UTILIZATION OF PROCTOTRUPOID WASPS IN KOREA FOR CONTROL OF THE PINE NEEDLE GALL MIDGE, THECODIPLOSIS JA PONENSIS (DIPTERA, CECIDOMYIIDAE)

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UTILIZATION OF PROCTOTRUPOID WASPS IN KOREA FOR CONTROL OF THE PINE NEEDLE GALL MIDGE, *THECODIPLOSIS JA PONENSIS* (DIPTERA, CECIDOMYIIDAE)[1)2)3)]

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Abstract

The pine needle gall midge is the most injurious pest of *Pinus densiflora* and *P. thunbergii* in Korea. In general, pine needle gall midge damage reaches a maximal level about 7 years following invasion by the midge, and parasite populations increase a few years thereafter. Four species of Platygastridae that parasitize the midge have been found in Korea, and their parasitization percentages are on the increase. Three of the parasites, ***P. matsutama, I. hockpari,*** and ***I. seoulis*** are effective natural enemies of the midge and have been utilized for biological control by translocation.

Introduction

In 1984, the total area of Korean forests damaged by the pine needle gall midge, *Thecodiplosis japonensis* Uchida et Inouye, comprised about 60 % of the area damaged

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by all forest pests. The fact that pure forests, which are highly susceptible to insect damage, comprise almost half of the total forest land in Korea largely accounts for the severity and extent of damage by the pine needle gall midge.

Since 1960, searches for natural enemies of the midge conducted in Korea have resulted in the discovery of four proctotrupoid wasps of the family Platygastridae. They are *Inostemma seoulis* (Ko), discovered in 1962 ; ***Plutygaster*** *matsutama* and ***Inostemma matsutama,*** both described by Yoshida and Hirashima (1979) ; and *Inostemma hockpari* Ko, discovered in 1980.

The four species are rather similar ecologically. All are solitary larval or egg-larval endoparasites. The eggs are laid in the eggs or newly hatched larvae of the midge. The parasites overwinter as larvae ***(Inostemma*** spp.) or embryos ***(P.*** *matsutama*) in the soil humus layer within the host larvae. They pupate within the host larvae from April through mid June. The adult parasites emerge from early May to late July. These species are important parasites of the pine needle gall midge except *I.* ***matsutama.***

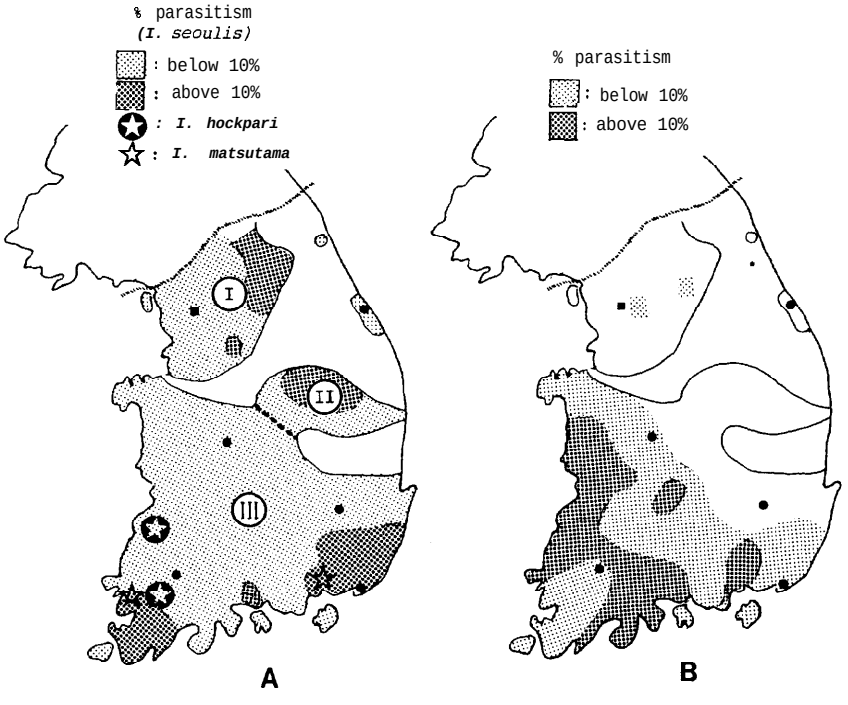

Fig. 1. Geographical distribution of Proctotrupoid wasps in Korea in 1984.
A: *Inostemma seoulis, I. hockpari* and *I. matsutamu,* B: *Plutygaster mutsutama*

