FORMICIDE PREDATORS OF THE SAWFLY NEODIPRION SWAINEI MIDD.

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CENTRE DE RECHERCHES FORESTIÈRES DES LAURENTIDES
SERVICE CANADIEN DES FORÊTS

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ABSTRACT

This study was made to determine species distribution, population level and predation of ants on *Neodiprion swainei* Midd. in a young jack pine (*Pinus banksiana* Lamb.) stand in Quebec. *Formica fusca* L. was the most abundant of 10 ant species in the study area. *Formica fusca, F. sanguinea subnuda* Emery, *Formica* spp. (*Rufa* group), *Formica* sp., and *Camponotus herculeanus* (L.) carried emerging and ovipositing adults, and sound and empty cocoons of *N. swainei* into their nests. *F. fusca* did not attack sawfly larvae in the trees. Ants preferred adult sawflies over sound or empty cocoons. Adult sawflies and cocoons were found in ant nests, tunnels, and rearing chambers 9 to 18 cm below the soil surface, and a few cocoons were found as deep as 41 cm. The studies showed that ants may be an important biological factor in jack pine sawfly populations.

RESUME

Cette étude fut exécutée pour déterminer la distribution des espèces et le niveau de population de fourmis et leur prédation de *Neodiprion swainei* Midd. dans un jeune peuplement de pin gris (*Pinus banksiana* Lamb.) au Québec. Dans le territoire étudié, *Formica fusca* L. était la plus abondante des 10 espèces de fourmis. *F. fusca*, *F. sanguinea subnuda* Emery, *Formica* spp. (groupe *Rufa*), *Formica* sp., et *Camponotus herculeanus* (L.) transportaient dans leurs nids des adultes émergeants et matures et des cocons pleins et vides de *N. swainei*. *F. fusca* n'attaquait pas les larves de la mouche à scie dans les arbres. Les fourmis préféraient les mouches à scie adultes par rapport aux cocons pleins ou vides. Des mouches à scie adultes et des cocons furent trouvés dans les nids de fourmis, dans les tunnels et les chambres d'élevages de 9 à 18 cm sous la surface du sol et quelques cocons furent trouvés jusqu'à une profondeur de 41 cm. Les études montrent que les fourmis peuvent être un facteur biologique important dans la lutte contre des populations de mouche à scie du pin gris.

INTRODUCTION

Ants are common and widely distributed insects. Their food ranges from fungi, plant sap, seed and honeydew to an exclusively carnivorous diet. Clausen (1956) and Tripp (1958) indicated that predacious ants, *Formica* and *Camponotus* spp., play a significant role in natural control of the jack pine sawfly, and Smirnoff (1959) observed ants, especially *Camponotus herculeanus*, carrying dead or weakened sawfly larvae. Morris (1963) stated that *Formica fusca* and *Formica sanguinea subnuda* may be valuable spruce budworm predators. Ayre (1963) found, in the laboratory, that *C. herculeanus* workers opened cocoons and removed the prepupae of *Neodiprion lecontei* (Fitch). However, it is still not clear whether ants are effective predators of forest insect pests (Adlung 1966; Cotti 1963). The present study was made to determine the role of ants in the predation of *N. swainei*.

METHODS AND OBSERVATIONS

Plot Description

Observations were made (May to September 1963) in two 66 x 132 ft plots in jack pine stands near Lake McLaren, Laviolette County, Quebec, elevation 1,400 ft. Plot 1 was situated in a

5-acre, 20-year-old stand with trees averaging 12 ft in height, at a mean density of 560 trees per acre. The ground cover was mainly *Cladonia rangiferina* (L.) and *Kalmia angustifolia* (L.), with patches of *Vaccinium pennsylvanicum* Lam., in open sunny areas. Small patches of *Politrichun commune* L. occurred in shaded areas around the base of the trees. The organic layer was thin and the soil was sandy. Plot 1 contained 112 jack pine and numerous decaying stumps and logs. The pines were lightly infested by jack pine sawfly in 1961-1962, but there was no tree mortality.

Plot 2 was approximately 500 ft northwest of Plot 1, in a 40-year-old jack pine stand with trees averaging 30 ft in height, at a mean density of 594 trees per acre. The ground vegetation was similar to that in Plot 1, with additional patches of *Caliergon Schreberi* Willd. and occasional clumps of *Epigea repens* (L.), *Gaultheria procumbens* (L.) and *Dicranum undulatum* Ehrh. The organic layer was thicker than in Plot 1, averaging about 2 inches.

