# Observations on the Hibernation of a Polydomous Ant, *Formica (Formica) yessensis* Forel[1)]

By

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*(With 5 Text-figures and 1 Table)*

In two successive papers Ito (1971, '73) described nest distribution, seasonal population trends and nest structure of *Formica (Formica) yessensis* Forel, a red wood ant species inhabiting northern Japan, mainly based upon the nest aggregation occupying a vast area of Ishikari shore facing the Japan sea, Hokkaido. As a third report of the serial work on biological and ecological studies of this species, the present paper deals with some observations on the hibernation which were not involved in the papers cited above.

The excavation of winter nests was made at Ishikari shore near Sapporo, the environmental conditions of which were described by Ito (1971). In the present survey some neighbouring nests were excavated. In this species different types of nests tend to exist closely nearby as a result of colony proliferation by budding as referred to later. The area studied was $10 \times 12$ m sq., involving 12 nests (Fig. 1). Each nest was marked with a pole since autumn to facilitate its discovery when covered with snow. The excavation was made from March 16 to 25, 1973, when the snow cover was about 50 cm deep. At excavation, a pit was dug at a nest side and the soil profile was broken down little by little with a hand shovel. Vertical shafts were traced by means of using a spoon. Among 12 nests excavated, Nos. 11 and 12 were studied as to nest structure alone but all others both on nest structure and population.

## Results

**1.** *Nest conditions*: All nests were provided with an upper chambers section (Brood section in Ito 1973) and one or more vertical shafts except No. 1 which was devoid of shaft (Fig. 2). The upper soil layer in the habitat was frozen down to 10 cm deep where most chambers were located. At excavation, the formation of ice crystals was observed in many chambers. Vertical shafts were 30 to 110 cm, in average 71 cm deep and 0.5 to 1.0 cm in diameter, each involving 0 to 20, in

1) Biological and Ecological Studies of *Formica yessensis* Forel. III.

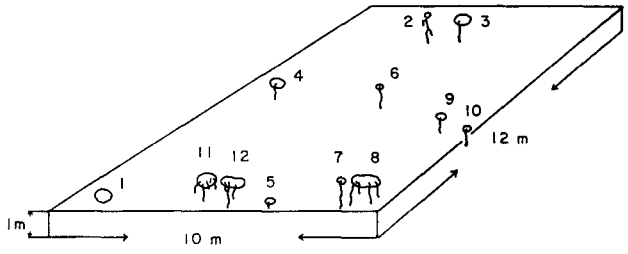


Fig. 1. Nest distribution in the area surveyed, showing the approximate extent of chambers section and depth of vertical shafts.

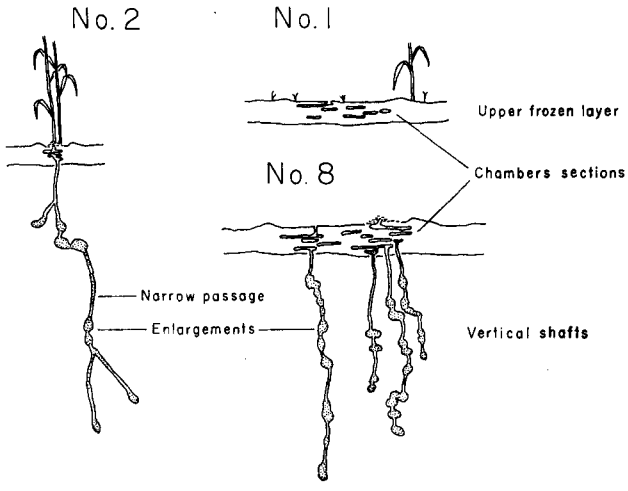


Fig. 2. Cross section of nests showing various types. No. 1 (Cs), No. 2 (oS), No. 8 (CS). Dotted parts: occupied by hibernating ants.

average about 8 enlargements, along the course. These enlargements were 2 to 8 cm long and 2 to 4 cm wide. Ants were scarcely obtained from the chambers, mostly aggregating in the shafts. In the shafts, most ants were concentrated in the enlargements, forming a compact mass, whereas the narrow passage parts were often free from inhabitants. Such enlargements (Oval chambers and partial enlargements in Ito 1973) are also present in active seasons, but seemingly not so abundant as in winter.

