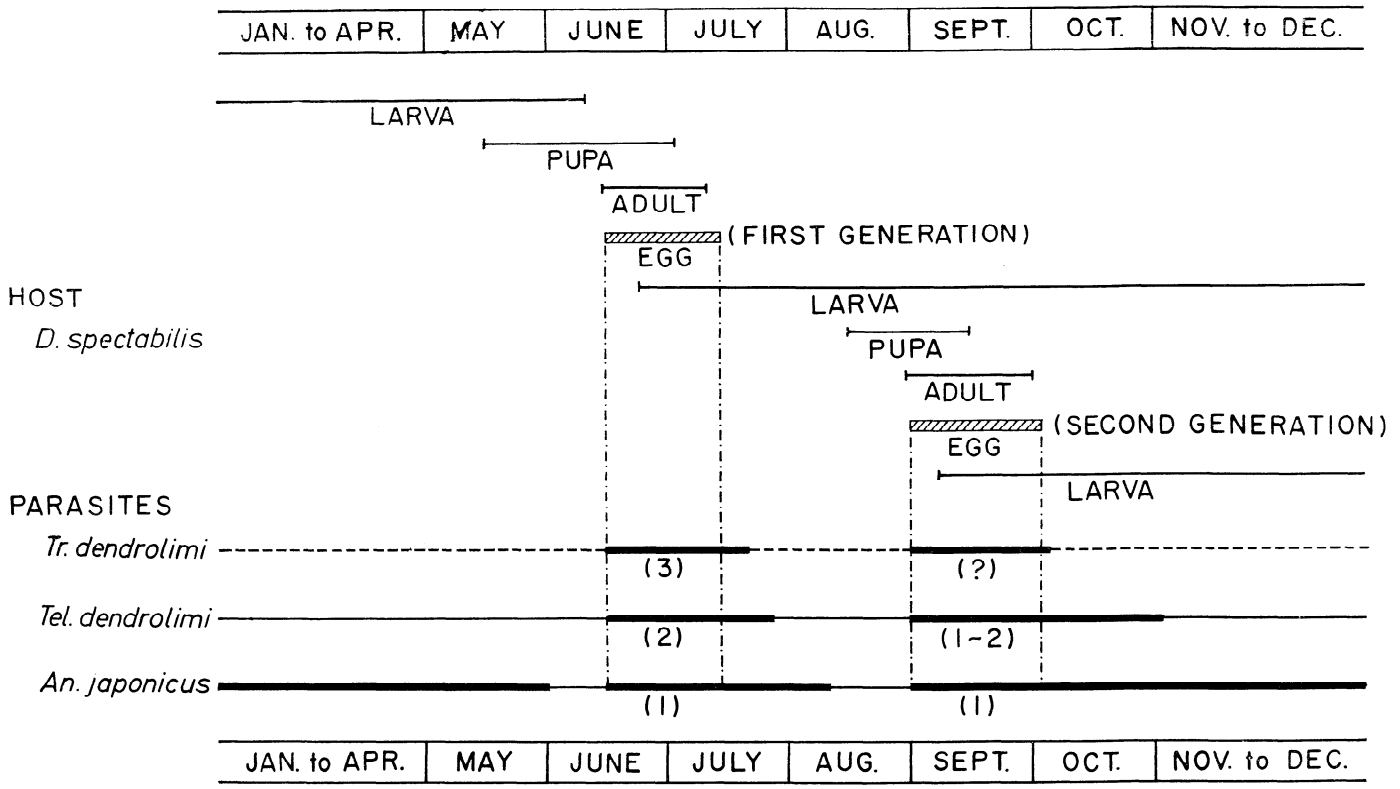

Fig. 1. Seasonal histories of the pine moth and its three hymenopterous egg parasites in the Japanese black pine forest near Fukuoka. For the part of the figure showing the seasonal histories of parasites: — A solid line shows the presence of parasites in the Japanese black pine forest, and thick parts of this line indicate the presence of the parasite in host eggs. The broken line indicates the absence of parasites in the Japanese black pine forest. Supposed numbers of generation of parasites in the pine moth eggs of each generation are shown in parenthesis.

Table 2. Seasonal abundance of the pine moth eggs and percentage parasitism by their hymenopterous parasites in a Japanese black pine stand near Fukuoka in 1963.

Host generation	Census date	Host density per tree	Percentage parasitism by		
			Tr. dendrolimi	*Tel. dendrolimi*	*An. japonicus*
First	June 23	14.8	0.7	3.8	0.3
	July 2	191.5	6.2	11.2	0.6
	July 12	22.1	27.5	34.6	2.2
	Total	228.4	7.9	13.0	0.7
Second	Sept. 29	21.4	0.3	65.5	8.8

those of the second generation are heavily attacked by *Telenomus dendrolimi* and *Anastatus japonicus*. With the exception of unusual high parasitization by *Anastatus japonicus*, this result indicates the general tendency of egg parasitism of the pine moth in the Japanese black pine forest each year.

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References

Aino, S. and A. Nobuchi (1960) (On the hymenopterous egg parasites of the pine moth, *Dendrolimus spectabilis* Butler). 70th Jap. For. Soc. 318-320 (In Japanese).

Hirose, Y. (1964) The activity of the egg parasites of the pine-moth, *Dendrolimus spectabilis* Butler in the Japanese black pine forest on the sea coast. Sci. Bull. Fac. Agr. Kyushu Univ. **21**: 13-24 (In Japanese with English summary).

(1967) Occurrence of two types of egg mass size in the pine moth, *Dendrolimus spectabilis* Butler (Lepidoptera: Lasiocampidae). Ibid. **23**: 15-21 (In Japanese with English summary).