Determination of Species Distribution and Population Level

The position of all nest entrances was marked and numbered. Samples of ants from each nest were collected and identified by C.D. Miller, Entomology Research Institute, Canada, Department of Agriculture, Ottawa. Ninety-four nests and 10 species of ants were found (Table I).

Table I. Number of nests of various ant species observed on two 66 x 132 ft rectangular sample plots near Lake McLaren, Laviolette County, Quebec.

Species	Plot I (open stand small trees)	Plot II (dense stand large trees)	Total
Formica fusca L.	40	11	51
Formica subnuda Emery	1	0	1
Formica spp. (*Rufa* group)	1	0	1
Formica sp.	1	0	1
Camponotus herculeanus (L.)	1	3	4
Lasius flavius Wheeler	4	24	28
Tapinonia sessile (Say)	0	3	3
Myrmica brevinodis (Emery)	2	0	2
Myrmica lobicornis fracticornis Emery	1	0	1
Leptothorax muscorum (Nyld.)	0	2	2
Total	51	43	94

The most prevalent species was *Formica fusca*, with 51 nests in the two plots. Eighty per cent of the *F. fusca* nests were located in Plot 1, primilarily on the south side at the base of jack pine trees or in open areas. Population density was one nest per 218 sq ft of surface foraging area. The average diameter of the five *F. fusca* nests was 41 cm, with an average depth of 81 cm. The entrance to each nest was a single main tunnel 8 to 15 mm in diameter. This tunnel branched into a network of lateral and vertical passage-ways. In Plot 2, only 11 colonies of *F. fusca* were located. Three were found in decaying stumps and the remainder in sandy soil on the south side of trees exposed to the sun.

One nest each of *Formica* sp. (*Rufa* group), *Formica subnuda* and *Formica* sp. were located in Plot 1; the first was found under a decaying log and the other two in decaying stumps. Four nests of *Camponotus herculeanus* were located in decaying logs, one in Plot 1 and the others in Plot 2. One *C. herculeanus* colony constructed an underground tunnel 1.69 metres from its nest to the base of a young jack pine tree.

Twenty-eight nests of *Lasius flavius* Wheeler were located, only four being in Plot 1. This species generally established its colonies in decaying wood. Of the colonies in Plot 1, three were nesting in sandy soil under *Cladonia rangiferina* (L.) and one in a decaying log. This species was abundant in Plot 2 (dense forest), where 24 colonies were recorded. Of these, one colony was in sandy soil and the remainder in decaying logs and stumps.

A nest of *Myrmica brevinodis* (Emery) was located in Plot 1 in a small piece of decaying wood covered with moss, *Politrichum commune* (L.). Three nests of *Tapinonia sessile* (Say) were found in Plot 2 in a decaying log. Two nests of *Leptothorax muscarum* (Nyld.) were found in decaying stumps.

Populations of the most prevalent species, *F. fusca*, were estimated by excavating five nests in Plot 1. Excavations were carried out on September 11; at that time, the mean temperature was 8°C and no activity was observed around the nests. Because the sandy soil was unstable, it was difficult to dig out and measure the nests; they were therefore "fixed" by pouring a mixture of lime and gasoline into each nest. Nests were later excavated and examined by following the lime trace; the dead ants were collected, counted and recorded. The average ant population per nest was 1,092 (range 821 to 1,468).

Storage of *N. swainei* Adults, Sound, and Empty Cocoons within Ant Nests

Plaster of Paris was funneled into the ant-nest entrance, which spread progressively downward and outward through the tunnels and chambers. When the plaster of Paris hardened, the tunnels, chambers, and food storage areas were examined by carefully breaking the casts and checking the contents (Figure 1). All sawfly cocoons and adults found in the nests were counted.

