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Nests of *Dolichovespula albida* from the Arctic Canada (Hymenoptera : Vespidae)[1]

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Abstract Two thriving nests of *Dolichovespula albida* were collected from the Arctic Canada in the summer of 1980. They were found each in "supraterrestrial" nest sites. The envelope paper was loose in texture, showing a close resemblance to that of *D. norwegica*. Both nests had only two (one worker and one reproductive) combs and about 170 cells, much smaller than in other *Dolichovespula* species in temperate regions. Adult productivity was also considerably low, but the colonies did have a good number of workers.

Introduction

Recently the biology of vespine wasps has received considerable attention (1, 4, 12). However, little has been studied on their habits in the high latitudes. *Dolichovespula albida* is one of the tundra-inhabiting species whose biology is known in quite restricted cases (2, 7). Two thriving nests (A & B) of this species were collected in the Arctic Canada by one of us (M. J. T.) in the Permafrost Expedition of Hokkaido University in 1980.

The material is enough intact to allow us to describe nest architecture and brood composition of the colonies. In this paper we describe nest sites, nest architecture, brood composition and productivity of the colonies, and discuss some features relating to tundra habitats.

The identification of the species was based on Miller (7) and Wagner (14)**. Some important morphological characters of the collected specimens are given below. Rufous markings on the 1st and 2nd gastral tergites absent in queens, whereas always present on the 2nd gastral tergite and

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** In structural characters *D. albida* well agrees with the Palaearctic *D. norwegica*. For this reason Eck considers them conspecific (Ent. Abhand., Dresden, Bd. 44, in press). Although one of us (Sk. Y.) agrees with her interpretation, we tentatively follow Miller (7) and Wagner (14) in this paper.

often also on the 1st in workers (60% in Nest A, 76.7% in Nest B). Ocellar triangle broad; the distance between the posterior pair (a) slightly shorter than that between one of the ocelli and the inner margin of the eye (b). b/a ratios as follows. Nest A: 1.03 (n=1) in the foundress, and 1.247 (1.18~1.31, n=21) in workers; Nest B: 1.125 (1.03~1.19, n=14) in new queens, and 1.223 (1.14~1.36, n=19) in workers.

Nests examined

Nest A was collected on July 22, 1980 at Tuktoyaktuk (69°26'N, 133°03'W) where the vegetation is of typical tundra, and the ground is thickly covered with live and dead mosses or other plants (Fig. 1). The nest was suspended from a twig of a dwarf birch tree of about 30 cm tall, and its lower part was hidden in a depression formed on the surface of accumulated moss, to which the nest's bottom was nearly attached (Fig. 2 A).

Nest B was collected on August 1, 1980 at Inuvik (68°22'N, 133°45'W), located just south of the tree line (Fig. 1). The general vegetation is of subarctic forest, mainly composed of spruce, birch, alder and willow trees; the ground is covered with moss and arctic plants such as *Sphagnum* and *Vaccinium*. The nest was constructed in a moss hollow under a small

