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Two new Phoretomorphic *Siteroptes* from Galleries of the Southern Pine Beetle

(Acarina: Pyemotidae)

With 37 text figures

Introduction

This paper provides taxonomic descriptions of two pyemotid mite species displaying polymorphic features discovered by MOSER & CROSS (1975). Polymorphism in the Acarina was first noted by CANESTRINI in 1888 for *Rhizoglyphus echinopus* (FUMOUZE & ROBIN). He associated the heteromorphic male with the normal homoeomorphic male of this species. Later, MICHAEL (1901) substantiated CANESTRINI's discovery and introduced the term hypopus for another stage or form (deutonymph) of the same species. This discovery had great biological significance. It showed that mites made adaptations to environmental conditions by physiological changes and that this form or stage was not a separate taxon. Reports of observations and studies on polymorphism in the Acarina are few. OUDEMANS (1906) and BAKER (1949) reported that heteromorphic males occurred in the family Cheyletidae. Recently, SMILEY [in press] and SMILEY & MOSER (1975) have studied a predatory male cheyletid mite which is now known to exemplify such a condition. Previously, this characteristic has been reported only for the male. Recently, it was discovered in the family by RACK (1974), CROSS & MOSER (1975) and MOSER & CROSS (1975) for the family Pyemotidae. FAIN (1974 Personal Communication) and DELFINADO (1975 Personal Communication) have observed heteromorphic males in the genus *Sturnophagoides*. HAARLOV (1974 Personal Communication) has found a heteromorphic male for *Ornithocheyletia hallae* SMILEY. MOSER & CROSS (1975) defined the term "Phoretomorph" as a heteromorphic female specialized for phoresy. Because of this discovery, a new generic classification for the family Pyemotidae is necessary. Also, the generic names applied for species described here may prove to be provisional. Polymorphism will undoubtably be found some day among other families of the Tarsonemoidea and is strongly suspected to occur in the family Tarsonemidae for the genus *Pseudotarsonemoides* VITZTHUM. Males are not known for this genus except for the species described by EWING (1939).

MOSER & CROSS (1975) present photomicrographs for the species being described here. In their paper figures 1 and 2 are termed "*Siteroptes* form" for the normal female and "*Pediculaster* form" for the phoretomorph. Also, figures 3 and 4 are termed "*Siteroptes* form" for the normal female and "*Pygmephorellus* form" for the phoretomorph. We now place each phoretomorph in the genus *Siteroptes* until further studies can be made on the generic classification of the family. The genera *Pediculaster* VITZTHUM, 1931 and *Pygmephorellus* CROSS & MOSER, 1971 are synonymized under *Siteroptes* AMERLING, 1861 because the first two genera are based on phoretomorphic forms of species described in *Siteroptes*.

Siteroptes fusarii SMILEY & MOSER, **new species**

figs. 1—16

The females of this species are separated from others in the genus by the long weakly dorsal setae and the lateral simple seta on tergite IV. The male is distinctive in having long weakly spiculate dorsal setae and a spur on tarsus IV.