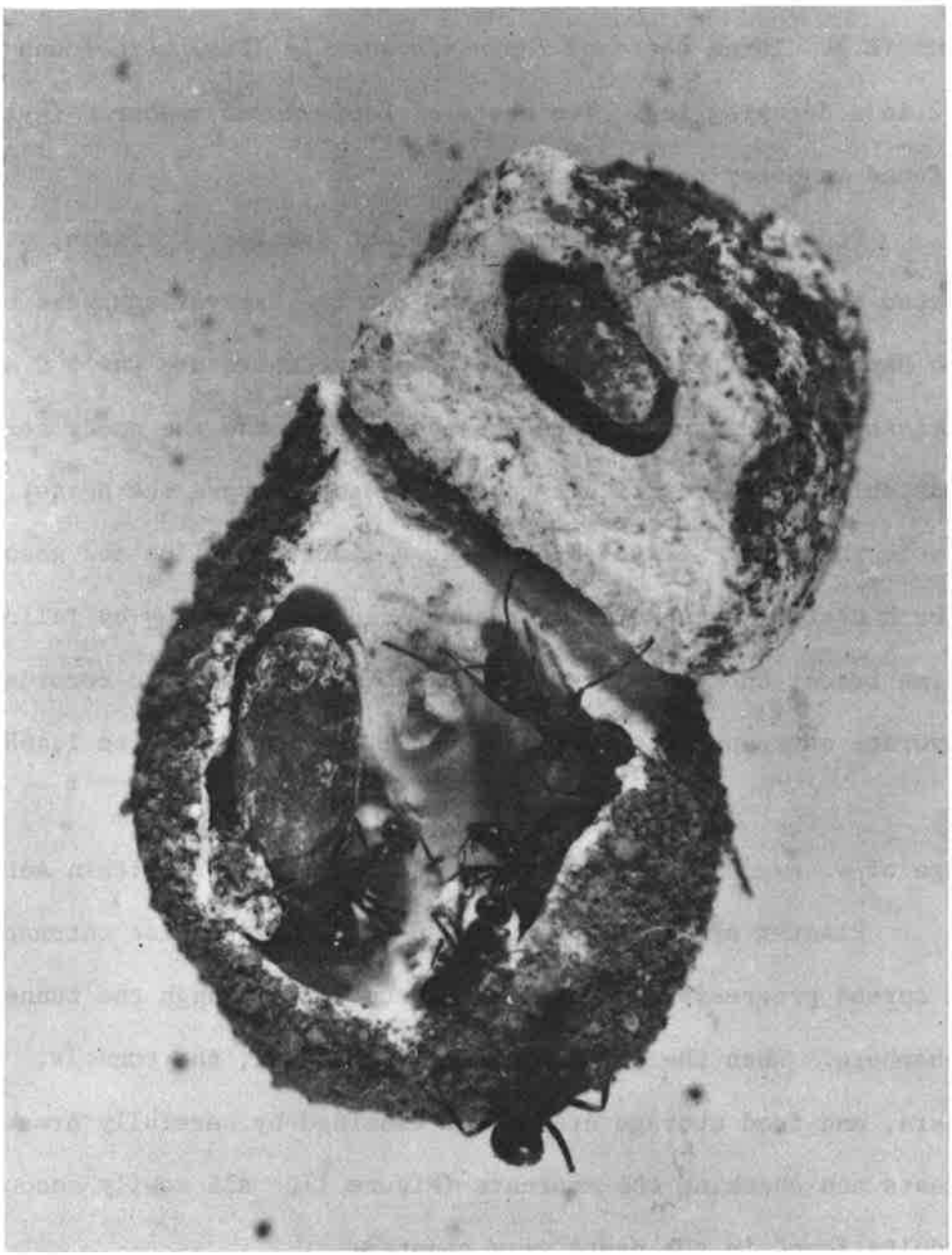

Figure 1. Split plaster cast of rearing chamber, from 16 cm below soil surface, showing stored sound cocoons and ants.

Behavior Studies

Particular attention was given to the pattern of ant activity outside the nests and its relationship to temperature. The foraging behavior of the ants was also studied to determine which species prey on *N. swainei*.

Although *Lasius flavius* and *F. fusca* construct masonary domes in Europe (Wheeler 1960), they did not do so in the study area. The entrances of *F. fusca* nests were exposed to the sun and most were free of vegetation. Sand mixed with dry pine needles, leaves, twigs and bits of wood were scattered around the openings. A few entrances were covered with *Cladonia rangiferina* and *Kalmia angustifolia*. The nest opening led to a main trail which carried heavy ant traffic. From most nests, ants constructed foraging trails running in an east-west direction under *C. rangiferina* to the stems of young jack pine trees. These trails branched as the ants spread out to hunt for prey.

