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SOCIAL WASPS VISITING CONIFER PLANTATIONS IN HOKKAIDO, NORTHERN JAPAN (HYMENOPTERA: VESPIDAE)

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Abstract

YAMANE, SK. and KAMIJO, K. 1976. Social wasps visiting conifer plantations in Hokkaidô, Northern Japan (Hymenoptera: Vespidae). *Ins. matsum. n.s.* 8: 59–71, 1 tab., 8 figs. (4 text-figs., 2 pls.).

In connection with investigations carried out in 1971 on the species composition and seasonal abundance of hymenopterous insects associated with various conifer plantations in Hokkaidô, one species of Polistinae and six species of Vespinae were collected. Among them two *Paravespula* species were most abundant, especially in young *Abies sachalinensis* plantations. Seasonal fluctuations of visiting wasps are analyzed. The results and direct observations show an intimate association between the *Paravespula* species and *Abies sachalinensis* plantation, and this association is assumed to be brought about by the medium of the honeydew excreted by aphids, especially by *Cinara matsumurana*. The role of the honeydew in the bionomics of social wasps is discussed together with differences in the food source preference among wasp species or genera.

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Introduction

Young conifer plantations are known to be heavily infested by various aphid species in Hokkaidô (Inouye, 1970). Some hymenopterous insects are associated with these aphids mainly as parasites or hyperparasites (Kamijo & Takada, 1973). Some others seem to utilize the aphid's excretion (honeydew) as a source of food for the adults, and among such insects are included social wasps which are compelled to develop a variety of food sources on account of the long span of their colonies and the large number of their colonial dwellers. Several authors have reported the relation of social wasps to the honeydew particularly in temperate zone (Kemper & Döhring, 1967; Thomas, 1960; Zoebelein, 1956a). But little has been investigated on the detailed status of aphid honeydew in the food source for social wasps, not to mention the seasonal changes in visiting activity of wasps to the honeydew.

In 1971 one of us, K. Kamijo, made investigations on the species composition and seasonal abundance of parasitic hymenoptera associated with various conifer stands, with the co-operation of Dr. S. Momoi, Kôbe University. During the investigations a good number of social wasps were collected in addition to parasitic wasps. Though the sampling was not carried out at satisfactorily short intervals needed for this kind of investigation, the results suggest the presence of an association, established by the medium of the aphid honeydew, between the todo-fir (*Abies sachalinensis*) plantation and social wasps.

1. Study areas and sampling method

Study areas: Seven stands were selected for the investigations, six being located in and near the field of Hokkaidô Forest Experiment Station, Bibai, central Hokkaidô, and the remaining one at Ashibetsu, nearly 40 km away to the northeast from Bibai.

A-I. Young *Abies sachalinensis* stand in the Experiment Station, planted in 1962 and attaining a mean height of 4 m in 1971. The ground was covered mainly with white clover (Fig. 6).

A-II. Young *A. sachalinensis* stand, planted in 1955 at the foot of a hill which was located only 500 m away from A-I and covered with hardwoods. The firs were 5 m in mean height, with *Sasa senanensis* dominant on the ground (Fig. 5).

A-III. Mature *A. sachalinensis* stand at Ashibetsu, planted in 1933. The trees were 15 m in mean height, with the canopy almost closed.

PC. *Picea abies* shelterbelt, planted in 1958 to protect A-I and other plantations in the Experiment Station. The mean height of the trees was 7 m and the breadth of the shelterbelt was about 5 m.

P. Young *Pinus densiflora* stand, planted in 1961 in the field of the Experiment Station. The trees were 5 m in mean height, and the ground was covered mainly with white clover.

L. *Larix leptolepis* stand, planted in 1960 in the field of the Experiment Station. The trees were 9 m in mean height, the canopy being almost closed. The ground was covered with various shrubs and weeds.

H. Hardwood stand, located on the hill near A-II, a second growth after a fire in 1913, consisting of more than 22 tree species, among which *Acer mono*, *A. japonicum*, *Quercus mongolica*, *Tilia japonica*, and *Betula platyphylla* were common.

The tree height of the upper story was about 10 m.