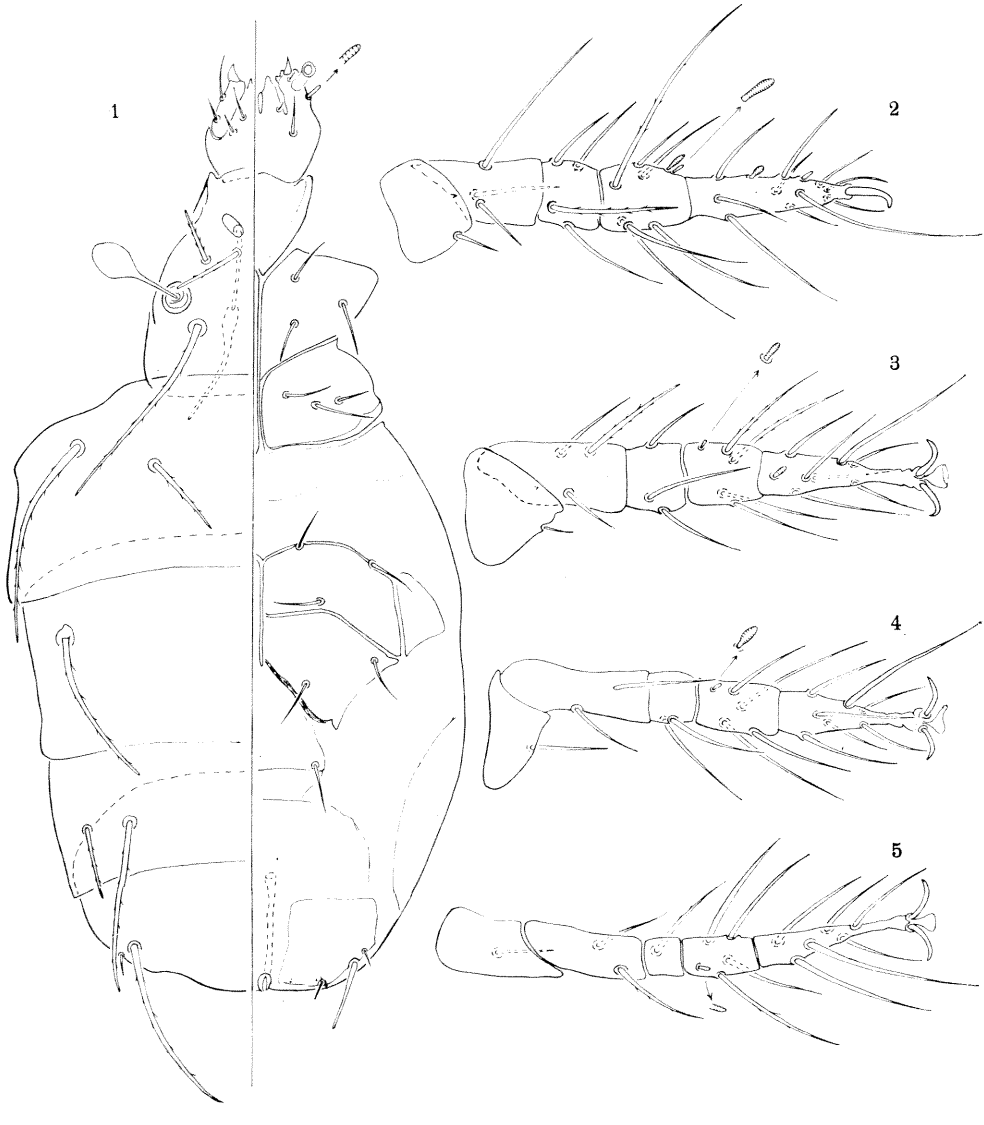
Female (normal): Gnathosoma elongated, dorsally with 2 pairs of simple setae; anterolateral pair longest. Venter with 1 pair of simple setae, longer than dorsal setae. Palpi 1 segmented with 2 simple setae, small solenidion, 1 oblong sucking apparatus; and 1 distal spinelike projection. Chelicerae small and styletlike.
Dorsum: Propodosomal shield subrectangular, longer than wide; with 3 pairs of weakly spiculate setae, anterior pair shortest; medial pair not as long as posterior pair. Stigmata with light sclerotized cuticular area. Peritreme long and slender; extending to tracheal trunk. Pseudostigmatal distal parts globelike and without spicules, Hysterosoma with 4 tergites; with inconspicuous spiculate setae; 1st tergite largest with a pair of medial and lateral spiculate setae; 2nd tergite with a pair of medial spiculate setae not subequal in length to lateral seta of 1st tergite; 3rd tergite with a pair of lateral setae spiculate, about $^1/_3$ as long as inner medial seta; 4th tergite with a lateral short spiculate seta, about $^1/_4$ as long as lateral seta on the 3rd tergite; medial seta of this tergite subequal to medial seta of 3rd tergite. Venter of propodosoma and hysterosoma as figured. Apodeme I short, converging with anteromedian apodeme; apodeme II longer than apodeme I; anteromedian apodeme converging with transverse apodeme. Posteromedian apodeme uniting with apodemes III and IV. Ventrocaudal lobe between leg IV wider than long; spade shaped distally; with a pair of simple setae. Coxal setal formula: 3—3—3—2. Leg I tapering distally, long and slender; tibia and tarsus distinct, not fused to form a single segment. Setation on femur, genu, tibia, and tarsus of leg I: 4—4—6+2 solenidia —6+2 solenidia +3 eupathidia; leg II, femur, genu, tibia, and tarsus: 3—3—4+1 solenidion —6+1 solenidion +1 eupathidium; leg III, femur, genu, tibia and tarsus: 2—2—4+1 solenidion —7; leg IV, femur, genu, tibia and tarsus: 2—1—3+1 solenidion —6; all claws uncinate and normal. Terminal posterior ventral plate each terminating with 3 pairs of setae as figured. Body 274 μ long by 109 μ wide.
Female („Phoretomorph"): Dorsal and ventral body chaetotaxy same as the normal female. This form differs from the normal female by having tarsus and tibia I fused, forming a single segment, by the large strong claw on this segment. and by the bifurcate claws for tarsi II and III. Leg I, robust, with strong recurved claw. Setation on femur, genu and tibiotarsus of leg I: 3+1 bladelike seta —4—7+5 eupathidia +4 solenidia; leg II, femur, genu, tibia, and tarsus: 3—3—4+1 solenidion —6+1 solenidion; leg III, femur, genu, tibia and tarsus: 2—2—4+1 solenidion —6; leg IV, femur, genu, tibia, and tarsus: 2—1—4+1 solenidion —6. Body 229 μ long and by 96 μ wide.
Male: Gnathosoma small and elongated; dorsally with 2 pairs of simple setae as figured. Venter with 2 pairs of simple setae, 1 oblong sucking apparatus, and 1 solenidion. Palpi absent. Chelicera not visible and may be lacking.
Dorsum: Propodosoma semi-circular anteriorly; wider than long; with 4 pairs of weakly spiculate setae; 1st pair (anteriorly) not as long as 2nd pair (posteriorly); 3rd pair (laterally) longer than 1st pair; 4th pair (proximally) longest and as figured. Hysterosoma with 3 pairs of setae as figured. Opisthosoma with 2 pairs of weakly spiculate setae anteriorly, and 2 pairs of simple setae; distally with seta and spurlike projection. Venter of the propodosoma and hysterosoma as figured. Coxal setal formula: 3—3—3—2. Setation on femur, genu, tibia, and tarsus of leg I: 4—4—5+1 solenidion —6+2 solenidia +4 eupathidia, claw as figured; leg II, femur, genu, tibia, and tarsus: 3—3—4+1 solenidion —5+1 solenidion —5+1 solenidion; leg III, femur, genu, tibia, and tarsus: 2—2—4+1 solenidion —6; leg IV, femur, genu, tibia, and tarsus: 1—1—3+1 spine +1 solenidion —4+1 spur +2 strong claws as figured. Body 179 μ long by 102 μ wide.
Larva: Gnathosoma similar to both females and male, but with 1 pair of dorsal cone-shaped solenidia. Palpi 1 segmented with 1 small solenidion, 1 strong, oblong sucking apparatus; and 1 distal spinelike projection. Chelicerae small and styletlike.
Dorsum: Body elongated, broadest in the region of the hysterosoma. Tergites not discernible. Dorsal body setae long and weakly spiculate as figured. Legs I longest; tarsus with 2 claws and without empodium. Legs II and III subequal in size and length; each tarsus with 2 claws and empodium. Body 146 μ long by 80 μ wide.

Holotype: Female, U.S. National Museum of Natural History No. 3681, collected from inner bark of *Pinus taeda* L. (loblollypine) killed by *Dendroctonus frontalis* ZIMMERMAN, cut May 1, 1974, Rapides Parish, Louisiana by JOHN C. MOSER.
Paratypes: Four females, 4 "Phoretomorphs", 2 ♂, and 1 larva with the above data. Where possible, one paratype of all stages will be deposited with the Institute of Acarology, Canadian National Collection; Zoologisches Museum, Universität Hamburg, FRG; and Zoological Department of the Hungarian Natural History Museum, Budapest.
Biology: Several small colonies of this mite were field collected from inner bark stripped from a dead *Pinus taeda* 3 weeks after being felled. The tree had been killed by the southern pine beetle, *Dendroctonus frontalis* ZIMMERMAN, and cut May 1, 1974 when brood adults of the beetle were emerging. All bark beetle activity had ceased two weeks prior to the collection of the mites.