F. fusca became active when the soil surface temperature reached about 10°C. Activity increased to a maximum at 41 to 43°C. Above 43°C, activity decreased and the ants disappeared underground. Foraging time depended upon temperature and sunlight. In summer, activity began in the morning when the temperature reached 10°C and terminated in late afternoon when daylight diminished and temperature dropped. In late spring, early summer and early autumn, there were two periods of activity; the main one was from about

0900 until 1100, and the other from 1400 until 1730. Following rainfall, more workers were seen around the nest surface and more sand was brought up from below than at other times.

Assessment of Predation

A sawfly population was established in the study area by distributing 5,000 sound cocoons of *N. swainei* on the ground just prior to adult emergence on June 13 in Plot 1. Upon emergence, sawfly adults flew into the trees, mated, and deposited 17 egg clusters on four trees.

Formica fusca reacted immediately to the presence of sawflies and cocoons. They were soon observed dragging newly emerged adult sawflies and sound and empty cocoons into the nests from all directions without forming trails. The ants crawled backward, dragging the adult sawfly by wings, head or thorax; sometimes the head or wings were bitten off. Occasionally an ant would drop the sawfly, run about, then return to pick up the victim and continue toward the nest. In one trip this behavior was repeated 2 or 3 times in 1 metre on a rough trail through vegetation. Some ants climbed backward up and down plants without releasing their prey and then continued backward toward the nest. Occasionally the cocoons were dropped close to the nest, and the ant continued unladen. Ants also captured ovipositing sawflies in the trees, dropped to the ground with their prey and carried the struggling

victims to their nests. No predation by *F. fusca* was noted on *N. swainei* egg clusters or on larvae except on one occasion when an *F. fusca* was observed carrying a decapitated sawfly oenymph.

Some of the other species of ants in the study area also preyed on adult *N. swainei*. *F. subnuda* were frequently observed capturing ovipositing adults and carrying them to the nest. *Formica* (*Rufa* group) sp., *Formica* sp. and *C. herculaneous* captured adult *N. swainei*; the latter also carried cocoons, and were twice observed taking fourth- and fifth- instar larvae. Small *L. flavious* ants were observed opening cocoons.

Because most predation was attributable to *F. fusca*, five *F. fusca* nests were selected at random for detailed observation during a 5-day period (Table II). Distribution of cocoons was approximately 125 per *F. fusca* nest, or 0.57 per square foot of foraging area. Emerging adults, sound and empty cocoons were transported into nests soon after the cocoons were distributed (Table II). Most adults were captured the day the cocoons were distributed. On subsequent days, fewer sawflies were taken and 8 days after introduction, no adults or cocoons were collected.

On June 13, when sawflies were introduced into the study area, no observations were made of the five nests so as not to disturb the populations. Additional observations were therefore made in late summer on five randomly selected *F. fusca* nests to determine where the adult sawflies and cocoons were stored and subsequently utilized as food.

On August 8, 100 live adults, 50 sound and 50 empty cocoons were placed on the ground 15 to 30 cm from the entrances of each of the five selected nests. *F. fusca* again reacted almost immediately and took all adults and some cocoons into their nests. This occurred before noon and in the afternoon. By 1700, most of the ants, all the adults and some cocoons had disappeared, and only a few ants remained, excavating and carrying sand from the nests.

On August 14, 6 days after feeding, all remaining cocoons near nest 1 were collected and recorded; the nest was fixed with plaster of Paris, and its contents were examined and recorded (Table III). The next two nests were treated in the same manner at 6-day intervals and the remaining two nests at 14-day intervals. All adult sawflies were found in the rearing chamber and tunnels, 9 to 18 cm below the surface. The cocoons were located in chambers and tunnels as deep as 41 cm underground.

Table II. Number of *Neodiprion swainei* (of various categories) transported by *Formica fusca* ants to five nests during a 5-day period. Five thousand N. swaine cocoons were distributed in the foraging area on June 13, 1963.

Date	No. of hr of Observation per day	Sawflies Transported		
		Adults	Sound cocoons	Empty cocoons
June 13	5.5	45	21	13
June 14	6.0	3	4	4
June 19	6.5	5	1	4
June 20	5.5	5	1	4
June 21	5.5	0	0	0
Total		58	27	25

Table III. Per cent recovery of *N. swainei* following introduction of 100 adults, 150 sound, and 50 empty cocoons around each of five *F. fusca* nests on August 8, 1963, Lac McLaren P.Q.