Geographical Distribution and Abundance of the Parasites

Korean Distributions

The distributions of the parasites in 1984 are shown in Fig. 1. Of the four species, only *I. seoulis* is distributed more or less generally in both inland and coastal pine forests (Fig. 1). Only *I. seoulis* occurs naturally in regions I and II of Fig. **1,** and the diversity of parasite species is accordingly greater in region III.

I. matsutama and *I. hockpari* have been encountered only in southern and southeastern coastal areas (region III of Fig. 1), respectively, and *P. matsutamu* is distributed mainly in the southern part of the Korean Peninsula (Fig. 1). Although it occurs naturally only in region III, *P. matsutama* was translocated to region I from 1979 through 1983 and has extended its range northward together with the midge in region III.

Parasite Abundance

In 1975 and from 1980 through 1984, the Forest Research Institute surveyed midge damage and parasitization levels, gun (county) by gun, throughout the range of the midge. For purposes of discussion, the areas surveyed are broken into the three regions indicated in Fig. 1.

In regions II and III, midge population levels remain high along the frontal zones of midge advancement. Otherwise, population levels in regions II and III have recently declined to non-injurious levels. Population levels are generally higher throughout region I, and gall formation rates are higher there than in regions II and III (Fig. 2).

Parasitization levels of *I. seoulis* have increased in regions I and II but remain low in region III. In the latter region, *Inostemma* spp. and *P. matsutama* have tended to be alternately predominant, suggesting interaction among the species (Fig. 3).

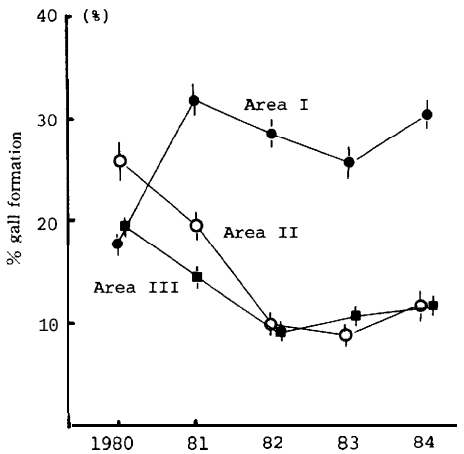

Fig. 2. Annual changes of the midge damage levels in areas I, II and III. (More than 300 plots in each area were surveyed annually. Vertical bars-standard error).

