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Predation of larval siricid woodwasps (Hymenoptera: Siricidae) by woodpeckers in Europe

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Key words: Predation, Siricidae, Woodpeckers.

Introduction

During oviposition activity, siricid woodwasp females drill holes in the wood, lay eggs and inject a symbiotic fungus into host trees (Spradbery 1977). After the eggs hatch, the larvae burrow through the wood, producing densely-packed, frass-filled tunnels. The developing larva occupies a chamber up to 4cm long and 1 cm in diameter in the wood where they feed on the fungal hyphae by scraping fragments of wood from the distal (head) end of the chamber. The duration of the larval stages in Europe can occupy from 1 to 3 years. Due to their relative inaccessibility within the timber, siricid larvae are well protected from all but a few specialised insect parasitoids (Spradbery and Kirk 1978) and predators capable of digging the larvae out of the wood. One such group of predators includes the woodpeckers which leave striking evidence of their activities when working trees for insect borers, and permit retrospective studies of predatory activity.

The predation of siricid woodwasp larvae by woodpeckers in Europe has been recorded by Evans (1922), Scheidter (1923) and Palmer (1958) although no quantitative information was presented. In North America, woodpecker predation of siricid larvae was determined from stomach analyses (Beal 1911, Collinge 1915, Reisch 1928) and Marshall (1967) studied host populations and levels of predation of *Sirex cyaneus* (F.) in Canada. During surveys in Europe for natural enemies of siricid woodwasps for use in the biological control of *Sirex noctilio* F. in Australia (Spradbery and Kirk, 1978), many trees were found with woodpecker excavations.

This study describes the levels of predation by woodpeckers on siricid larvae inhabiting coniferous trees collected in several European locations.

Materials and methods

Woodpecker-excavated logs were cut into 1 m lengths and debarked after collection in 10 localities in Belgium, Germany, Corsica and Switzerland during the winter months of 1963-71 and consigned to Silwood Park, Imperial College Field Station, Ascot. Excavation sites were examined by splitting the timber and recording the depth of excavation, the number of empty siricid larval chambers resulting from the predation and the point of entry to the larval chamber. The number of exit holes on the surface of the logs that were made by the emerging adult siricids was also recorded and the timber finally dissected for living larvae to obtain total populations

per log. Total emergence of adults from all timber collected in the various localities was obtained by counting exit holes.

Results

Localities from which woodpecker excavated timber was collected, number of logs, number of prey and total siricid populations are given in Table 1. Of the logs collected, 17% had been worked by woodpeckers. Tree species worked by the woodpeckers were *Picea abies* (L.) Karst., *Abies alba* Mill., *Pinus nigra* Arnold and *P. sylvestris* L. The species of siricid larvae preyed upon were *Sirex noctilio*, *S. juvencus* (L.), *S. cyaneus*, *Urocerus gigas* (L.) and *Xeris spectrum* (L.).

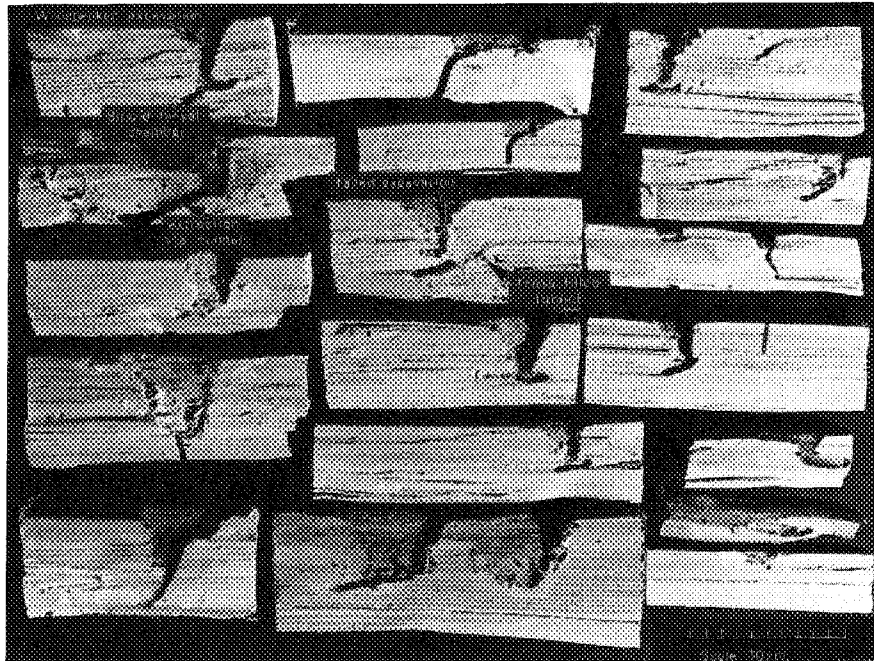


Fig. 1. Samples of siricid-infested timber cut to display woodpecker excavations.