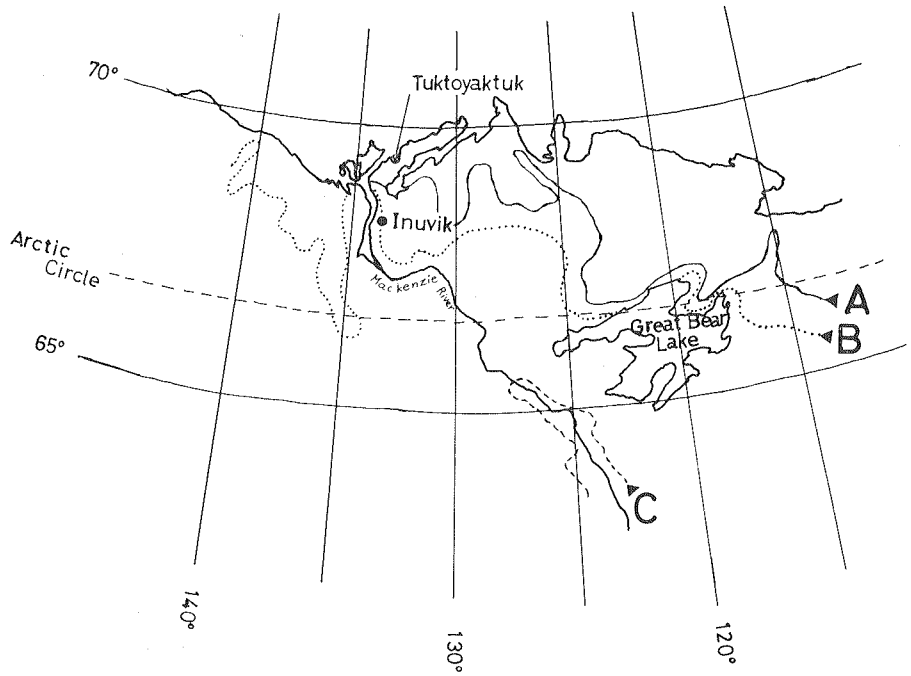


Fig. 1. Map of the Arctic Canada, showing collection localities. A: Northern limit of tree species; B: Northern edge of subarctic forest; C: Northern edge of boreal forest (A, B, after 8; C, after 10)

depression (15 cm long and 10 cm deep) between two moss hammocks. The hollow narrowed at the top so as to form a crevice or an entrance (ca. 2～4 cm in diam.) leading to the outside (Fig. 2 B).

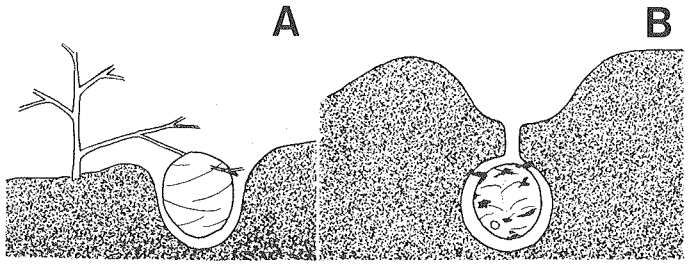
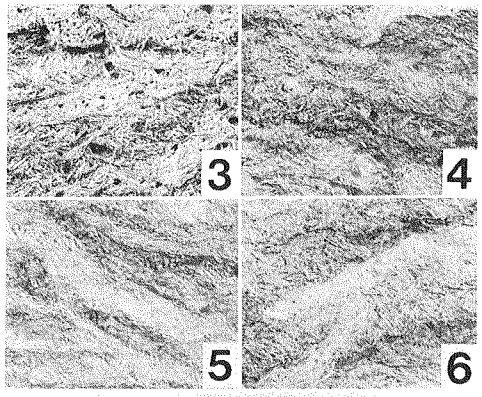


Fig. 2. Schematic drawing of nest sites of *Dolichovespula albida* (Nest A and B)

Nest architecture

Nest material was pliable and grey. In Nest B, the envelope was nearly spherical in shape, 75 mm in width and 81 mm in height; its thickness was 12 mm at the bottom, 10～11 mm at the middle and 9 mm at the top (Fig. 7). In Nest A which was partly crushed at collection, the envelope measured 60～70 mm in width, but its height and thickness could not be measured. Envelope structure rather differed between the two nests. In Nest A the envelope was composed of three to five sheets, which were nearly completely separated from each other at least in the middle and lower part. On the other hand, in Nest B it was composed of six to eight sheets interconnected with each other at many points, and incorporated dead moss and plant fragments. The combs were wholly covered with the envelope except for an entrance hole (13×7 mm in Nest A and 12×12 mm in Nest B in diameter) opening nearly at the bottom of the nest (A) or laterally in the lower part (B).