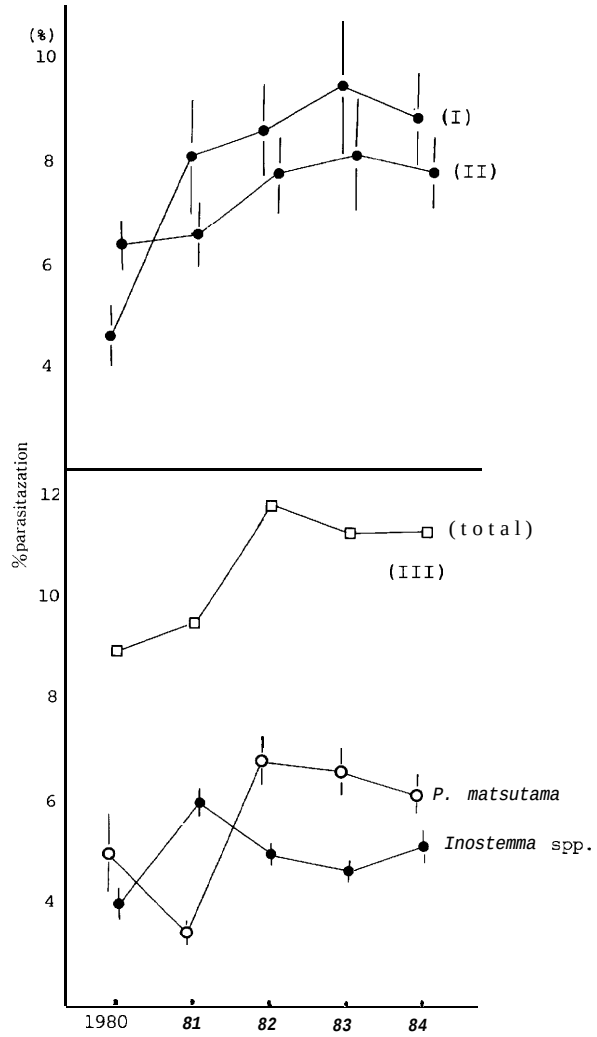

Fig. 3. Annual changes of the parasitization levels in areas I, II and III. (Vertical bars-- standard error).

In region III, parasitization levels along the frontal zone of midge advancement have been low, whereas there have been high levels of *I. seoulis* parasitization along the frontal zones in regions I and II.

Parasite Utilization

Because *I. seoulis* is believed to be the only species present when the midge expands its range into areas where it had not occurred previously, and because the initial densities of *I. seoulis* are low and do not build up with sufficient rapidity,

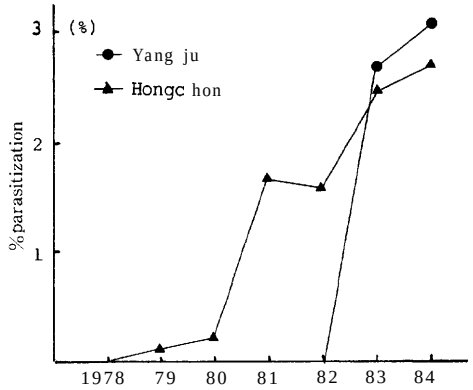

Fig. 4. Increase of parasitism of *P. matsutama* at released sites.

biological control by parasite translocation has been given priority. Translocation involves collecting the host galls from areas with high parasitization levels, rearing out the adult parasites, and then releasing them in areas with high midge population levels but low levels of parasitization.

Three species, *P. matsutama, I. hockpari,* and I. *seoulis*, have been utilized for translocation. Detailed biological studies of *I. seoulis* and *P. matsutama* indicated that translocation of parasite adults tends to produce higher settlement rates than does translocation of galls containing the hosts and the overwintering stages of the parasites.

The translocation process begins with the collection of gall-bearing needles in the autumn. The needles are stored on a bed of pine sawdust for emergence of the host larvae and for overwintering of the latter and any parasites inside them. The overwintering sites are in forests near the insectaries where the parasite adults are to be reared. In April, the layer of needles is removed and the sawdust containing the parasitized and unparasitized midge larvae is placed in large rearing containers. The containers are then moved to the insectaries and placed on shelves in specially designed rearing rooms with temperature and humidity controled. The rearing rooms have one side that is equipped with polystyrene collectors which funnel the emerging adult parasites upward into tubes through which they pass into the parasite holding containers. The collectors are lighted from behind by mercury lamps or sunlight. The adult midges that are also emerging are not positively phototropic, and so only the parasites move toward the light from the otherwise darkened room. The few midges which do happen to enter the holding containers die within 24 hours.

Nine insectaries are being used for this parasite rearing work. One of them is in Seoul at the Forest Research Institute, and the others are at eight provincial forest experiment stations. During the past seven years, parasites have been translocated to a total of about 15,000 hectares, and approximately 20,000 parasites per hectare were released.

As previously indicated, *P. matsutama* does not occur naturally in regions I and II

of Fig. 1. *P. matsutama* has been translocated to two forest sites in region I, with approximately 10,000 to 80,000 parasite adults being released per hectare from 1979 through 1983. Fig. 4 shows the annual increases in parasitization levels that have been achieved at those sites. The parasitization levels following initial translocation were 0.1% at Hongchon and 2.7 % at Yangju, and the higher level at the latter is perhaps explained by better coincidence of parasite releases with the oviposition period of the host. Although parasitization percentages have increased since translocation, they are still rather low (2.7 % at Hongch'ŏn and 3.0 % at Yangju), but it is expected that parasitization levels will increase sufficiently to reduce midge damage to tolerable levels.

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