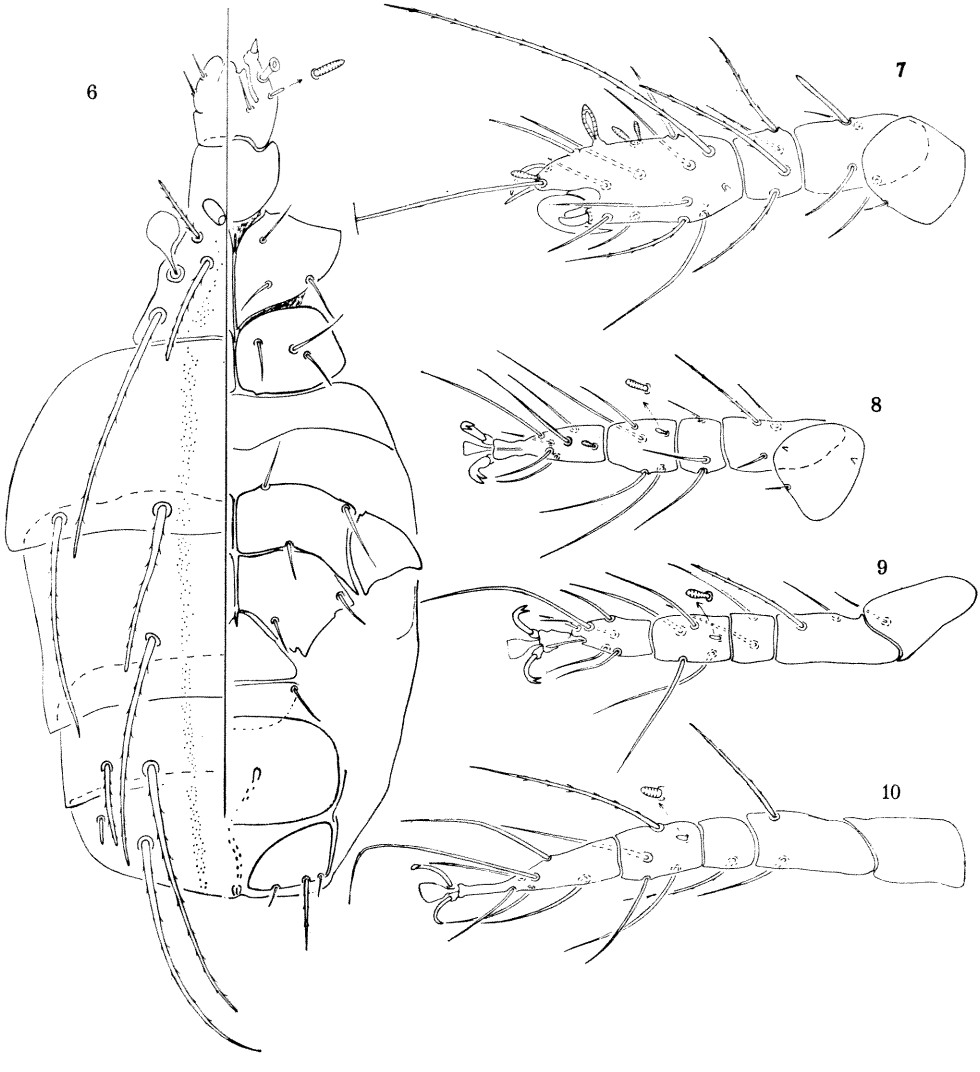
The mites were seen only in the vicinity of a white mycelium, which occurred sporadically under the bark. This fungus may have been either *Fusarium solani* MARTIUS (Det. S. N. SMITH, Dept. Plant Pathology, Univ. California, Berkeley) or the mycangial fungus, *Ceratocystis minor* (HEDGCOCK) HUNT var. *barrasii* J. TAYLOR (Det. T. PERRY, Southern Forest Experiment Station, Pineville, La.). Attempts to feed the mites these fungi were unsuccessful because the mite population died out before the fungi could be cultured. Sclerotia and perithecia of *Ceratocystis minor* were also abundant throughout the bark (Fig. 17, 18, 19).

The several small colonies of the mites generally consisted of physogastric females, normal and phoretomorphic swollen females, eggs, larvae, "pupae" and males (Fig. 17,

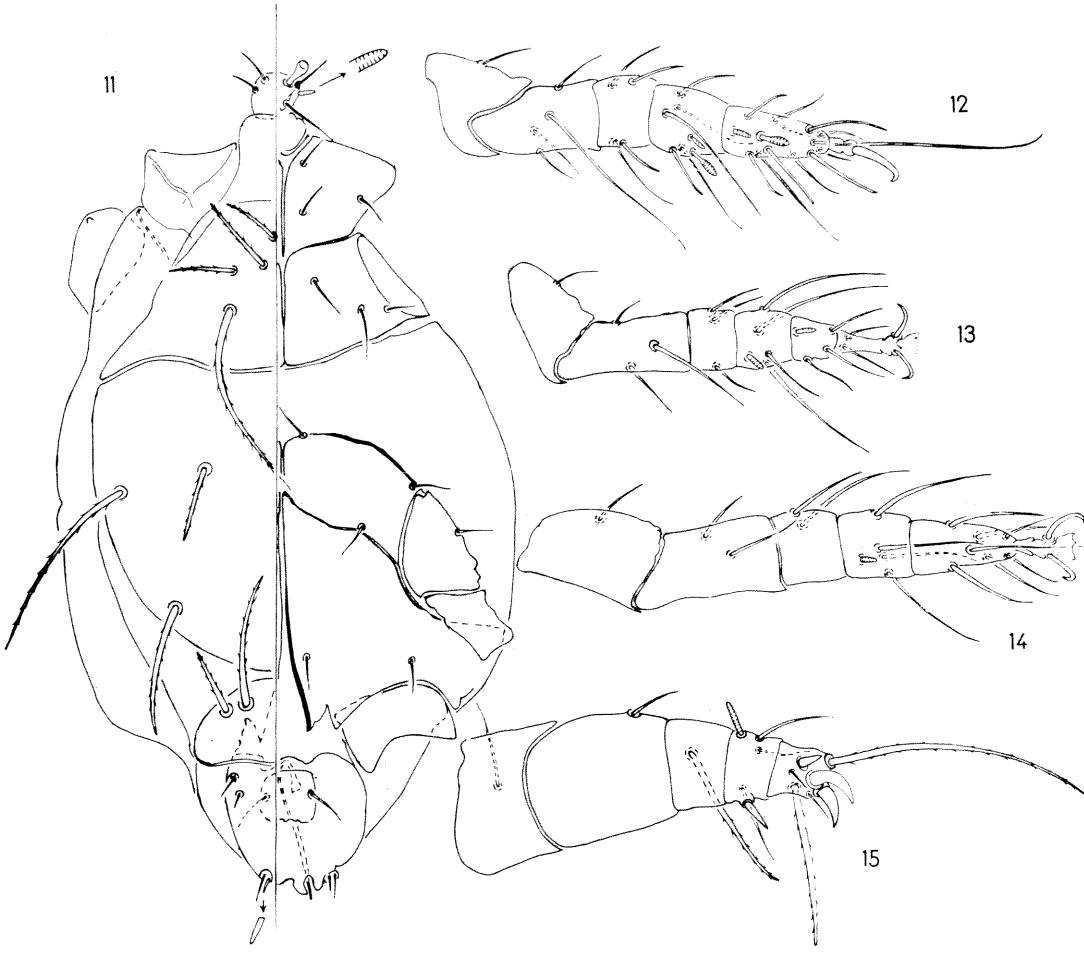
18, 19). Swollen females always were observed to lay eggs in a normal manner, and never burst open as did *S. trichoderma*. The morph of the physogastric mothers was not determined.



Figs. 1–5. *Siteroptes fusarii*, new species. Female: Fig. 1. dorsal and ventral view. – Fig. 2. left leg I. – Fig. 3. left leg II. – Fig. 4. left leg III. – Fig. 5. left leg IV



Figs. 6–10. *Siteroptes fusarii*, new species. Phoretomorph: Fig. 6. dorsal and ventral view. – Fig. 7. right leg I. – Fig. 8. right leg II. – Fig. 9. left leg III. – Fig. 10. left leg IV



Figs. 11–15. *Siteroptes fusarii*, new species. Male: Fig. 11. dorsal and ventral view. – Fig. 12. right leg I. – Fig. 13. right leg II. – Fig. 14. right leg III. – Fig. 15. right leg IV