Both nests had two combs (Table 1). The combs were connected with each other and the first comb with the top of the nest by the suspensoria. In Nest A the first and second comb each had only one main stay (2×2 mm thick in the 1st comb, 1×2 mm in the 2nd) located near the centre. In Nest B the first comb had the main stay (3×2 mm thick) and six additional ribbon-like suspensoria in peripheral part which varied in length from 2 to 5 mm, and the second had the main stay laterally attached by a ribbon (7 mm long). At least in Nest B peripheral parts of the first comb were connected with the inner surface of envelope. Remnants of pedicel made by the foundress in the solitary stage was found at the top of Nest B and suggested that the pedicel had been coated with queen's secretion as in other congeneric species (cf. 5). The upper surface of the first comb was thinly coated with lustrous substance around the main stay.



Figs. 3–6. Texture of envelope paper (×2.5)
3: *D. albida*
4: *Vespula "rufa" schrenckii*
5: *D. saxonica nipponica*
6: *D. media media*

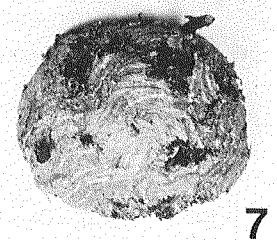


Fig. 7. Envelope of Nest B

Envelope paper texture

The envelope paper texture of *D. albida* was compared with those of *D. media media*, *D. saxonica nipponica*, and *Vespula "rufa" schrenckii* from Japan. It is the loosest in *D. albida*, followed by *V. "r." schrenckii* in which fibres are somewhat finer than in *D. albida* (Figs. 3 vs. 4). Probably because of the fine fibres and loose texture, envelope sheets of *V. "r." schrenckii* feel the most feeble. Paper texture is distinctly close in *D. m. media* and *D. s. nipponica* (Figs. 5 & 6); we could find no difference between them. Judging from the photos by Spradbery (12: plates X (a) & XIV), *D. norwegica*, a Palaearctic vicariant of *D. albida*, shows a close resemblance to *D. albida* in the coarse texture of envelope paper.

Nest contents and productivity

Adults: The foundress and 21 workers were collected from Nest A and 19 workers and 14 new queens from B. Three wasps (probably new queens) escaped on the collection of Nest B. No males were seen in the nests.

Brood: Brood composition in the nests is given in Table 1. The first comb contained immatures of workers and males, and the second comb was composed of reproductive (large) cells containing new queen and male (?) immatures. Interestingly, Nest B had only pupae and the fifth instar larvae, while Nest A had all the immature stages. There were many empty

cells, especially in the first comb (Nest A: 34.5% in the 1st comb, 9.4% in 2nd; Nest B: 76.5% in 1st, 50.0% in 2nd).

Productivity: The number of adults having emerged by the time of collection was estimated by subtracting the total number of pupae and prepupae from that of meconia found at the bottom of cells (Table 1). However, it was difficult to determine the sex and caste of the initial occupants of cells owing to the complete trimming by adults of the cocoon remnants which are sometimes a good indicator of sex and caste. Therefore, the precise estimation in the numbers of males and new queens already emerged could not be made. No males were present in the nests at collection. This is either because males had already dispersed from the nests or because they had not yet emerged. The former case seems more likely, as male production and dispersal usually precede those of new queens.

Assuming that 5th instar larvae, prepupae and pupae present in the nests at collection could successfully grow up by the time of colony dissolution, the total adult production is estimated at 94 in Nest A and 135 in Nest B. If the males had not yet emerged when the nests were collected, the total number of produced workers estimated in the same way, for example, should be 70 in Nest A and 67 in Nest B. However, actual numbers are likely to be less than these estimates for reasons mentioned earlier. The estimated ranges in the total production of each sex and caste are given in Table 2.

