

EVALUATING *PYEMOTES DRYAS* (VITZTHUM 1923) (ACARI: PYEMOTIDAE) AS A PARASITE OF THE SOUTHERN PINE BEETLE^{1, 2}

J. C. Moser³, B. Kiełczewski⁴, J. Wiśniewski⁴ and S. Bałazy⁵

----- **ABSTRACT** — Populations of *Pyemotes dryas* (Vitzthum 1923) from Poland were bioassayed for potential use in the biological control of the southern pine beetle in the United States. The mite apparently rides and attacks a wide range of European bark beetles that attack conifers and readily consumes brood of the southern pine beetle. However, it is not phoretic on the southern pine beetle or six other associated beetles. -----

INTRODUCTION

The genus *Pyemotes* is a cosmopolitan group of predatory mites, several species of which are among the most successful natural enemies of bark beetles. Under endemic conditions they are always present, but occasionally they explode in numbers, decimating bark beetle populations.

One reason for the success of the southern pine beetle (SPB), *Dendroctonus frontalis* Zimmerman 1868 may be that it has no *Pyemotes* naturally associated with it, with the minor exception of *Pyemotes parviscolyti* Cross and Moser 1971. The latter is a parasite of *Pityophthorus annectans* LeConte 1878 [= *P. bisulcatus* (Eichhoff 1868)], which infests small branches of pine. *Pyemotes parviscolyti* occasionally attacks broods of *D. frontalis* when the niches of the two scolytids overlap (Moser et al., 1971).

In 1973, a search was begun in Poland⁶ to locate *Pyemotes* and other mites to see if any could be used to assist in biological control of the southern pine beetle. Of the several species of *Pyemotes* found, *P. dryas* (Vitzthum 1923) appeared most promising because it was a natural enemy of bark beetles, and because the female is morphologically identical to that of *P. parviscolyti*. *P. dryas* was introduced to the United States to investigate its biology and biosystematics.

P. dryas was first collected near Liebenau, Austria in June 1921, from the galleries of *Pityogenes bistridentatus* Eichhoff 1878, in *Pinus mugo* var. *pumilio*. Subsequently, two accounts from Poland were published relating attacks by *P. dryas* on bark beetles. Kiełczewski and Bałazy (1966) recorded *Pyemotes* sp. parasitizing about 1% of the eggs of *Polygraphus poligraphus* (L. 1758), *Pityogenes chalcographus* (L. 1761), and *Pityophthorus pityographus* (Ratzeburg 1837). Fortunately both males and females of the above *Pyemotes* sp. were preserved on slides. They were identified in 1977 by J. C. Moser and E. A. Cross and *P. dryas*. Seniczak (1968) recorded *Pyemotes scolyti* (Oudemans 1936) attacking eggs and larvae of *P. chalcographus* and *P. poligraphus*. Since *P. scolyti* is only known to attack the scolytid genus *Scolytus* in the field, we assume that the species was misidentified, and that the mite parasite was again, *P. dryas*. In addition to the above published accounts, Bałazy in 1966 (unpublished) recorded a *Pyemotes* attacking brood in galleries of *Cryphalus asperatus* (Gyllenhal 1813) (= *C. abietis* (Ratzeburg 1837)), and in laboratory cultures of *Leperisimus varius* (Fabricius 1775) (= *L. fraxini* (Panzer 1799)). Male and female specimens of this *Pyemotes* were also determined by J. C. Moser and E. A. Cross in 1977 as *P. dryas*.

Here we discuss the biology and biosystematics of *P. dryas* in relation to its suitability

1. *Dendroctonus frontalis* Zimmerman 1868 (Coleoptera: Scolytidae).
2. Investigation financed by U. S. Department of Agriculture. Project No. PL-FS-65.
3. Southern Forest Experiment Station, USDA Forest Service, Pineville, Louisiana 71360, U. S. A.
4. Institute of Forest Protection, Academy of Agriculture, Wojska Polskiego 71c, Poznan 31, Poland.
5. Wielkopolski National Park, 62-040 Puszczykowo, Poznan Distr. Poland.
6. PL-480 Grant PL-FS-65 (FG-PO-292), "Bark beetle acarofauna in different types of forest habitat"; principal investigator- Prof. Dr. Bohdan Kiełczewski.

as a potential parasite for the southern pine beetle. Its taxonomic status is discussed in Cross, Moser, and Rack (in preparation).

METHODS AND MATERIALS

Two shipments of bark-beetle-infested Norway spruce, *Picea abies* (L. 1753) Karst 1881 (= *P. excelsa* Link 1841), collected by S. Balazy, were forwarded to the Pine Bark Beetle Research Project, Southern Forest Experiment Station at Pineville, Louisiana.

