FORMICA INTEGRA (HYMENOPTERA: FORMICIDAE)

1. HABITAT, NEST CONSTRUCTION, POLYGNY, AND BIOMETRY

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ABSTRACT

Formica integra Nylander was studied during late May 1972 in its native habitat: an oak-hickory forest on a ridge in the Lower Piedmont, west-central Georgia. Sexual and worker broods were present in subterranean portions of the numerous, closely-spaced nests which were typically associated with rotting oak logs. Functional polygyny was demonstrated by the presence of numerous wingless, subterranean females (with sperm and mature eggs) per nest. The number of ovarioles per ovary, worker body measurements, and (size-dependent) worker pigmentation patterns were similar to those published for polygynous European species of the F. rufa group, especially Formica polyctena Forest. from Germany.

Formica integra Nylander 1856 belongs to the Formica rufa L. group (Creighton 1960, Wheller 1913). Certain European species in this group of “red wood ants” are effective predators of forest tree pests and are actively managed for biological control purposes. Two polygynous species, Formica polyctena Forst. 1850 and Formica lugubris Zett. 1840, have been used extensively in Central Europe, parts of East and Southeast-Europe including the Soviet Union, and in Italy (Gosswald 1941-65; Gosswald et al. 1953-65; Horstmann 1970; Kloft 1960, 1966; Kratzer 1964, 1969; Otto 1959-65; Pavan 1959, 1960; Wellenstein 1952-63).

Only recently has serious thought been given to the role and use of ants for control of forest tree pests in North America (Bradley and Hinks 1968, Bradley 1972, Finnegan 1971). Attempts have been made to introduce F. lugubris from Italy into Quebec, Canada on an experimental basis, where Dr. R. J. Finnegan (personal communication) found this ant readily attacked diprionid sawflies such as Neodiprion lecontei (Fitch) and Neodiprion swainei Middleton. Before similar introductions of European ant species into Florida might be attempted, it seemed desirable to learn as much as possible about one or more New World species from the southeastern United States. Transfer from more northerly latitudes and higher altitudes in Europe and successful establishment in Florida are considered problematical. Only the 2 mentioned species (F. polyctena and lugubris) among 8 European species within the F. rufa group are believed to possess the characteristics necessary for successful management and control of forest pests (Finnegan 1971).

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4F. integra was identified by Dr. W. F. Buren, Center for Disease Control, Atlanta, Georgia.
5Large ant size, high populations per nest, large populations per unit area, polygyny, intraspecific tolerance, ease of laboratory rearing and establishment in the field, predatory aggressiveness-efficiency, and climatic adaption are some desirable qualities discussed by this author.
This paper reports on certain biological and ecological aspects of *F. integra*. Comparisons of this ant with European species are based on the personal knowledge and considerable first-hand experiences of the senior author.

**Distribution, Location, Habitat, and Nests**

Creighton (1950) indicated the range of *F. integra* as eastern North America from Nova Scotia to northern Georgia and Alabama and west to the Black Hills of South Dakota. The species was listed by Wesson and Wesson (1940) for south-central Ohio, and by Carter (1962) as common near Highlands in North Carolina. Dr. W. F. Buren (personal communication) found *F. integra* at our study site in west-central Georgia, the southernmost known location for a member of the *F. rufa* group in the eastern United States.

Ants were collected and studied in the field on 27 May 1972 at F. D. Roosevelt State Park on highway 190, connecting U.S. highways 27 (alt.) and 27, between Warm Springs and Columbus in west-central Georgia. This location is near the southern edge of the Lower Piedmont, about 22 km south of lat. 33°N and at an altitude between 250 and 300 m.

The study colony was located on a well-drained site with a slight northwest slope near the top of a NE-SW ridge dominated by a mixed hardwood-conifer forest.


We found the ants living in a very large colony consisting of many nests, in agreement with the observations of Carter (1962) and Wheeler (1913). The nests were irregularly distributed, commonly spaced about 4-6 m apart, and usually located under and in partially decomposed fallen logs with loose bark (Fig. 1) or stumps. A mass of organic litter (principally oak and hickory leaves, twigs, catkins, and mast worked over by the ants) was characteristically piled along the infested logs and around the stumps, and sometimes around the bases of living trees. Nest surfaces were typically exposed to the South or Southeast. Most nest mounds were relatively low (5-8 cm) compared with mounds of many European species (e.g., *F. polyctena*, *F. lugubris*, *F. aquilonia* (Yarrow), and *F. (Coptoformica) exsecta* Nyl.), rarely exceeding 15-20 cm in height. The small size of the *F. integra* mounds may reflect the relatively warm climate of Georgia; nest-mound shape and size in Europe are known to vary with respect to such factors as regional climate and microclimate of the particular site.