Table 1. Brood composition in the two nests of *D. albida*

Nest and comb no.		Comb size in mm.	No. of cells	Brood composition												Estimated[1] no. adults emerged
				Eggs	Larvae						Pupae					
					1	2	3	4	5	T	♀♂	♂	♀	?	T	
A	1	43×36	113	5	9	5	3	7	23[2]	47	16	5	0	1	22	36
	2	26×24	53	0	14	9	5	7	13[3]	48	0	0	0	0	0	0
	T		166	5	23	14	8	14	36	95	16	5	0	1	22	36
B	1	49×24	81	0	0	0	0	0	19[4]	19	0	0	0	0	0	52
	2	50×43	86	0	0	0	0	0	34[5]	34	0	0	9	0	9	30
	T		167	0	0	0	0	0	53	53	0	0	9	0	9	82

1) See text. 2) 15 ♀♀♂♂, 6 ♂♂, 2 ? (♀♂ or ♂). 3) All ♀♀. 4) 13 ♀♀♂♂, 4 ♂♂, 2 ? (♀♂ or ♂).
5) Almost all were supposed to be new queen (♀) larvae.

Table 2. Estimated ranges in the total production of each sex and caste

Nest	worker	male	new queen
A	52~70	11~29	13
B	32~67	4~55	57~73

The ratio of small to large cells was 2.13 in Nest A and 0.94 in Nest B. The second use of a cell was observed only in the first comb of both nests. In Nest A 16 of 47 larvae and two of 16 worker pupae were reared in cells for second use, and in Nest B so were all of 19 larvae.

Discussion

Species of *Dolichovespula* are principally aerial nesters. However, most species other than *D. media* and *D. maculata* probably nest underground on occasion (5). Underground nests are even common in *D. sylvestris* in England (3). Up to the present two records for the nest site of *D. albida* have been reported from underground (2), though at least one of them (from Teller, Alaska) could be regarded to be "supraterrestrial", as Wagner (14) applies the term to one case of *D. saxonica* nest in Alaska. Though *D. norwegica*, a close relative of *D. albida*, usually builds its nests above ground even in the high latitudes, a few nests were found "in the ground", just below the moss cover (6, 13). The present cases for *D. albida* are also supraterrestrial and may represent the nest site in tundra regions where the ground is covered with thick moss. K. W. Richards (9) found a similar condition in *Bombus polaris* in Ellesmere Island, Canada (81°49'N, 71°18'W), and argues that surface moss and liverworts of the marsh meadow are not so affected by ice and permafrost, being warmer and drier than in most of the lemming burrows.

Probably reflecting the short colonial duration and low temperature, the colony sizes in the present two cases were quite small. They had only two small combs and less than 170 cells. The total productivity of adults was estimated at only 94 to 135. In temperate regions congeneric species usually build three or more combs and several hundred cells. In Pullman, Washington State, USA, *D. arenaria* often constructs more than 4 combs (max. 6) and 2,000 cells (max. 4,290) (5). In Hokkaido, northern Japan, *D. media media* and *D. saxonica* had a mean productivity of 694 adults (264～1,241, n=8) and 873 adults (338～1,629, n=4), respectively (Makino, unpub.).

It has sometimes been implied that in Arctic regions some "social" aculeates may lose their worker caste (15, 17). This speculation was based upon some bumblebee species apparently lacking workers. However, these species later proved to be social parasites or actually to have workers (e. g. 9). Sakagami (11) concluded that at the social level attained by bumblebees, the complete reversal to solitary life seems unlikely. The same can be said for vespine wasps. The colony productivity in *D. albida* in the high latitudes is no doubt distinctly inferior to its temperate congeners. But, it does have workers and its colony size even approaches that of *Vespa analis* in Hokkaido, northern Japan, in which the total number of cells amounts to 267 (range : 150～442, n=9), and the total number of adults produced 186 (range : 86～352, n=9) (16). Thus, *D. albida* can be said to be well adapted to

the severe climate in the Arctic regions retaining its basic mode of social life.

Acknowledgments

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