The first shipment, containing *Polygraphus poligraphus* (L. 1758) with its parasitic mite, *Pyemotes dryas*, was collected on 29 May 1976 near Skrzynka Lake, Wielkopolski National Park, and reached Pineville on 15 June. The second, containing *Pityophthorus pityographus* Ratzeburg 1837 with *P. dryas* was collected on 17 May 1977 on Gora Krzyzowa near Krynica, and reached Pineville on 10 June.

Upon arrival of the specimens, two thirds of the bark was removed from the spruce bolts, and the species and abundance of insects and mites in the beetle galleries were noted. The remaining portion was placed in a rearing container and the numbers of adult beetles emerging and numbers and location of mites on beetles were tallied.

In addition, SPB's and 6 associated beetles, *Corticium glaber* LeConte 1878, *Ips avulsus* (Eichhoff 1867), *Ips calligraphus* (German 1824), *Ips grandicollis* (Eichhoff 1867), *Pityophthorus annectans* LeConte 1878, and *Pityophthorus confusus* Blanford 1904, were exposed in rearing dishes to adult virgin females of *Pyemotes dryas* to see if they were acceptable as phoretic hosts. Five males and five females of each beetle species were tested with the first generation of the 1977 population of *P. dryas* and the 1976 population (which by then had been in culture for one year) to see if the mites would attach to the 7 beetle species.

Pyemotes dryas were cultured on SPB brood and studies on mite biology, biosystematics, and phoretic behavior were conducted using the methods of Moser et. al. (1971). Cultures were maintained in open slender dishes at room temperatures and humidities of about 21°C and 40% R. H.

RESULTS AND DISCUSSION

Pyemotes dryas was the only associate found in the galleries of either of the imported bark beetles. In the 1976 shipment, practically all of the *Polygraphus poligraphus* brood had been decimated by the hundreds of physogastric females and thousands of unswollen females teeming under the bark. Most larvae and pupae had 1-3 female mites attached and feeding. Several had as many as 5. Rarely, an isolated larva or pupa was seen that somehow had escaped predation. About 150 brood adults emerged from undissected bark. Nearly 25% possessed phoretic females. As many as six were attached to one beetle, but most beetles had 2-3 that held on to the coxal setae with the large claw on tarsus I. Occasionally, female mites also attached to leg setae.

Pityophthorus pityographus in the 1977 shipment were all in the egg and early larval stage. Of 84 eggs found, only 4 had been attacked by mites. None of the early larvae had been attacked presumably because none of the *P. dryas* females had yet given birth to a second generation. From the undissected bolts, 28 parent adult beetles emerged, none of which had phoretic mites. No brood adults emerged because, for unknown reasons, none of the brood survived in the undissected bolts.

It appears that the phoretic behavior of *P. dryas* is similar to that of its closely related species, *P. parviscolyti*, whose phoretic females are common on brood adults but rare on parent adults of its scolytid host (Moser, et al. 1971). However, *P. dryas* never rode either the SPB or its 6 associates.

In the laboratory cultures, the mites fed and developed only on late larvae and preferred pupae of SPB. Eggs and first instar larvae were punctured and killed, but not fed on despite the fact that the mite survived on eggs of *Pityophthorus pityographus*. Callow and mature SPB adults were not attacked.

P. dryas females had little or no venom. Some pupae of *D. frontalis* were seen moving two days after mites attacked and began to swell. The frequency of attack by mated, unfed *P. dryas* females was less than that of two other species of *Pyemotes* that we also were culturing. Of 950 laboratory reared females from 10 mothers of *P. parviscolyti*, 58.9% attacked and produced progeny; of 982 females from 10 mothers of *P. n. sp. "C"* (Cross & Moser 1975), 35.1% attacked and reproduced. In contrast, only 12.7% of 496 females from 10 mothers of *P. dryas* were successful.

Attack and feeding by *P. dryas* was similar to that described for *P. parviscolyti* (Moser et al., 1971). Females searched actively and fed intermittently once a host was located. Physogastry was noticeable 24 hours after attack and swelling continued until birth at about the 9th or 10th day. After 2 days, movement was greatly hampered by size, and by the 3rd day the female had settled in one place, permanently inserting her mouthparts into the body of the pupa. Opisthosoma of fully swollen females reared on single pupa averaged 700 μ , with extremes as large as 1 mm. Average size tended to be smaller when more than one female attacked the same pupa. When host material was scarce, physogastric females were sometimes cannibalized by unfed females.