		Inside Nests			Outside Nests		
No. Nests	Days following introduction	Adults %	Sound Cocoons %	Empty Cocoons %	Adults %	Sound Cocoons %	Empty Cocoons %
1	6	20	4	8	0	40	84
2	12	8	14	4	0	32	72
3	18	4	18	10	0	26	78
4	33	0	14	8	0	28	64
5	40	0	4	2	0	24	82

Alternate Food Sources

The food collected by *F. fusca* consisted of living and dead insects belonging to the following families: Diprionidae, Phychopteridae, Metopidae, Tabanidae, Miridae and Ephemeridae. The ants also collected many bits of leaves, stems and charcoal, and during the summer they fed on honeydew of the aphid *Cinara banksiana* (Pepper and Tissot).

SUMMARY AND CONCLUSIONS

Ant predation on the Swaine jack pine sawfly was studied in two jack pine stands in Quebec. *Formica fusca* was the most abundant species; colonies of *F. subnuda*, *Formica* spp. (*Rufa* group) *Camponotus herculeanus*, *Lasius flavius*, *Tapinonia sessile*, *Myrmica brevinodis*, *M. lobicornis frocticornis*, and *Lasius muscarum* were also present. Most nests were in sandy soil and without mounds. Foraging of *F. fusca* began at 10°C and ceased at 41-43°C. *F. fusca* nests averaged about 41 cm in diameter, 81 cm in depth, and contained about 1,100 ants. *F. fusca* reacted immediately to the presence of *Neodiprion swainei* Midd. artificially distributed in foraging areas by dragging adults and cocoons into their nests. Newly emerged and ovipositing *N. swainei* adults were also collected by *F. subnuda* and *C. herculeanus; F. fusca* did not attack the larvae. Adult sawflies were preferred over sound or empty cocoons and were found in nests at depths from 9 to 18 cm. A few cocoons were found as deep as 41 cm.

On the basis of the sex ratio established by Tripp (1958),

3,572 adult females would be expected to emerge from the 5,000 cocoons distributed in the study area. However, only 17 egg clusters were recorded on four trees. Perhaps some adults flew to the adjacent 40-year-old stand, or some cocoons were parasitized or eaten by mammals (McLeod 1960). These 17 colonies virtually disappeared by the end of summer.

ACKNOWLEDGMENTS

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REFERENCES

Adlung, K.G. 1966. A critical evaluation of the European research on use of red wood ants (*Formica rufa* group) for the protection of forests against harmful insects. Z. Angew. Entomol. 57:167-189.

Ayre, G.L. 1963. Laboratory studies on the feeding habits of seven species of ants (Hymenoptera: Formicidae) in Ontario. Can. Entomol. 95:712-715.

Clausen, C.P. 1956. Biological control of insect pests in the continental United States. U.S. Dep. Agric. Bull. 1139. 151 p.

Cotti, G. 1963. Bibliographia ragionata 1930-1961 del Gruppo Formica rufa in Italiano, Deutsch, English. Minist. Agric. Forest. Roma, Coll. Verde 8. 413 p.

Ilnytzky, S. and J.M. McLeod. 1965. Notes on ants associated with *Neodiprion swainei* Midd. in jack-pine stands in Quebec. Can. Dep. For. Bi-mon. Progr. Rep. 21(2):1-2.

MacLeod, C.F. 1960. The introduction of the masked shrew [Sore cinereus cinereus] into Newfoundland. Can. Dep. Agric. Div. For. Biol. Bi-M. Progr. Rep. 16(2):1.

Morris, R.F. 1963. The dynamics of epidemic spruce budworm populations. Mem. Entomol. Soc. Can. 31. 332 p.

Smirnoff, W.A. 1959. Predators of *Neodiprion swainei* Midd. (Hymenoptera: Tenthredinidae) larval vectors of virus diseases. Can. Entomol. 91:246-248.

Tripp, H.A. 1958. Studies on the general biology and natural control of the jack pine sawfly, *Neodiprion swainei* Midd. Can. For. Res. Lab., Ste-Foy, Qué. Annu. Tech. Rep. 1957. [39 p.]

Wheeler, W.M. 1960. Ants. Their structure, development, and behavior. Columbia University Press, New York. 663 p.