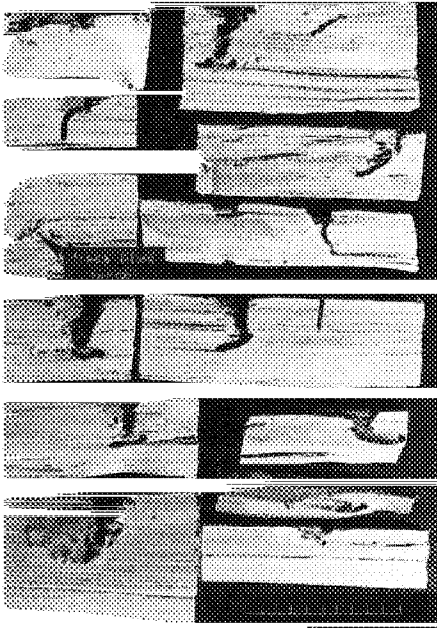
In 531 (85.9%) of the 618 excavation sites, the woodpeckers were successful in reaching one or more siricid larvae (Fig. 1). The excavations in the wood were generally 0-3 cm but some were 21 cm deep. An average of 1.6 larvae were secured by woodpeckers at each excavation

Table 1. Predation of siricid larvae by woodpeckers

Locality	Total siricid	Logs with	Siricid populations	No. of larvae	Per cent predation
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Table 1. Predation of siricid larvae by woodpeckers

Locality	Total siricid infested logs collected		Logs with woodpecker predation		Siricid populations		No. of larvae preyed upon		Per cent predation	
	No.	Per cent	No.	Per cent	Total from locality	Number available in woodpecker predated logs	Total from locality	Number available in woodpecker predated logs	Of woodpecker predated logs	Of total population from all logs
SWITZERLAND										
Corbieres	13		10	76.9	619	476	76	16.0	16.0	12.3
Le Devin	16		4	25.0	1112	278	20	7.2	7.2	1.8
Le Noir Bois	19		1	5.3	1482	78	55	70.5	70.5	3.7
Chatillon	56		6	10.7	2249	241	84	34.9	34.9	3.7
Guimfres	79		23	29.1	4565	1329	292	18.8	18.8	6.4
GERMANY										
Sababurg	13		7	53.8	923	497	161	32.4	32.4	17.4
Ebesburg	38		10	26.3	1566	412	254	61.7	61.7	16.2
Gengenbach	70		5	7.1	1890	137	48	35.0	35.0	2.5
BELGIUM										
Bure	70		6	8.6	1096	94	18	19.1	19.1	1.6
CORSICA										
L'Ospedale	75		4	5.3	1444	77	34	44.2	44.2	2.4
Total	449		76		16946	3617	1042			

site. Of 321 excavations examined for the point of entry into the larval chamber, 38.6% were at the head end, 29.6% at the posterior end and 31.8% at the centre. Based on woodpecker-worked logs, a total of 1042 siricid larvae were taken by woodpeckers from a host population of 3617, an overall predation level of 28.8%. Based on all logs pecked, the predation was 6.1%. The relationship between larval populations per woodpecker-worked log and predation showed that percentage prey collection was greatest when prey populations per log were low and that this rate decreased as prey population per log increased ($r = 0.6498$, $P < 0.001$, $n = 35$).

There was a positive linear relationship between numbers of larvae taken and the total population of siricids per log for all localities ($P < 0.05$ to < 0.001).

Discussion

In the present study it was not possible to determine which species of woodpecker were responsible for feeding on siricid larvae but it seems likely that the Greater Spotted (*Picoides major* (L.)) and the Black Woodpecker (*Dryocopus martius* (L.)) were primarily implicated as both species were common in the different localities and have been recorded feeding on woodborers, including siricids (Evans 1922, Palmer 1958).

Although the economic benefit of woodpecker predation of insect pests has been frequently cited (Solomon and Morris 1970), few data have been published to support these claims. On individual trees worked by woodpeckers, Marshall (1967) recorded 40% predation of siricid larvae in conifers, Solomon (1969) recorded 13-65% predation of borers in living hardwoods and Hay (1972) reported 36% predation of borers on oak trees. Wolf (1969) recorded up to 80% predation of siricid larvae in Belgium. In the present study, predation of siricid larvae was 29%.

The efficiency of excavation as measured by the numbers of excavation sites resulting in successful predation was 86% compared to 45-60% in the Canadian study (Marshall 1967) and 35% in the oak borer study (Hay 1972).

The positive linear correlation between number of larvae taken and prey density was similar to that recorded by MacLellan (1970) for woodpecker predation of codling moth in Nova Scotian orchards. However, Marshall's (1967) data supported a curvilinear relationship such that prey consumption increased at a progressively decreasing rate as prey density (larvae/log) increased, a functional response characteristic of many insect parasitoids and predators.

Although woodpeckers tend to be local in their distribution and do not work all infested trees in an area (17% in the present study and 86% according to Hay 1972), they are undoubtedly part of the complex of natural enemies which helps maintain wood-borer populations at or below economically damaging levels.