2. *Distribution of ants within nests*: Only dealated queens and workers were obtained by excavation. The absence of immatures coincides with the hibernating trait general to the genus. Under the air temperature of ca. 0°C at excavation, they could crawl slowly but did not exhibit acid secretion and biting characteristic to this species in active seasons. Similar observations were reported in *F.* (*Coptoformica*) *ulkei* Emery (Holmqust 1928).

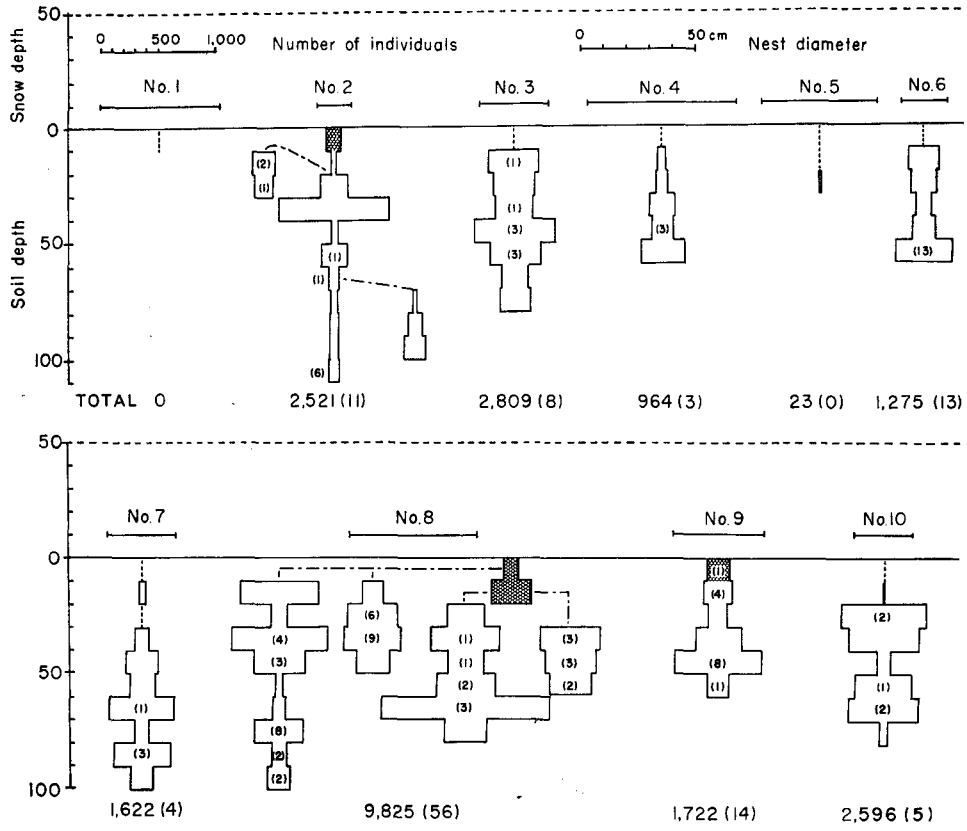


Fig. 3. Vertical distribution of ants in each nest, each shaft shown separately. Number of ants at each depth is given by horizontal bars. Shaded blocks mean ants captured from chambers section, and vertical broken lines the parts without ants. Numerals parenthetically given are numbers of queens.

The number of ants collected from each nest is given in Fig. 3, those from chambers and each 10 cm section of shafts shown separately. Although the ants were obtained from the top to the bottom of nests, a concentration in particular sections was observed in many cases, which mostly corresponds to the presence of enlargements. However, throughout various nests, there is found no clear preference for a particular depth. For instance in No. 2 the majority was collected from 35 cm, but in one shaft in No. 8 the maximum was at 65 cm deep. In No. 10 a segregation of two groups was observed, one in the part shallower than 40 cm and the other in the part deeper than 50 cm. Although the thermal gradient along the soil layer was not registered, no marked concentration on a definite horizontal zone was detected.

