MITES ASSOCIATED WITH SOUTHERN PINE BARK BEETLES IN ALLEN PARISH, LOUISIANA

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Contents

Abstract *Can. Ent.* 103: 1775–1798 (1971)

Ninety-six species of mites were associated with the southern pine beetle and allied scolytids in an outbreak area in Allen Parish, La. The complex was evaluated to ascertain which species may be of value as biological control agents.

I. Introduction

One has only to pry the bark from a tree infested with bark beetles to notice large numbers of mites scurrying about. Further examination reveals that many species are involved, and that their ecological roles are diverse. For years forest entomologists have wondered about their impact on bark beetles, and whether any could be used to control these insects.

A current outbreak of the southern pine beetle, *Dendroctonus frontalis* Zimm., in Allen Parish, La., provided an excellent opportunity to catalogue the mites associated with this bark beetle and its allied scolytids (Thatcher, Thesis 1971, unpub.). In addition, some information was obtained on mite biologies and life histories, which should aid in the construction of life tables for the beetle. At present, development of life tables for bark beetles is hampered because mortality

due to mites can only be identified for the egg and early instar stages of the beetle (Berryman 1968).

Lindquist (1969*a*) exhaustively reviewed the literature of mites associated with nearctic Scolytidae including southern pine bark beetles. He reported that mite associates of individual bark-beetle species had not been comprehensively studied, and that mite biologies, with few exceptions, were poorly understood. He further emphasized that, until recently, bark beetle researchers in North America were primarily concerned with curtailing outbreaks by chemical methods. This emphasis has not been altogether fruitful, and there is an apparent need for more economical and longlasting control than chemicals alone can provide. Research leading to a thorough evaluation of naturally occurring biological agents, including mites, is necessary for developing an integrated control system (Chant 1966). In such a system, partially effective natural enemies are augmented by chemical controls only when necessary.

II. Methods and Materials

Mite data were collected from infested loblolly pines (*Pinus taeda* L.) in the West Bay Game Management Area of Allen Parish, La., from 8 February 1966 to 17 April 1967. One beetle-infested tree was felled every 2 weeks in summer and every 4 weeks in winter. Bolts 18 in. long were cut from the trees at 7-ft intervals as high as southern pine beetle broods occurred. During the study, 90 bolts were removed from 31 trees.

The bark on one-third of each 18-in. bolt was inspected within 24 hours after cutting; this environment is referred to in the text as early inner bark (EIB). The remaining 12 in. of bolts were placed in rearing containers in an outdoor insectary until all beetles had emerged (1–2 months in summer, 3–6 months in winter). The inner bark of each bolt, as well as boring dust at the bottom of containers, was carefully examined for the presence of mites. The data from these examinations are recorded in the text as late inner bark (LIB) and boring dust (BD). Developmental stage and relative abundance of each mite species within each bolt varied greatly. Thus, it was necessary to make several examinations of each bolt to obtain a complete picture of mite activity. In all, 239 examinations were made.

Supplemental data were obtained from a number of additional infested bolts collected at irregular intervals from 1964 to 1968.

In addition, the outside bark of a few uninfested trees was examined, and beetles captured in flight in the field were inspected for phoretic mites. The data were recorded on 80-column punch cards and processed by computer.

III. Taxonomic Results

Ninety-six species of mites were associated with scolytids; 58 were found in the bolt study and 38 in supplemental inspections. Specialists who determined the mite species are listed after family names or higher categories.