Acknowledgments

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Summary

Predation by woodpeckers on siricid larvae was examined in Germany, Corsica and Scotland. In all areas, siricid larvae were taken from woodpecker excavations worked by woodpeckers. Overall, 28.8% of siricid larvae preyed upon. Overall, 6.1% of siricid larvae were taken from woodpecker-worked logs. There was a positive linear relationship between total larval population per log

References

- Beal, F.E.L. (1911) Food of woodpeckers. *Annals of the Entomological Society of America* 2, 1-10.
- Collinge, W.E. (1915) A study of the habits of woodpeckers and their relation to the bark beetle. *Annals of the Entomological Society of America* 22, 789-791.
- Evans, W. (1922) Notes on the habits of woodpeckers to the present day. *Annals of the Entomological Society of America* 13, 1-10.
- Hay, C.J. (1972) Woodpecker predation on the oak. *Annals of the Entomological Society of America* 65, 273-284.
- MacLellan, C.R. (1970) Woodpecker predation on the codling moth. *Annals of the Entomological Society of America* 63, 273-284.
- Marshall, H.G.W. (1967) The biology of the siricid Siricidae (Hymenoptera: Siricidae). *Annals of the Entomological Society of America* 60, 978-985.
- Palmer, C.E. (1958) Woodpecker predation on the siricid. *Annals of the Entomological Society of America* 51, 89-98.
- Reischer, V.A. (1928) Die forstschädlichen Insekten. *Zur Kenntnis der Forstschädlinge* 1, 89-98.
- Solomon, J.D. (1969) Woodpecker predation on the siricid. *Annals of the Entomological Society of America* 62, 273-284.
- Solomon, J.D. & Morris, J.H. (1970) Woodpecker predation on the siricid. *Proceedings of the Entomological Society of America* 1, 1-10.
- Spradbery, J.P. (1977) The biology of the siricid. *Annals of the Entomological Society of America* 70, 273-284.
- Spradbery, J.P. & Kirk, A.A. (1977) Woodpecker predation on the siricid in Europe, Turkey and the Middle East. *Annals of the Entomological Society of America* 70, 273-284.
- Wolf, F. (1969) Sur les habitudes de prédation des picéens sur les larves de siricides. *Royale d'Entomologie* 1, 1-10.

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Summary

Predation by woodpeckers of siricid woodwasp larvae inhabiting coniferous trees in Belgium, Germany, Corsica and Switzerland was studied. Siricid-infested logs with evidence of woodpecker excavations were dissected to determine total siricid populations and numbers of larvae preyed upon. Overall predation was 28.8% of a total population of 3617 larvae in logs worked by woodpeckers. Based on the total siricids available in all timber collected, predation was 6.1%. There was a positive correlation between numbers of larvae preyed upon and the total larval population per log. Predation levels were greatest when larval populations were low.

References

- Beal, F.E.L. (1911) Food of the woodpeckers of the United States. *US Department of Agricultural and Biological Surveys Bulletin* No. 37.
- Collinge, W.E. (1915) A preliminary report upon the economic status of the British species of woodpeckers and their relation to forestry. *Journal of the Board of Agriculture, London* **22**, 789-791.
- Evans, W. (1922) Notes on the wood-wasps (*Sirex*) occurring in Scotland with special reference to the present day distribution. *Scottish Naturalist* 175-189.
- Hay, C.J. (1972) Woodpecker predation on Red Oak Borer in Black, Scarlet and Northern Red Oak. *Annals of the Entomological Society of America* **65**, 1421-1423.
- MacLellan, C.R. (1970) Woodpecker ecology in the apple orchard environment. *Proceedings of the Tall Timbers Conference on Ecological Animal Control by Habitat Management* No. 2, 273-284.
- Marshall, H.G.W. (1967) The effect of woodpecker predation of wood-boring larvae of families Siricidae (Hymenoptera) and Melandryidae (Coleoptera). *Canadian Entomologist* **99**, 978-985.
- Palmer, C.E. (1958) Woodpeckers in woodlands. *Forestry Commission Leaflet* No. 42.
- Reisch, V.A. (1928) Das Verhalten paläarktischer Vögel gegenüber den wichtigeren forstschädlichen Insekten (v-ix). *Zeitschrift für angewandte Entomologie* **13**, 483-512.
- Scheidter, F. (1923) Zur Lebensweise unserer Holzwespen. *Zeitschrift für Schädlingsbekämpfung* **1**, 89-98.
- Solomon, J.D. (1969) Woodpecker predation on insect borers in living hardwoods. *Annals of the Entomological Society of America* **62**, 1214.
- Solomon, J.D. & Morris, R.C. (1970) Woodpeckers in the ecology of southern hardwood borers. *Proceedings of the Tall Timbers Conference on Ecological Animal Control by Habitat Management* No. 2, 309-315.
- Spradbery, J.P. (1977) The oviposition biology of siricid woodwasps in Europe. *Ecological Entomology* **2**, 225-230.
- Spradbery, J.P. & Kirk, A.A. (1978) Ecology of siricid woodwasps (Hymenoptera, Siricidae) in Europe, Turkey and North Africa. *Bulletin of Entomological Research* **68**, 341-359.
- Wolf, F. (1969) Sur les ennemis de hymenoptère Siricidae. *Bulletin et Annales de la Société Royale d'Entomologie de Belgique*, **105**, 202-224.