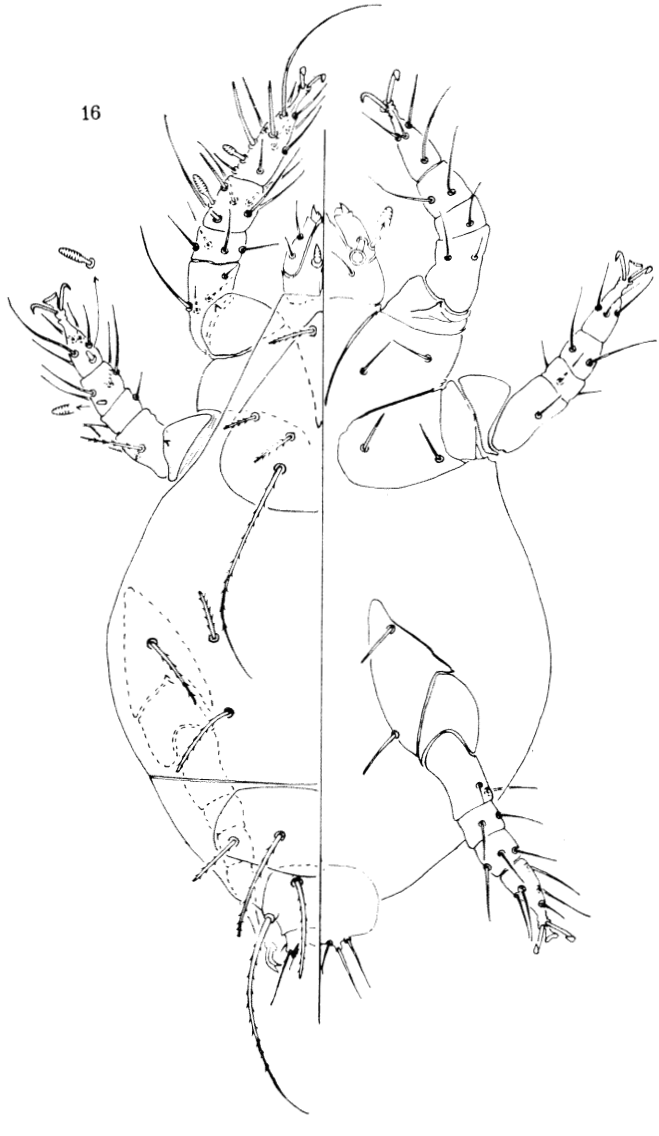


Fig. 16. *Siteroptes fusarii*, new species. Larva: dorsal and ventral view. Photographs

Siteroptes trichoderma SMILEY & MOSER, **new species**

figs. 17—36

The short weakly spiculate dorsal setae will separate the females of this species from other species of the genus. The male of this species is distinctive from other males of the genus by having short, weakly spiculate dorsal setae and 2 spines on tarsus IV.

The female differs from *S. fusarii* in possessing shorter body setae and in having smaller leg setae. The "Phoretomorph" differs from the "Phoretomorph" of *fusarii* in having shorter body setae and in having a modified tarsus I with large strong recurved claw and basal spur. The male differs from the male of *fusarii* by having short, slender body setae and by lacking the spur on tarsus IV.

Female (normal): Gnathosoma elongated, dorsally with 2 pairs of simple setae; anterolateral pair longest. Venter with 1 pair simple setae, longer than dorsal setae. Palpi I segmented with 2 simple setae, 1 small solenidion, 1 oblong sucking apparatus; and 1 distal spinelike projection. Chelicerae small and styletlike.

Dorsum: Propodosomal shield subrectangular, longer than wide; with 3 pairs of short, weakly spiculate setae, 1st and 2nd pairs subequal, 3rd pair (posteriorly) twice as long as 1st or 2nd pairs. Stigmata without heavily sclerotized cuticular area. Pseudostigmata distal portion oblong with minute spicules. Hysterosoma with 4 tergites; with inconspicuous spiculate setae; 1st tergite largest with a pair of medial and lateral spiculate setae; 2nd tergite with a pair of medial setae subequal to medial setae of the 1st tergite; 3rd tergite with a pair of lateral spiculate setae, about 2/3 as long as inner pair; 4th tergite with 2 pairs of subequal setae, slender and longer than setae for other tergites. Venter of propodosoma and hysterosoma as figured. Apodeme I short, converging with anteromedian apodeme; apodeme II longer than apodeme I; anteromedian apodeme converging with transverse apodeme. Posteromedian weak anteriorly, but uniting with apodemes III and IV. Ventrocaudal lobe between legs IV wider than long; spadeshaped distally, with a pair of simple setae. Coxal setal formula: 3—3—3—2. Leg I stubby, tapering distally; tibia and tarsus distinct and not fused to form a single segment. Setation on femur, genu, tibia, and tarsus of leg I: 4—4—5+2 solenidia +1 eupathidium —8+2 solenidia +4 eupathidia; leg II, femur, genu, tibia, and tarsus: 3—2—4+1 solenidion; leg III, femur, genu, tibia, and tarsus: 2—2—4+1 solenidion—6; leg IV, femur, genu, tibia, and tarsus: 2—1—4—6. All claws uncinate and normal. Terminal posterior ventral plate each terminating with 3 pairs of setae as figured. Body 223 μ long by 89 μ wide.

Female ("Phoretomorph"): Dorsal and ventral body chaetotaxy same in number, but stouter than setae for the normal female. This form differs from the normal female by having tarsus and tibia I fused forming a single segment, and by the large claw on this segment. It differs from the "Phoretomorph" of *fusarii* by having normal uncinate claws for tarsi II, III, and IV. Leg I, robust, with strong recurved claw and basal spur. Setation on femur, genu, tibia, and tarsus of leg I: 4—4—8+4 eupathidia; leg II, femur, genu, tibia, and tarsus: 3—2—3+1 solenidion —5+1 solenidion +1 bladelike seta; leg III, femur, genu, tibia, and tarsus: 2—2—4+1 solenidion —5; leg IV, femur, genu, tibia, and tarsus: 2—1—4—6. Body 204 μ long by 102 μ wide.

Male: Gnathosoma small and elongated; dorsally with 2 pairs of simple setae as figured. Venter with 2 pairs of simple setae, sucking apparatus absent; with 1 solenidion. Palpi absent. Chelicerae not visible and may be lacking.

Dorsum: Propodosoma semi-circular anteriorly; wider than long; with 4 pairs short, weakly spiculate setae; 1st pair (anteriorly) not as long as 2nd pair (posteriorly); 3rd pair (laterally) longer than 1st pair; 4th pair (proximally) longest and as figured. Hysterosoma with 3 pairs of setae as figured. Opisthosoma with 2 pairs of weakly spiculate setae anteriorly; medially with a pair of spindle-shaped solenidion; distally with seta and spurlike projection. Venter of propodosoma and hysterosoma as figured. Coxal setal formula: 3—3—3—2. Setation on femur, genu, tibia and tarsus of leg I: 4—4—5+2 solenidia —7+4 eupathidia +2 solenidia; claw as figured; leg II, femur, genu, tibia, and tarsus: 3—2—4+1 solenidion —5+1 solenidion; leg III, femur, genu, tibia, and tarsus: 2—2—4+1 solenidion —6; leg IV, femur, genu, tibia, and tarsus: 2—1—3+1 spine +1 solenidion —2+2 spines +2 strong claws as figured. Body 179 μ long by 96 μ wide.

Larva: Gnathosoma similar to both females; i.e. with 2 pairs of simple setae dorsally and ventrally. Palpi 1 segmented with 1 small solenidion, 1 oblong sucking apparatus; and 1 distal spinelike projection. Chelicerae small and styletlike.
Dorsum: Body oval, broadest in the region of the hysterosoma. Tergites not discernible. Dorsal and ventral setae weakly spiculate as figured. Legs I—II subequal in size and length; each tarsus with 2 claws. Body 89 μ long by 64 μ wide.