Sampling method: A sweeping method was adopted to collect hymenopterous insects. It was carried out from mid-May of 1971 to the beginning of November, just before the lying of snow cover. In the spring and summer the sampling was taken every week or nearly so and in the autumn every 10th day at each study area, where the foliages of trees were swept for just one hour by the use of a net of 42 cm diameter across the aperture and with a handle 3 m long. All hymenoptera captured were killed and pinned for identification.

2. Species captured

The following seven species belonging to the family Vespidae were collected from 19th May to 4th November in 1971.

Polistinae *Polistes snelleni* Saussure
Vespinae *Vespa simillima* Smith
Vespula (*Paravespula*) *lewisi* Cameron
Vespula (*Paravespula*) *A**
Vespula (*Allovespula*) *rufa schrenckii* Radoszkowski
Dolichovespula (*Dolichovespula*) *media media* Retzius
Dolichovespula (*Boreovespula*) *saxonica nipponica* Sk. Yamane

The number of specimens collected for each species and each sampling place is given in Table 1. The number of the collected species corresponds to about a half of social vespid species inhabiting central and northeastern Hokkaidô, and the species composition represents the general lowland fauna of this region of Hokkaidô. Remarkable differences were seen in the number of obtained individuals among the species and among the sampling places. In the number of individuals A-I and A-II occupied 87.7%, and *Vespula A* and *V. lewisi* occupied 93.1%, of the whole. An explanation to this will be given later.

* This form considerably resembles *V. lewisi* and is often confused with the latter. Though taxonomic study of these forms is not yet completed, in the present paper we tentatively treat them as different species. In *Vespula A* the inner margin of a whitish marking situated on the sinus of the eye is strongly emarginate (not so in *V. lewisi*); the queen and worker clypeus with a median black bar usually reaching its ventral margin (always detached from the ventral margin in *V. lewisi*); and the male mandible with a black triangular marking at the base (without in *V. lewisi*) (Fig. 1).

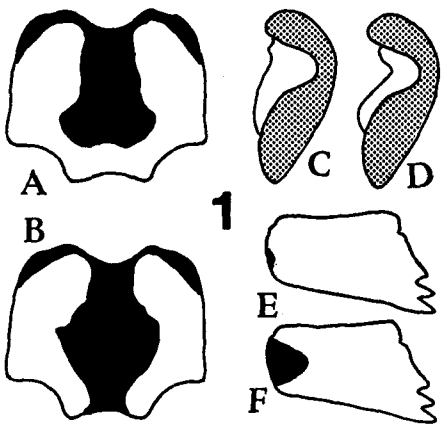


Fig. 1. Characters separating *Vespula A* from *V. lewisi*. A, C & E, *V. lewisi* — B, D & F, *V. A* — A & B, clypeal marking (♀, ♂) — C & D, white marking on sinus of eye (♀, ♂, ♂) — E & F, black spot on mandibular base (♂).

Table 1. Number of specimens collected.

Species	A-I	A-II	A-III	PC	P	L	H
Polistes snelleni			1우				
Vespa simillima	1♂	2♀ 1♂					
Vespula lewisi	54♀ 5♂	12♀ 2♂	3♀	1♀	6♀ 1♂	1♀ 3♂	2♀
Vespula A	166♀ 2♂	179♀63♂	2♀ 3♂	2♀	19♀	5♀	7♀ 3♂
Vespula rufa	6♀	1♀ 3♂	3♂	1♀			
Dolichovespula media	1♀	2♀ 1♂	2♀				
Dolichovespula saxonica	1♀	6♀ 2♂	1♀ 2♀	2♂			

우: queen, ♀: worker, ♂: male.