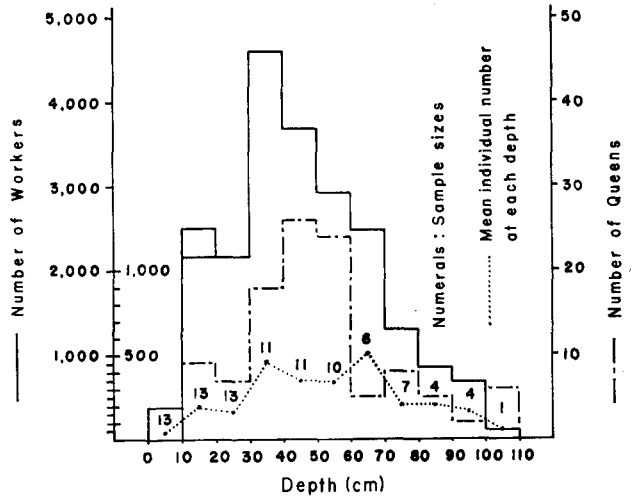


Fig. 4. Vertical distribution of total ants collected.

Fig. 4 presents the vertical distribution of total ants collected. The steep peak at 35 cm is partly caused by the relative scarcity of deeper shafts. But the distribution of mean individual number at each depth is relatively higher at the range between 35 and 65 cm. This indicates that the range shallower than 30 cm is less preferred for hibernation. Whether the range deeper than 70 cm is avoided or not must be clarified through accumulation of further observations.

3. *Seasonal change of nest types*: As in some European and Nearctic polydomous relatives, the colony proliferation of this species is achieved by means of budding. New nests are mainly established in spring and early summer. Combining the conditions of two major nest components, chambers section (C=well developed, c=poorly developed) and vertical shafts (S=well developed, s=poorly developed), Ito (1973) distinguished four nest types; CS, Cs, cS and cs. CS were regarded as well developed, all season nests and cs as recently founded ones. Concerning the other two types showing intermediate states, he assumed Cs as representing the summer type and cS the winter type.

Among 12 nests excavated in winter, eight were CS, two cS and two Cs. The two Cs nests, Nos. 1 and 5, were assumed as abandoned. No. 1 had neither shafts nor inhabitants, and No. 5 was very shallow with only 23 individuals. Two cS nests, Nos. 2 and 6, had respectively 2,521 and 1,275 ants. Six CS nests examined, Nos. 3, 4, 7, 8, 9 and 10, contained respectively 2,809, 964, 1,622, 9,825, 1,722 and 2,596 inhabitants. The mean individual number of inhabitants was 2,917, excluding the two abandoned cases, lower than the mean 6,800 and s.d. 9,500 in nests during active seasons (Ito 1973).

Table 1 presents the seasonal distribution of each nest type from the results

Table 1 Seasonal distribution of each nest type. Numerals in parentheses mean numbers of abandoned nests.

| | CS | Cs | cS | cs | |
|---|---|---|---|---|---|
| Mar. | 8 | (2) | 2 | 0 | winter |
| Apr. | No record | | | | |
| May | 7 | 1 | 2 | 0 | spring |
| Jun. | 5 | 2 | 0 | 0 | |
| Jul. | 4 | 3 | 0 | 1 | summer |
| Aug. | 4+*2* | 2+*6(3)* | 0 | (1)+*4(1)* | |
| Sept. | 2 | 2 | 3 | (3) | autumn |
| Oct. | 8 | (3) | 4 | (1) | |
| Nov. | No record | | | | winter |
| Dec. | 0 | 0 | 1(1) | 0 | |

by Ito (60 in total), together with those (12 in total) excavated by me in winter, 1973. Italicized numbers (16 in total) are those newly established since the spring and excavated in the following summer by me, 1973. Ito defined only nests shallower than 20 cm as Cs or cs. But hereafter nests shallower than 30 cm are assumed as Cs or cs, because the range shallower than 30 cm is rarely preferred for hibernation as mentioned in the previous section. Active Cs nests were mainly observed in spring and summer but cS ones from autumn to spring through winter. Although the available data are still insufficient the results suggest that cS type starts mostly in autumn while Cs in spring and partly in early summer, supporting the assumption held by Ito that cS type would mainly be used for hibernation.