Holotype: Female, U.S. National Museum of Natural History No. 3682, laboratory reared with plated *Trichoderma* stock taken from *Pinus taeda* with emerged *Dendroctonus frontalis* ZIMMERMAN and *Ips* sp., 1 July 1974, Rapides Parish, Louisiana by JOHN C. MOSER.

Paratypes: One female, 2 "Phoretomorphs", 1 ♂ and 1 larva with the above data. Where possible paratypes of all stages of this species will be deposited in the institutions as mentioned for *S. fusarii*.

Biology: On July 10, 1974, a single physogastric female of *S. trichoderma* was field collected under loose bark of the same felled tree from which the *S. fusarii* was taken in May.

Surrounding the specimen under bark was a dense concentration of *Trichoderma harzianum* RIFAI (Det. F. A. UECKER, Mycology Laboratory, ARS-USDA, Beltsville, Md.).

This fungus appeared to be readily consumed by the mites in culture plates, although several foreign fungi introduced with the mites could also have been utilized as food. *S. trichoderma* refused to feed on the *Fusarium solani* that was found under bark with *S. fusarii*.

When giving birth, the physogastric females burst open, usually releasing larvae, pupae, or rarely eggs, but never adults. Similarily, ripe females of the morphologically related *Siteroptes* (= *Pygmephorellus*) *bennetti* CROSS and MOSER also disintegrate, but release adults, or pupae that quickly eclose to adults; the mothers never release eggs or larvae.

In contrast, *S. fusarii* and *Pyemotes parviscolyti* CROSS and MOSER both give birth "normally", the former to eggs, the latter to adults.

The progeny of 12 physogastric females were counted every 24 hours in separate culture dishes of *T. harzianum*. Because the bodies of the females so completely disintegrated, identification of the morph of the physogastric mother was not verified.

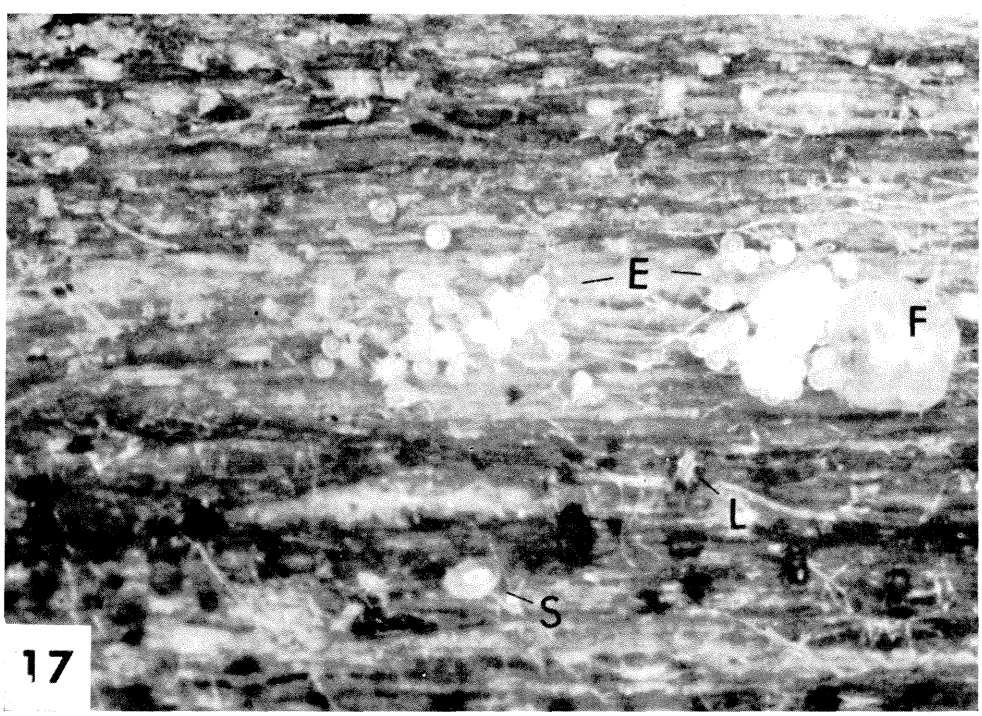
Number of progeny were low compared to other pyemotids. One female gave birth to 1 egg and 13 larvae, another produced 19 larvae, and 10 had 6, 7, 8, 8, 8, 9, 15, 15, 26, and 26 pupae. Possibly, some of these pupae and larvae may have been larvae or eggs when conceived, since the time interval between stages may be less than one day. Further observations made every 24 hours showed that two larvae became pupae within 24 hours, and that 7 pupae eclosed to adults within 1, 1, 1, 2, 2, 2, and 2 days.

In most pyemotids males appear first, but of seven clutches only 2 produced males first. Five of seven mothers produced mixed phoretomorphic and normal females. One mother produced only phoretomorphs; another only normal females.

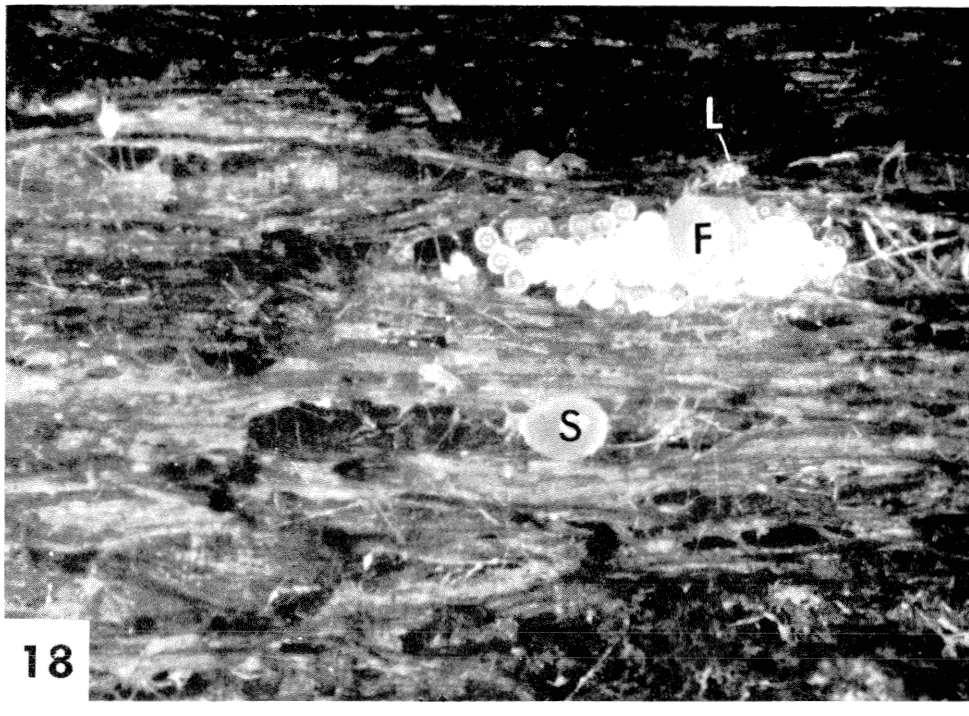
On August 10, the population of *S. trichoderma* in the culture plates of *Trichoderma hartzianum* peaked at about 40 mothers with several hundred progeny of various stages. By Sept. 1, only 5 mothers and their progeny remained. Despite efforts to keep the population vigorous, the last female died Sept. 20. Presumably inbreeding precipitated this drastic decline, since the colony was started with a single physogastric female.