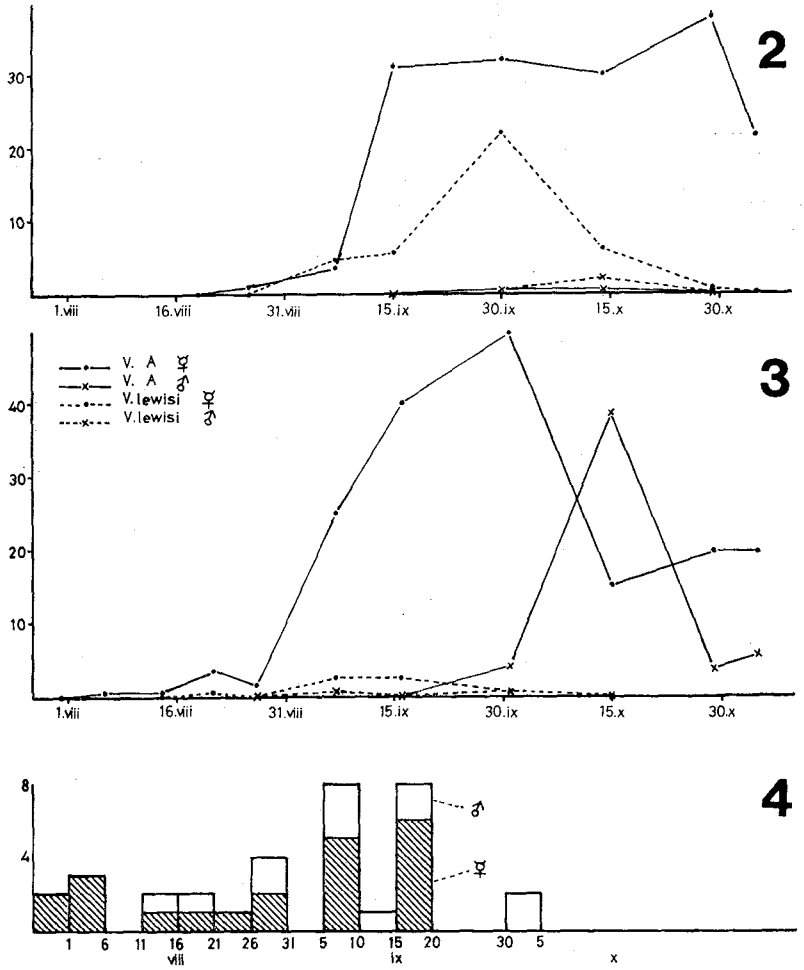
3. Seasonal fluctuations and behaviour of wasps

Seasonal fluctuations of Vespula A and V. lewisi: Seasonal changes in the number of visiting wasps are shown in Figs. 2 and 3. In A-I the sampling was started on 19th May and two workers were captured first on 26th August, and in A-II it was started on 14th June and the first capture of the worker was on 6th August. In other places, the first capture was on 20th August in A-III, on 15th September in PC, on 19th August in P, on 27th August in L, and on 6th August in H. Thus, no wasp was captured from May to July and in PC even in August, and only a few workers were captured during August in every other place. It must be pointed out that no queen was captured throughout the whole sampling period. In A-I most *Vespula A* workers were collected from mid-September to late October without a distinct peak and the activity lasted till snowfall on 8th November, while in A-II a distinct peak was at late September, then the visiting activity decreased remarkably. As for *V. lewisi* an obvious peak was seen at late September in A-I, while not in A-II.

The male was first captured for *Vespula A* on 30th September in A-I and on 1st October in A-II, and for *V. lewisi* on 30th September in A-I and on 7th September in A-II. In A-II the male activity of *Vespula A* shows its peak at mid-October, exceeding the worker activity on 15th October (Fig. 3). The number of males captured, however, is much fewer than that of workers as a whole, especially in A-I.

Seasonal fluctuations of other species: As only a few individuals of *Vespula rufa, Dolichovespula media* and *D. saxonica* were captured and their seasonal visiting patterns seem to be similar to each other, the wasps of these species sampled from all the stands are lumped together in Fig. 4. Workers of these three species started to visit the sampling places at late July and ceased at early October, showing an early decline of activity in comparison with the two *Paravespula* species. This tendency was also observed for the male activity.

Behaviour of wasps: The behaviour was observed only for *Vespula A, V. lewisi* and *V. rufa* visiting the todo-fir plantations A-I and A-II. The wasps busily roamed about among the needles of todo-firs and licked honeydew sprinkled by aphids on the needles (Figs. 7 & 8) where *Cinara matsumurana* Hille Ris Lambers was abundant and its honeydew gave rise to the abundant development of sooty mould. The wasps were not concerned about aphids themselves and did not come in contact with them. Most wasps did not insist upon one twig, but flew