Hokyo, N., Kiritani, K., Nakasuji, F. and M. Shiga (1966) Comparative biology of the egg parasites of the southern green stink bug, *Nezara viridula* L. Appl. Ent. Zool. **1**: 53-61.

Lung, C., P'eng, C., Ch'ien, Y., Ch'iu, I., Li, S., Hsieh, H., Chu, S. and L. Lin (1957) A preliminary biological study of two egg-parasites of the pine caterpillar. Acta Ent. Sinica **7**: 261-284 (In Chinese with English summary).

Matsumura, S. (1925) On the three species of *Dendrolimus* (Lepidoptera), which attack spruce- and fir-trees in Japan, with their parasites and predaceous insects. Ann. Mus. Zool. Acad. Sci. URSS. **26**: 27-50.

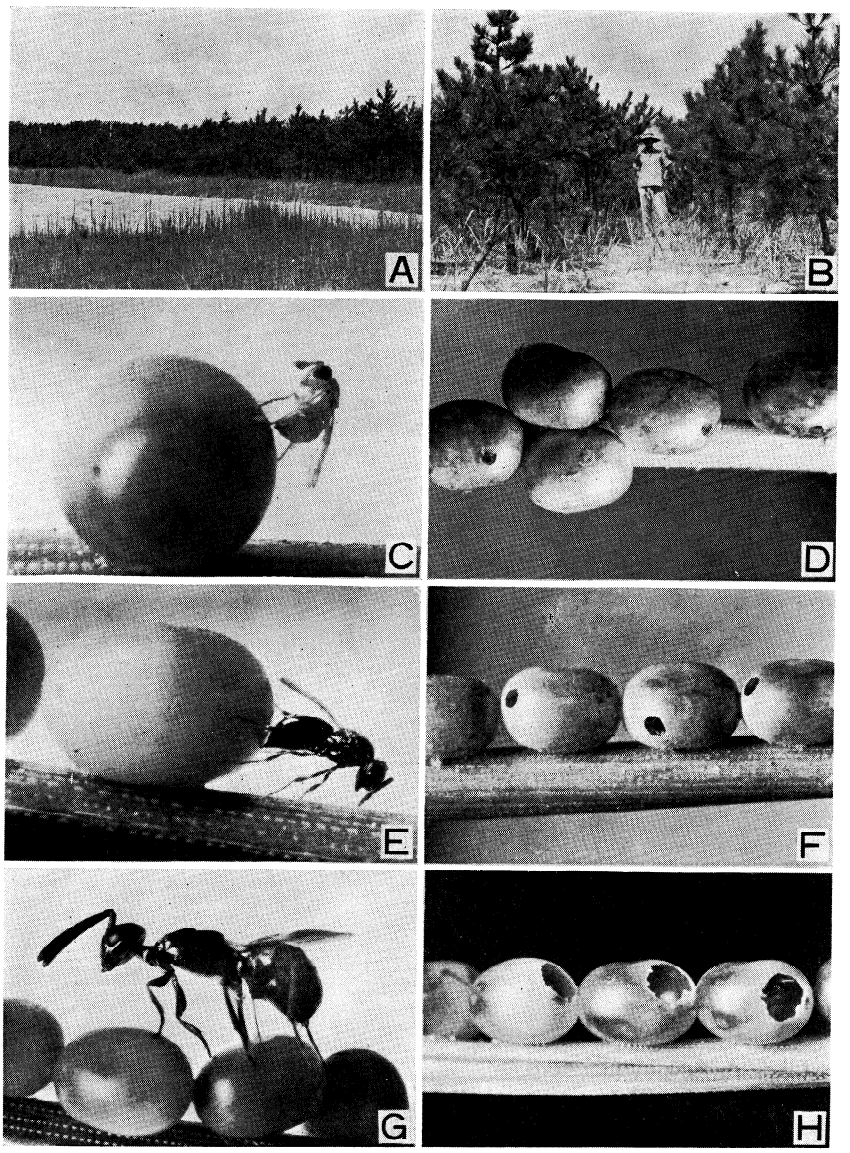
Quednau, W. (1960) Über die Identität der *Trichogramma*-Arten und einiger ihrer Ökotypen (Hymenoptera, Chalcidoidea, Trichogrammatidae). Mitt. Biol. Bundesanst. Berlin-Dahlem **100**: 11-50.

Tachikawa, T. (1965) *Anastatus japonicus* Ashmead, p. 281. *In* Iconographia Insectorum Japonicorum Colore naturali edita, Volumen 3, Yasumatsu, K. et al., editors. Hokuryukan, Tokyo, 358 pp. (In Japanese).

Yasumatsu, K. and C. Watanabe (Ed.) (1964) A tentative catalogue of insect natural enemies of injurious insects in Japan. Part. 1. Parasite-predator host catalogue. Ent. Lab. Fac. Agr. Kyushu Univ., Fukuoka, 166 pp.

Explanation of Plate 5

Fig. A. Japanese black pine stand chosen for this study (outward aspect).
Fig. B. Do. (a part of the sampling plot).
Fig. C. Female of *Trichogramma dendrolimi* ovipositing in a pine moth egg.
Fig. D. Pine moth eggs showing exit holes of *Trichogramma dendrolimi.*
Fig. E. Female of *Telenomus dendrolimi* ovipositing in a pine moth egg.
Fig. F. Pine moth eggs showing exit holes of *Telenomus dendrolimi.*
Fig. G. Female of *Anastatus japonicus* ovipositing in a pine moth egg.
Fig. H. Pine moth eggs showing exit holes of *Anastatus japonicus.*



Egg parasites of the pine moth