Acknowledgement

We wish to thank Dr. GISELA RACK, Zoologisches Museum, Universität Hamburg (FRG) for reviewing this manuscript.



Figs. 17–19. *Siteroptes fusarii* on inner bark of *Pinus taeda*. The extensive black areas of phloeum are due to *Ceratocystis minor* (F — Physogastric female laying eggs; S — swollen Physogastric female (s); E — eggs; L — larva)



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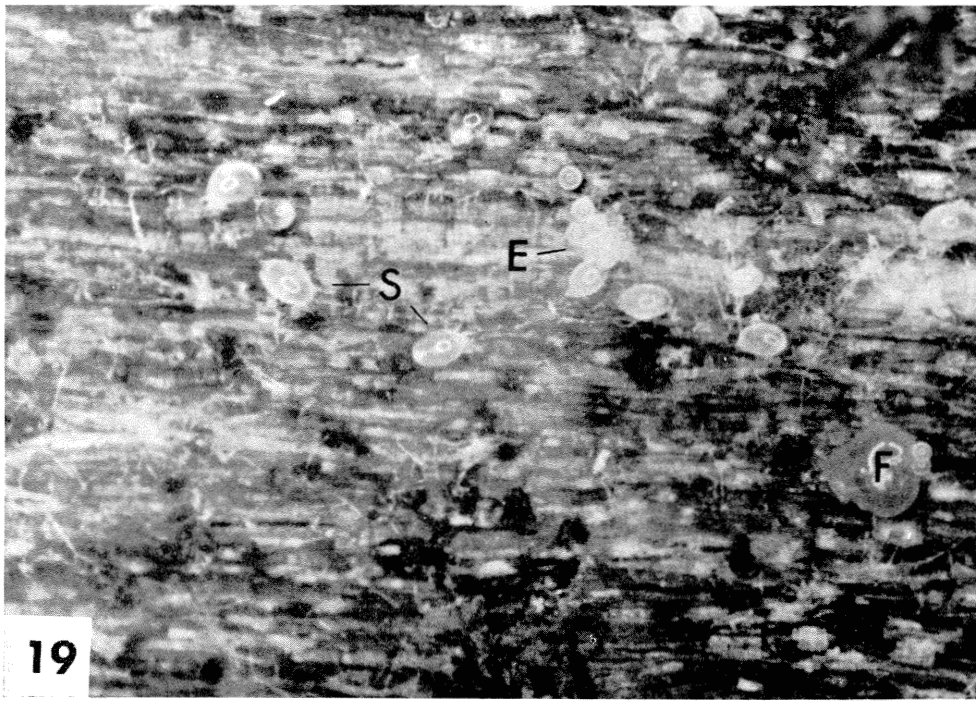