Figs. 2–4. Seasonal fluctuations of wasps visiting plantations. 2, *Vespula A* & *V. lewisi* in Stand A-I — 3, ditto in A-II — 4, *Vespula rufa*, *Dolichovespula media* & *D. saxonica* combined. Ordinate: number of individuals.

from twig to twig and from tree to tree. Three other *Cinara* species are known from *Abies sachalinensis* in Hokkaidô: *C. todocola* Inouye, *C. hattorii* Kôno et Inouye and *C. longipennis* Matsumura (Inouye, 1970). These species were also found in the areas under the investigations. However, the wasps appear not to have close relations to them because these aphids are largely parasitic on the trunk, sprinkling honeydew on the needles only in small amounts. In addition to this, *C. todocola*, a quite common species, is intimately associated with ants and defended by them.

4. Discussion

As the wasps other than the three species mentioned above have not been observed for their behaviour, it is unknown what they do in the plantation. The

workers of *Vespa simillima*, and also of *Dolichovespula media* and *D. saxonica*, may have visited the todo-fir to hunt insects visiting honeydew. In Iwate Pref. *Vespa analis* and *V. xanthoptera* workers were observed hunting flies and even small wasps such as *Vespula lewisi*, which visited willow trees to lick honeydew excreted by aphids (Sk. Yamane, unpub.). Such information is essentially needed when we try to analyze the insect fauna of a plantation. Captures of males of *V. simillima*, *D. media* and *D. saxonica*, however, strongly indicate that they seek for the honeydew itself in the present case. The scarcity of these wasps at every sampling place may be explained by their habit to prefer the nectar or tree sap to the honeydew. In Hokkaidô the colony span of *Dolichovespula* species is much shorter than that of *Paravespula* species (S. Yamane, 1970) and largely coincides with the flowering period.

On the other hand, *Paravespula* species are known to depend at least partially upon the aphid's excretion (Thomas, 1960 for *V. germanica* in New Zealand; Sk. Yamane, unpub. for *V. lewisi* in Japan), though Kemper and Döhring (1967) think little of the honeydew as the food of social wasps. In the present survey no overwintered queen was captured and most workers were captured from September on. The first workers of *Paravespula* species usually emerge from late June or early July in central Hokkaidô. All this indicates that queens and early born workers take food from sources other than the honeydew. Thomas' observation that from the time when the first workers appear in February until mid-March and early April wasps choose an animal protein regimen and rarely feed on sweets gives a hint to this problem, but we have no evidence for this in Japan. In the present case the aphid honeydew as the food source of workers during September undoubtedly contributes to the colony development of wasps, and particularly to the production of sexuals. During October and November, however, workers diminish their value to stay in the colony because the production of the next generation has nearly been completed and the only task assigned to them is to feed new queens with sugars. The *Vespula* males having left the colony swarm around trees (nuptial flight) and often visit the honeydew (Shida, 1959; Sk. Yamane, unpub.). As they must sustain themselves outside the colony during the nuptial flight and the blooming seasons are ending from September on in Hokkaidô, the abundance of aphid's excretion at this season would result in supplying sufficient food for them. Thus, the plantation provides a special habitat, indeed artificial, for social wasps, by the medium of the honeydew.

It must be emphasized that the abundance of *Paravespula* in young todo-fir plantations may be well explained from the abundance of aphids, especially *Cinara matsumurana*, which are less common on mature trees (A-I & A-II *vs.* A-III). But the fact that a few wasps visited the stands L, P, and H, where a lot of aphids were observed, needs further explanation. The aphids were *Cinara laricicola* Matsumura on *Larix leptolepis*, *C. piniformosana* Takahashi on *Pinus densiflora* and various species in the hardwood stand. The difference in the honeydew excretion among aphid species may be relevant. Aphid-ant relationships must also be taken into consideration, for ants often repulse other insects visiting the honeydew (Zoebelein, 1956b).