*Chestnut oak dominated many of the dry, rocky ridge tops and its foliage was fed upon at the ant colony site by an aphid, *Neosmydobius* sp. (det. Dr. A. N. Tissot, Univ. Fla.). *F. integra* consistently attended this aphid in the study colony area.*
Single nests sometimes extended for a long distance along a log (2-4 m), and it was often difficult to decide on the limits of adjacent nests. Dense populations of workers, larvae, and pupae were found in rotted logs, under bark, within nest piles, and sometimes beside the nests under dry oak and hickory leaves.

We dug out most of one typical nest for transfer to the Forest Insect Laboratory in Gainesville, Florida. This nest was in a decaying oak log ca. 40 cm long which was bounded on the southeast side by surface organic material. The nest extended about 40 cm deep into the soil under the log and spread out underground principally in a southeast direction. The soil of the subterranean nest area was dark, enriched with organic litter, and contained workers, larval brood, and queens. Many European red wood ant species also have large nest areas underground, especially *F. polyctena* in which larval brood and queens are found in subterranean nest areas during the summer.

Clusters of *F. integra* sexual pupae in newly-spun cocoon and worker larvae were present in nests in the interior of the forest on 27 May. In one atypical shallow nest established under oak leaves spread out along a roadside ditch with full southeast exposure, we found clusters of well developed sexual pupae (♀ and ♂), a few newly-emerged sexual adults (♀ and ♂), and large numbers of worker (♀) pupae, all at the same time. Wheeler (1926) reported swarming during August (latitude and altitude unspecified). Our observations indicated that swarming had not yet commenced during May 1972 at the study site. Most workers emerged from their pupal cases a few days after transfer to Gainesville, Florida.
The Problem of Polygyrn

A key factor concerning potential use of a particular red wood ant species for biological control is the number of functional (mated-ovipositing) queens in the nests. Only when there are many such queens per nest (polygyrn) is it possible to artificially colonize the species by dividing nests and transplanting the ants to other places (Gosswald 1941, 1951). Workers and queens of a given polygyrnous species exhibit considerable tolerance toward each other so that it is often possible to mix ants from different nests and origins. Functional polygyrn (“obligatory polygyrn” of Buschinger 1972) has been proven conclusively in Europe only for F. polyctena, but is presumed for other species such as F. lugubris, F. aquilona, F. pratensis, and probably F. (Coptoformica) spp.

Obligatory polygyrn in F. polyctena is correlated with polydomy, a situation in which colonies consist of many nests. Such colonies are formed by sociotomy, which involves emigration of part of the workers carrying brood and queens with them to new nesting sites. The large number and close proximity of nests suggested that F. integra is also a polygyrnous species which practices sociotomy.

F. integra in fact proved to be a polygyrnous species. As partial evidence we dug up 74 queens (♀) from the woodland nest and 6 were recovered from a small sample of the roadside nest. These were presumed to be functional because they were found in the soil, were wingless, and swarming had not yet occurred. Most important, dissection of 8 (10%) of the collected ♀ showed the presence of sperm in their spermathecae and the presence of mature eggs in their ovarioles. The ♀ contained 48-55 ovarioles per ovary, corresponding closely with the polygyrnous F. polyctena from Europe. According to Gosswald (1941), ♀ of the monogyrnous F. rufa have 110-135 ovarioles per ovary, while ♀ of the polygyrnous F. rufa rupratisn minor (= F. polyctena) have 55-60 ovarioles per ovary.

Biometrical Studies

Data were collected to supplement published descriptions of F. integra (principally Creighton 1950, Wheeler 1913), to describe some size and color variations within the worker caste, and for comparison with European species. Specimens in a random sample of over 300 freshly-killed workers from the woodland nest were placed dorsal-side-up in rows on double-sticky tape attached to glass slides, after which the head and gaster were gently stretched to minimize distortion of body form. All measurements were made by the same observer (W. J. K.) by means of an ocular micrometer and stereomicroscope.

Entire body length: distance from tip of closed mandibles to posterior tip of gaster. Only 110 workers with undistorted gasters were selected for this measurement in order to exclude specimens with greatly distended or shrunken gasters. Fig. 2 illustrates a range in body length of 4.2-8.7 mm, mean of 6.59 mm, and “incipiently bimodal” (Wilson 1971, p. 141) distribution of data.