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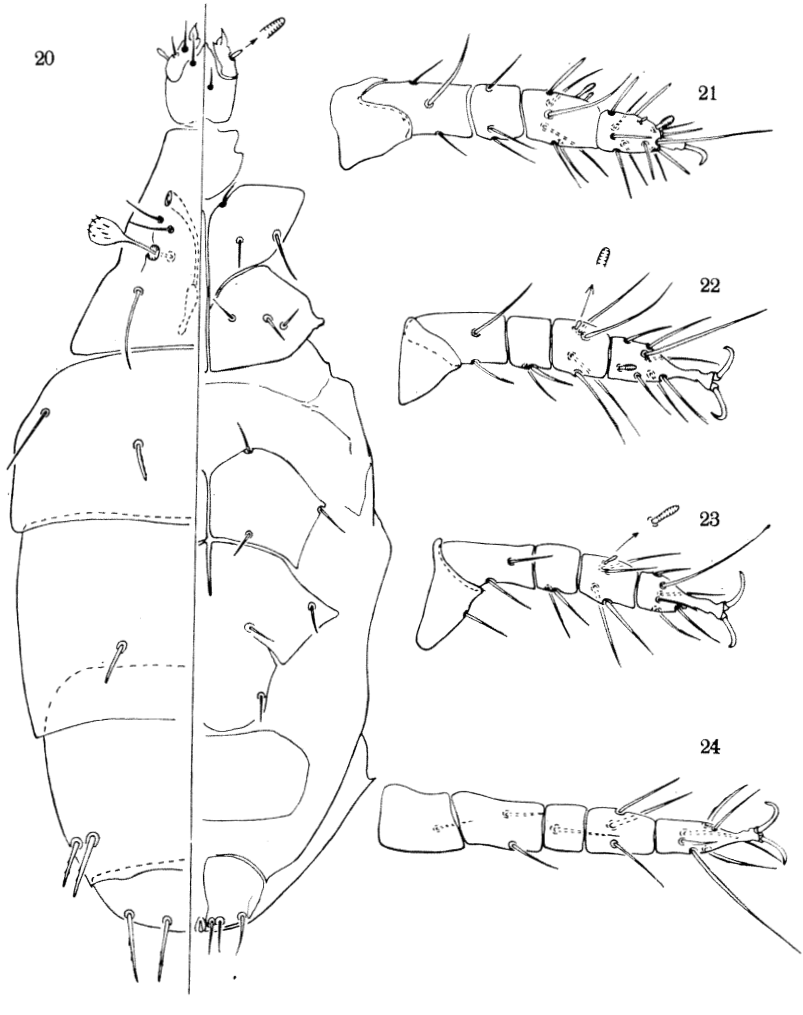
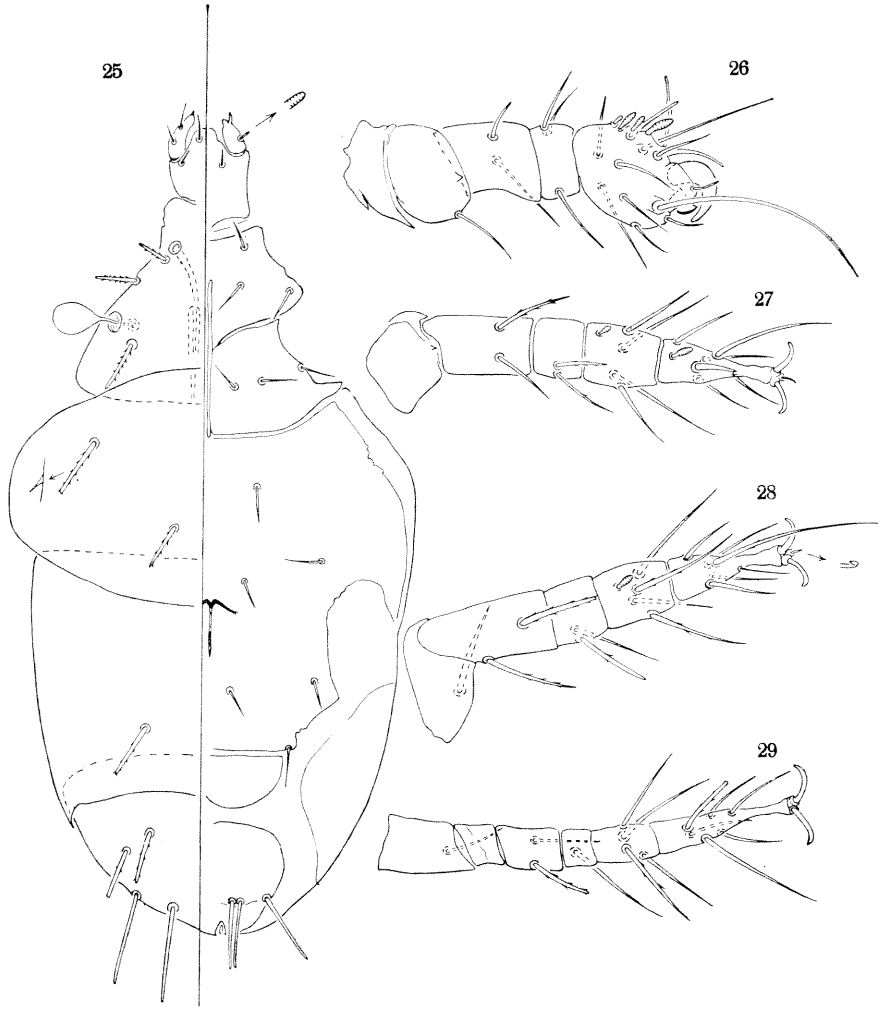
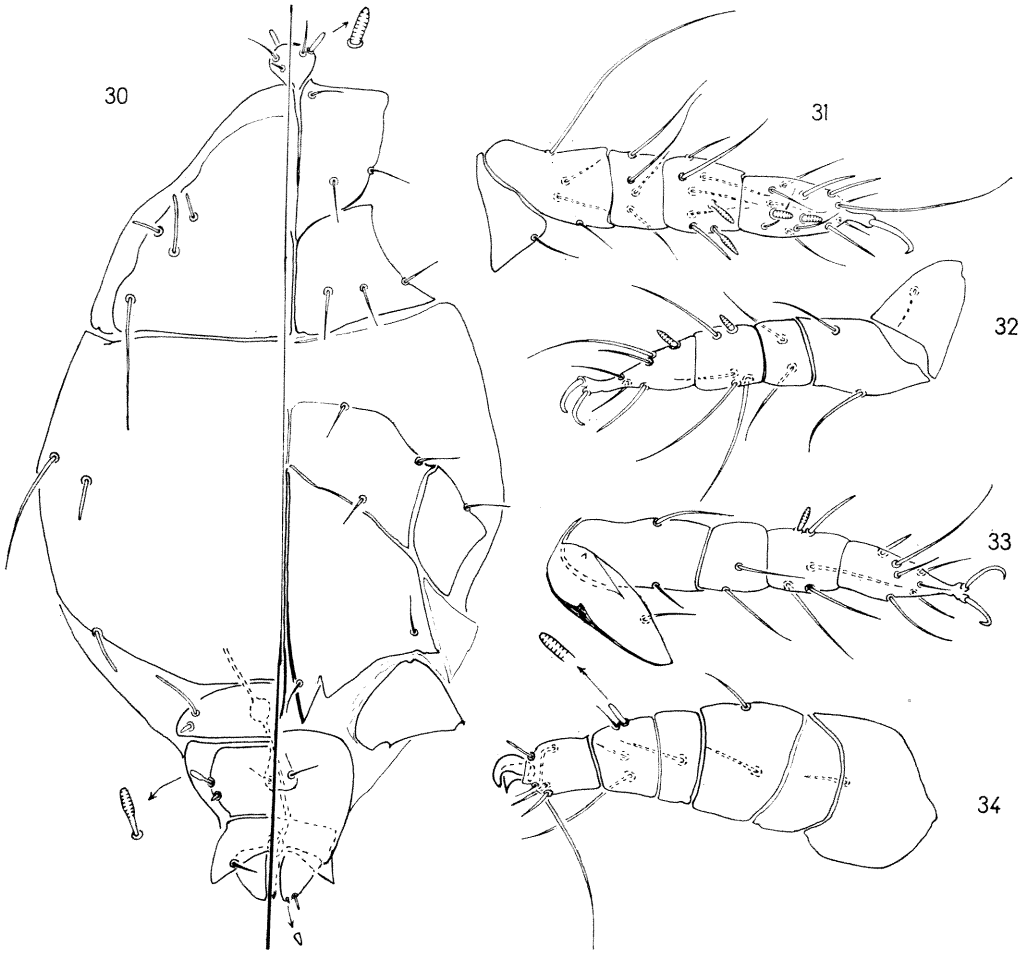


Figs. 20–24. *Siteroptes trichoderma*, new species. Female: Fig. 20. dorsal and ventral view. – Fig. 21. left leg I. – Fig. 22. left leg II. – Fig. 23. left leg III. – Fig. 24. left leg IV



Figs. 25–29. *Siteroptes trichoderma*, new species. Phoretomorph: Fig. 25. dorsal and ventral view. – Fig. 26. left leg I. – Fig. 27. left leg II. – Fig. 28. left leg III. – Fig. 29. left leg IV



Figs. 30–34. *Siteroptes trichoderma*, new species. Male: Fig. 30. dorsal and ventral view. — Fig. 31. left leg I. — Fig. 32. left leg II. — Fig. 33. left leg III. — Fig. 34. left leg IV, larva

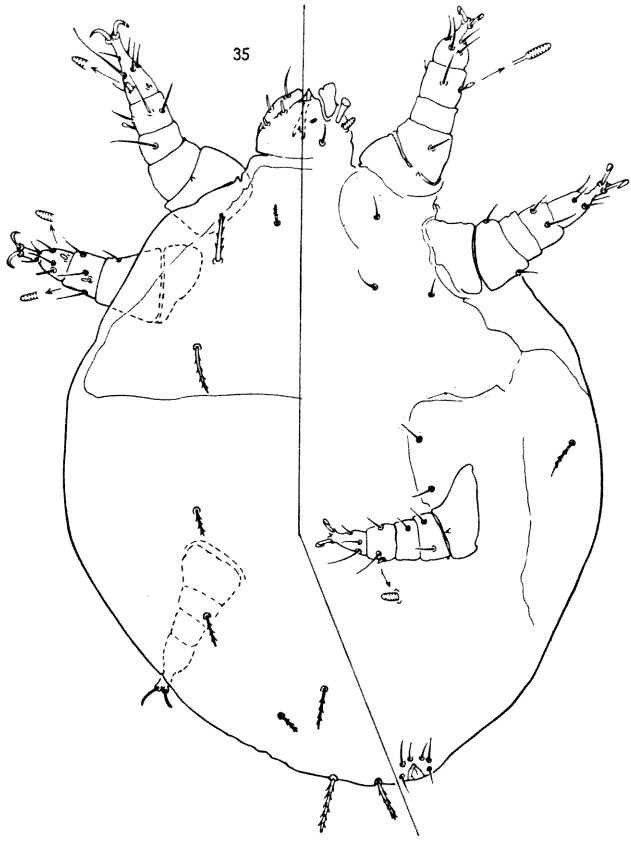


Fig. 35. *Siteroptes trichoderma*, new species. Larva: dorsal and ventral view. Photographs