Numerous insects of various families use the aphid honeydew as a source of food (Zoebelein, 1956a; Bodenheimer & Swirski, 1957). They may take part in cleaning the aphid's environment soiled by the viscous honeydew. On the part of social wasps, since their colonies continue for long, it is not easy for the adults to

gain sufficient food rich in sugars constantly through the active season. In temperate zone, food source of social wasps may be roughly divided into 1) flower nectar, 2) honeydew excreted by aphids or scales, 3) tree sap, and 4) larval excretion produced within their own colonies. They may also use whatever obtainable, for example, fruits, and sweets or juice in artificial environments. All these food sources with varying combinations and proportions provide adult nutrition during colony life. As stated above, an apparent difference is seen between *Paravespula* and *Dolichovespula* in their food source preference. Kemper and Döhring (1967) also mention as follows: "Die Dolichovespulinen und die Polistinen sind offenbar auf Nektarsammeln mehr eingestellt als die Paravespulinen und *V. crabro*." Thus the colony maintenance should be discussed in terms of not only the climate and condition concerning prey supply but also adult nutrition. The honeydew should be evaluated from this point of view. Nevertheless, little has been studied about the composition of food sources and its seasonal change during the colony life. Even Weyrauch (1936), who intensively studied comparative biology of *Vespula* and *Dolichovespula*, did not pay attention to this matter, which, however, may not be a minor one in the study of phylogeny and evolution of social wasps.

Acknowledgements

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PLATES

Plate XI

Abies sachalinensis plantations in Bibai, Hokkaidô.
Fig. 5. Stand A-II.
Fig. 6. Stand A-I.


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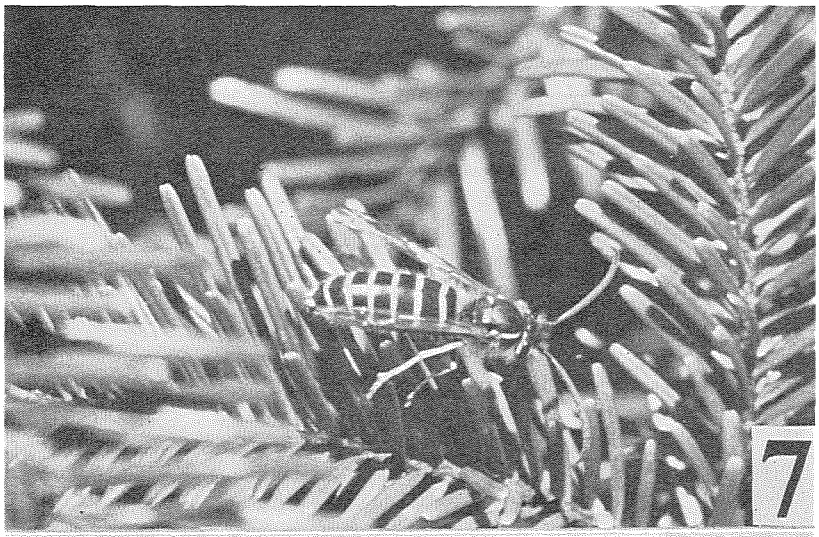
Plate XII

Vespula A licking honeydew on *Abies sachalinensis* needles.
Fig. 7. Male.
Fig. 8. Worker.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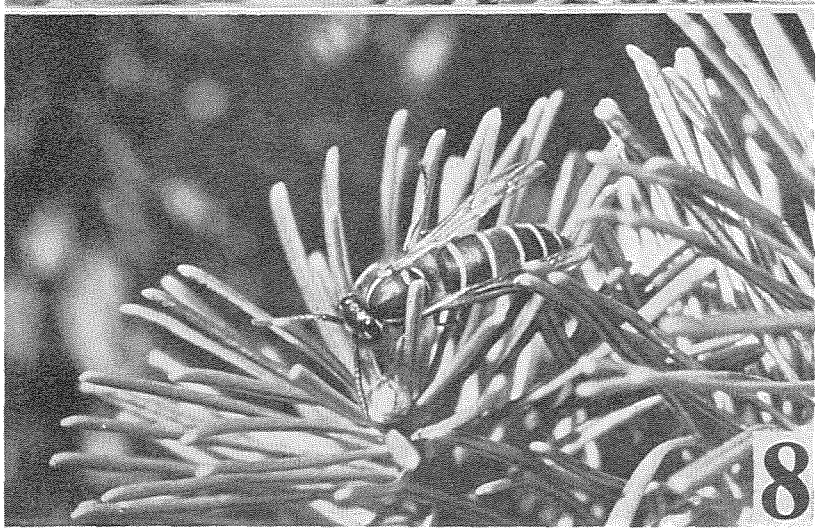
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