Head width: distance across widest part of head along an assumed line bisecting compound eyes. Fig. 3 shows a range in head width of 0.9-1.9 mm, mean of 1.35 mm, and incipiently bimodal distribution. The mean value is important for comparison with the data of Otto (1959-60*) who published on the head
Fig. 2. Distribution of entire body lengths in *F. integra* workers.

Fig. 3. Distribution of head widths in *F. integra* workers.
Fig. 4. Distribution of thorax lengths in *F. integra* workers.

Fig. 5. Distribution of thorax widths in *F. integra* workers.
widths of *F. rufa* group workers from 104 nests in Germany. The range in average values (x̄) for polygynous spp. ♀ from 69 nests was 1.27-1.77 mm, with corresponding mean values for monogynous spp. ♀ from 35 nests of 1.59-1.99 mm. The average head width for *F. integra* (1.35 mm) corresponds closely with x̄ values given for *F. polyctena*.

**Thorax length**: Distance from anterior margin of prothorax to anterior margin of scutellum. Fig. 4 depicts a range in thorax length of 1.5-2.8 mm, mean of 2.08 mm, and incipiently bimodal distribution.

**Thorax width**: Distance across widest part of prothorax. Fig. 5 indicates a range in thorax width of 0.7-1.3 mm, mean of 0.94 mm, and incipiently bimodal distribution.

The tendency toward bimodal distribution of size measurements in *F. integra* is similar to that in workers of certain ant species showing elementary polymorphism (evolutionary step 2 of Wilson 1971, loc. cit.). The distribution in *F. integra* is also similar to that described for polygynous species in the European *F. rufa* group (Otto 1999-60), and may reflect periodic changes in trophic competition between worker broods and the relatively large sexual broods (especially ♀) produced in such species (Gosswald 1953, Lange 1956).

Other measurements included (1) entire body length of ♀ (n = 5): x̄ = 12.0 (11.5-12.6 mm); (2) dimensions of sexual pupae (N = 12): length x̄ = 10.1 mm (9.7-10.5 mm), diameter x̄ = 4.66 mm (4.5-4.9 mm); and (3) dimensions of worker pupae (n = 20): length x̄ = 6.3 mm (4.7-7.1 mm), diameter x̄ = 2.98 mm (2.0-3.3 mm).

Pigmentation on the dorsum of the worker's thorax is a character used in the taxonomy of the European *F. rufa* group, but variations may occur due to environmental factors (Lange 1956). According to Betrem (1960), the degree of black pigmentation on the red-brown thorax may be assigned to 6 classes, ranging from pigment-free (class 1) to extensive pigmentation of the pro- and

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<td>1</td>
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<td>68</td>
<td>11</td>
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<td>80</td>
<td>52</td>
<td>8</td>
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<tr>
<td>2.5-2.8</td>
<td>12</td>
<td>19</td>
<td>1</td>
<td>1</td>
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<td>TOTAL OF INDIVIDUALS PER SIZE CLASS</td>
<td><strong>34</strong></td>
<td><strong>129</strong></td>
<td><strong>121</strong></td>
<td><strong>20</strong></td>
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Fig. 6. Distribution of thorax pigmentation patterns in *F. integra* workers of different sizes.
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meta-thorax (class 6) (F. aquatonia, F. rufa, and F. lugubris). Lange (1956) has demonstrated the same distribution in F. rufoprateris minor (= F. polycytena). We set up 4 pigmentation classes for F. integra (0, 1, 2, 3 in Fig. 6) which corresponded well with the 6 European classes, as shown. Although the data totals for all 304 specimens show a fairly normal distribution within our 4 pigmentation classes, the break-down by worker size classes indicates that pigmentation in our sample was size-dependent. Thus, smaller workers were most frequently represented in the darker classes, the largest workers most frequently in the lighter classes, and medium-size workers were intermediate in this respect.

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LITERATURE CITED


Pavan, M. 1959. Attivita per la lotta biologica con formiche del gruppo For-


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ANNUAL MEETING OF FLORIDA ENTOMOLOGICAL SOCIETY

The 56th annual meeting of the Florida Entomological Society will be held at the Deauville Hotel, Miami Beach, September 12-14. The theme of the meeting will be: Entomology, An environmental Science. Invitational speakers from agricultural, medical, commercial, and biological control aspects of our science will develop talks around this theme, showing the concern that entomologists have always had for the environment.