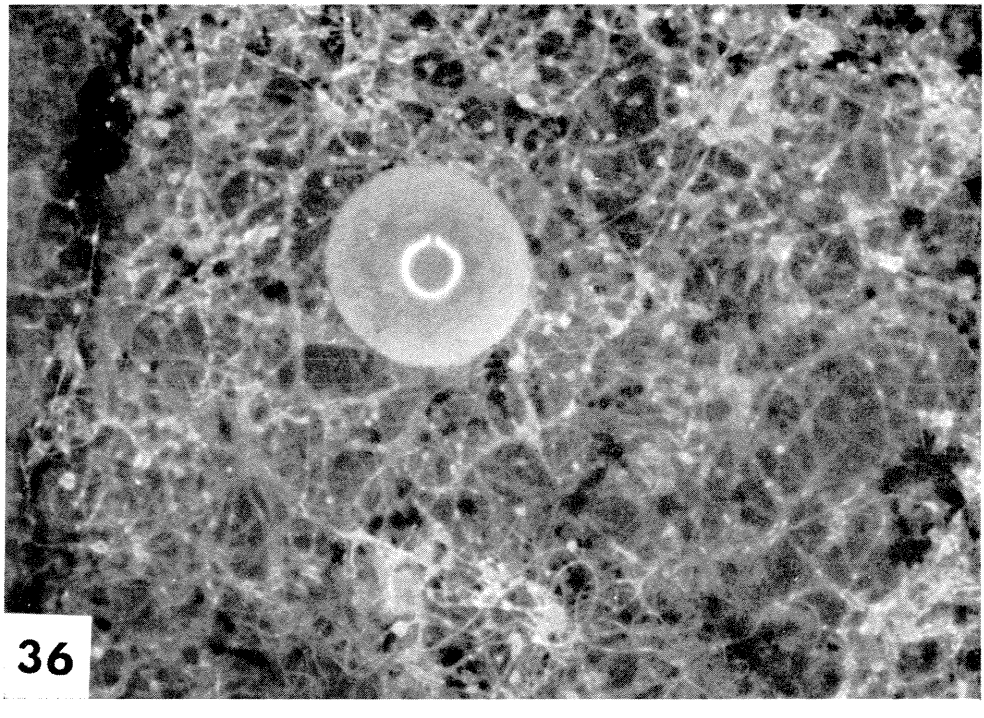


Fig. 36. Fully swollen Physogastric female of *Siteroptes trichoderma* on nutrient agar culture of *Trichoderma hartzianum*.

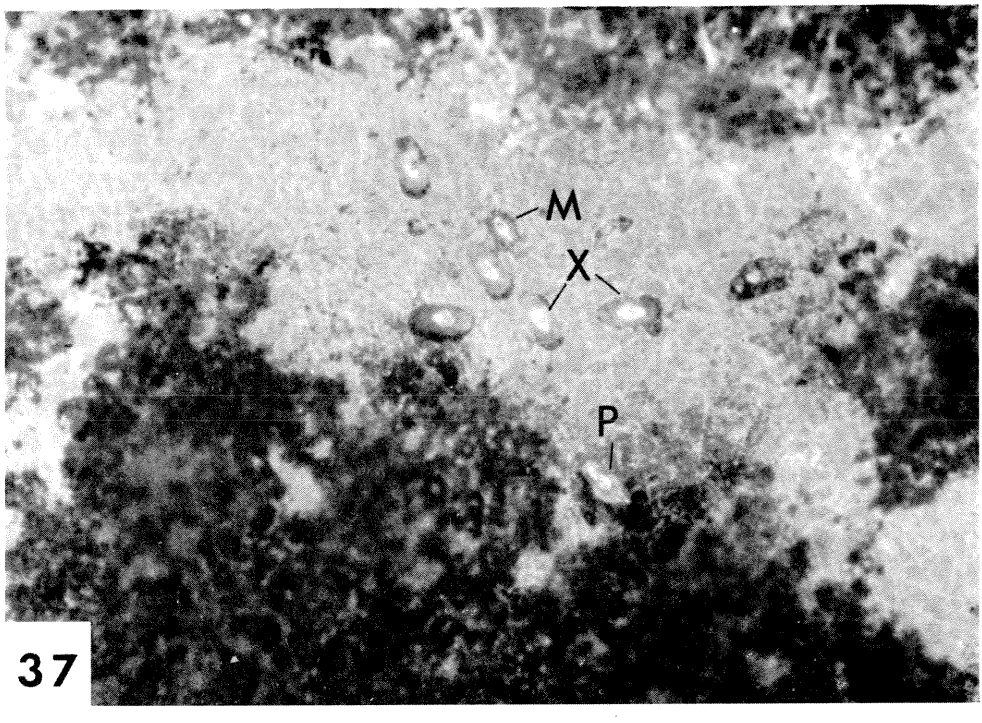


Fig. 37. Clutch of brood from "disintegrated" mother of *Siteroptes trichoderma* on nutrient agar culture o *Trichoderma hartzianum*. (P — Phoretomorphic female (1); M — Male (1); X — pupae (5))

Summary

Two new phoretomorphic species, *Siteroptes fusarii* and *S. trichoderma* are described. The genera *Pediculaster* VITZTHUM, 1931, and *Pygmephorellus* CROSS & MOSER, 1971, are synonymized under the earlier name *Siteroptes* AMERLING, 1861, because the first two names are based on Phoretomorphic forms of species described in *Siteroptes*.

Specimens of the two new species were reared in laboratory culture by the U.S. Forest Service, Pineville, Louisiana. It was discovered that there were two different distinct female forms for each species and are not separate generic taxa as previously assigned.

Zusammenfassung

Zwei neue phoretische Arten, *Siteroptes fusarii* und *S. trichoderma* werden beschrieben. Die Gattungen *Pediculaster* VITZTHUM, 1931, und *Pygmephorellus* CROSS & MOSER, 1971, werden als Synonyme des früheren Namens *Siteroptes* AMERLING, 1861, erklärt; denn die ersten beiden Gattungen sind errichtet auf phoretischen Formen von Arten, die als *Siteroptes* beschrieben sind. Obwohl beide neuen Arten zusammen unter der Rinde von *Pinus taeda* gefunden wurden, unterschied sich ihre Lebensweise beträchtlich, und sie ernährten sich offensichtlich von verschiedenen Pilzen.

Die beiden neuen Arten wurden in Laborkulturen durch den U.S. Service, Pineville, Louisiana gezüchtet. Dabei wurde entdeckt, daß es zwei verschiedene weibliche Formen für jede dieser Arten gibt und daß diese nicht getrennten Gattungen angehören, wie vorher angenommen worden war.

Резюме

Описываются два новых форетических вида, *Siteroptes fusarii* и *S. trichoderma*. Роды *Pediculaster* VITZTHUM, 1931, и *Pygephorellus* CROSS & MOSER, 1971, считаются синонимами бывшего названия *Siteroptes* AMERLING, 1861, так как первые два рода основываются на форетических формах видов, которые описываются как *Siteroptes*. Несмотря на то, что оба вида были совместно найдены под корой *Pinus taeda* их образ жизни различается значительно, и очевидно, они питаются разными грибами. Оба новых вида были выращены в лабораториях U.S. Service, Pineville, Louisiana. При этом было установлено, что у каждого из этих видов имеются две разные формы самок, которые не относятся к разным родам, как предполагалось раньше.

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