The gestation period of about 10 days was typical of most species of *Pyemotes*. The parturition period, however, lasted only 6-10 days, less than one-half as long as for most *Pyemotes*. Males were born first by 17 of 20 females studied. They were extremely polymorphic, ranging from small males to very large heteromorphic males. For purposes of discussion here, we refer to them only as "larger" and "smaller," as viewed through a 30X dissecting microscope used to manipulate the cultures. Detailed studies of male polymorphism required mounting specimens on slides and examining them under a compound microscope (Cross, Moser, and Rack-in-preparation).

One mother bore 231 females but the average number was about 100. Typically, one to four males were born to each mother, but occasionally mothers produced as many as 44 males along with a normal complement of females. Although mothers usually died before all progeny were born, they generally gave birth to several more females after death.

Although large heteromorphic males were common in the 1976 shipment from Poland, they were short-lived, inefficient in mating, and gradually disappeared in subsequent laboratory rearings. In the first laboratory generation reared from SPB pupae, nine mothers produced a total of 20 males, of which 9 were judged large and 11 small. From the second generation, 10 mothers gave birth to 1 large male and 38 small males. Only small males were seen in 50+ subsequent generations. Nine of the above large males died within 24 hours, and the single remaining large male lived no longer than 2 days. In contrast, 12 of 25 small males lived longer than 24 hours, and at least 2 lived 6 days.

After birth, the male usually sat quietly on the opisthosoma of the mother, usually with its gnathosoma inside the vulva (the slit-like opening of the birth canal) perhaps feeding. As many as 4 were seen in this position on one female. Only the small males were observed mating. More than one half of the large males crawled off the mothers immediately after they were born, and never returned to any mother. None of the small males were seen leaving mothers.

Males clumsily assisted in the birth of females, which emerged gnathosoma first. Females not assisted by males usually took about 3 minutes to separate from the mother. Births assisted by males took only about 1 minute. Birth of *P. parviscolyti* without male assistance often took hours (Moser, et al. 1971).

Unlike most other species of *Pyemotes*, including *P. parviscolyti*, the males of *P. dryas* did not mate with virgin females immediately after they left the birth canal. Instead, he clumsily manipulated her for 20-30 seconds until they both were in an inverted "V" position with the tips of their abdomens pointed upward. In this position, mating took 30-60 seconds. When more than one male was present, they competed briefly, but one always dominated and finished copulation. One female was seen mating twice. Single males mated with up to 58 females.

Copulation occurred sooner and was more efficient when *P. parviscolyti* males assisted in the birth of *P. dryas* females. The sequence of events in mating behavior was the same as that which took place when a *P. parviscolyti* male mated with a female of its own species. These mated, but not fertilized, females of *P. dryas* attacked hosts in the same lethargic manner as those normally mated by males of *P. dryas*. Progeny of all *parviscolyti* male x *dryas* female matings only resulted in small male *dryas*.

In absence of males, virgin females remained on or near the mothers, dying in 5-10 days if a male did not appear. In the rare cases where virgins attacked, progeny were all male.

CONCLUSIONS

Because there are no known phoretic hosts of *Pyemotes dryas* in North America, the mite is presently precluded from being released in the United States for control of southern pine bark beetles. But since this species is phoretic on, and attacks a wide range of spruce and pine bark beetles in Europe, a suitable phoretic host may yet be found in the U. S. If the mite can be reprogrammed to ride the SPB or one of its associates, it could become a significant factor in the biological control of the SPB.

LITERATURE CITED

- Cross, E. A. , and J. C. Moser. (1975). A new, dimorphic species of *Pyemotes* and a key to previously-described forms (Acarina: Tarsonemoidea). *Ann. Entomol. Soc. Am.* 68: 723-732.
- Kiełczewski, B. , and S. Bałazy. (1966). A problem of predation of barkbeetle eggs by mites. *Ekol. Pol. ser. B*, 12: 161-163. (In Polish with English summary).
- Moser, J. C. , E. A. Cross, and L. M. Roton. (1971). Biology of *Pyemotes parviscolyti* (Acarina: Pyemotidae). *Entomophaga* 16: 367-379.
- Seniczak, S. (1968). An appearance of bark beetles and associated entomofauna in crown zones of spruces in relation to tree cover in the research forest Laski, PTPN- Poznan. *Pr. Kom. Nauk Roln. i Kom. Nauk Leśn.* , 24: 325-354. (In Polish with English summary).
- Vitzthum, G. H. (1923). *Acarologische Beobachtungen 7 Reihe. Archiv fur Naturgeschichte, Abt. A.* 89: 97-181.
-