## Discussion

As chambers section and shallower parts of shafts were not inhabited by ants in winter, Cs nests are assumed as unfavorable for hibernation. To cope with this difficulty, two ways are possible for ants. One is to abandon Cs nests and to enter into other nests of CS or cS types equipped with deep shafts, and the other to develop and deepen shafts toward winter. As to the first way, nest abandonment is frequently observed in autumn. Ito (1973) excavated three abandoned Cs nests in October, and in the present study two Cs nests were found abandoned (cf. Table 1). Apparently the polydomous system with little internidal hostility must play an important role for the realization of this practice. In the discrete system of *F. rufa rufa* observed by Gösswald (1951), migrations to new nesting sites occurred toward winter. But in this case the nests newly built were often attacked by the occupant colonies of the area.

The second way seems also possible. The data of 16 nests excavated by me in August (Table 1, Italicized) show a tendency of developing chambers prior to shafts.

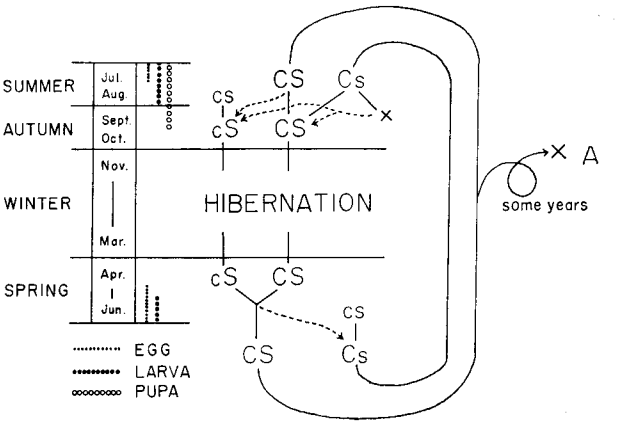


Fig. 5. Presumed transformation of nest types in the annual course. X. Nest abandonment; Broken lines. Drifting of inhabitants.

No cS nests have been found in summer and only two out of 16 belong to CS type. The results could be interpreted by one of the following alternatives. 1. Leaving two CS nests, all others would be abandoned before winter. 2. Some nests, at least, Cs and cs ones, would develop shafts, shifting respectively into CS and cS. Until sufficient information is accumulated, the relative prevalence of these two possibilities cannot be estimated. But the latter case seems more likely as several cS nests have been found from autumn to spring.

Thus the presumed transformation of nest types in the annual course is schematized in Fig. 5. The Cs nests first appear in spring or summer. In autumn, they either grow into CS or abandoned, and in the former case, they are used for hibernation and continue as CS until some unfavorable conditions force the ants to abandon them (Fig. 5, A). The cS nests first appear in autumn, are used for hibernation, grow into CS in the next summer, and remain as CS as in cases developed from Cs. Among the possible causes acting against the permanence of CS nests, decaying of the root system seems to be the most serious one, for the root system is essential to keep the sandy soil compact in the littoral shore habitat.

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## Summary

As a third report of the serial studies of a Japanese red wood ant, *Formica* (*Formica*) *yessensis* Forel, some nests were excavated in winter to know the

hibernating state. The results obtained are:

1) Only dealated queens and workers over winter. When excavated under ca. 0°C, they keep the ability to crawl slowly as in other congeneric species, though acid secretion and biting characteristic to this species in active seasons are absent.

2) Ants avoid chambers section, and concentrate mostly in the enlargements made along the shafts.

3) Transformation of nest types in the annual course is seemingly important for hibernation, together with the polydomous system facilitating internidal drifting.

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