CLASS ACARI

Order PARASITIFORMES

Suborder MESOSTIGMATA

Cohort Liroaspina

Uropodellidae—det. Camin

**Uropodella laciniata* Berlese 1888

Cohort Gamasina

Ameroseiidae—det. Lindquist
**Ameroseius longitrichus* Hirschmann 1963
Ascidae—det. Lindquist
**Blattisocius keegani* Fox 1947
**Gamasellodes rectiventris* Lindquist 1971
**Lasioseius corticeus* Lindquist 1971
* " *dentatus* (Fox 1946) (= *scapulatus* Kennett 1958)
" *epicriodopsis* DeLeon 1963
* " *neometes* McGraw and Farrier 1969
Melichares n. sp. nr. *monochami* (Lindquist 1962)
**Proctogastrolaelaps libris* McGraw and Farrier 1969
Proctolaelaps bickleyi (Bram 1956)
* " *dendroctoni* Lindquist and Hunter 1965
* " *fiseri* Samsinak 1960
* " *hystricoides* Lindquist and Hunter 1965
" *hystrix* (Vitzthum 1923)
" *xyloteri* Samsinak 1960
Digamasellidae—det. Hurlbutt
**Digamasellus brachypoda* Hurlbutt 1967
* " *isodentatus* Hurlbutt 1967
* " *neocornutus* Hurlbutt 1967
* " *neodisetus* Hurlbutt 1967
" *quadrisetosimilis* (Hirschmann 1960)
* " *rotoni* Hurlbutt 1967
* " *varipunctatus* Hurlbutt 1967
" *quadritorus* Robillard 1971
**Longoseius cuniculus* Chant 1961
Laelapidae—det. Hunter
**Androlaelaps casalis* (Berlese 1887)
**Hypoaspis disjuncta* Hunter and Yeh 1969
" *krantzi* Hunter 1967
**Pseudoparasitus thatcheri* Hunter and Moser 1968
Macrochelidae—det. Krantz
**Macrocheles boudreauxi* Krantz 1965
Cyrtolaelapidae—det. Ryke
**Gamasiphis* sp.
Parasitidae—det. Farrier
**Eugamasus lyriformis* McGraw and Farrier 1969
Phytoseiidae—det. Chant
**Amblyseius guatemalensis* (Chant 1959)
Podocinidae—det. Wong
**Podocinum* n. sp. nr. *pacificum* Berlese 1896
Veigaiidae—det. Farrier
**Gamasolaelaps subcorticalis* McGraw and Farrier 1969

Cohort Cercomegistina

Cercomegistidae—det. Kinn
**Cercoleipus coelonotus* Kinn 1970

Cohort Antennophorina

Celaenopsidae—det. Kinn
**Pleuronectocelaeno drymoecetes* Kinn 1968

Cohort Uropodina

Uropodidae—det. Ainscough
*Fuscuropoda americana n. sp.[1]
*Leiodinychus australis n. sp.[1]
* " hirsutus n. sp.[1]
*Nenteria orri n. sp.[1]
Oodinychus sp.
*Urodinychus lamellosus n. sp.[1]
* " denticulatus n. sp.[1]
Uropodidae sp.

Order ACARIFORMES

Suborder ACARIDEI—det. Woodring

Tyroglyphidae
*Glycyphagus n. sp.
*Histiogaster arborsignis Woodring 1963
* " rotundus Woodring 1966
*Tyrophagus putrescentiae (Schrank 1781)

Anoetidae
*Anoetus conjuncta Woodring and Moser 1970
* " insolita Woodring and Moser 1970
" media Woodring and Moser 1970
* " sordida Woodring and Moser 1970
* " varia Woodring and Moser 1970

Suborder TARSONEMINI

Pyemotidae—det. Cross
*Bakerdania sellnicki (Krczal 1958)
Pyemotes parviscolyti Cross and Moser 1971
*Pygmephorus bennetti Cross and Moser 1971

Tarsonemidae—det. Lindquist and Smiley
*Heterotarsonemus lindquisti Smiley 1969
*Iponemus calligraphi calligraphi Lindquist 1969*b*
* " confusus oriens Lindquist 1969*b*
" truncatus eurus Lindquist 1969*b*
Tarsonemus fusarii Cooreman 1941 (= *moseri* Smiley 1967) (det. Cooreman)
ips Lindquist 1969*c*
subcorticalis Lindquist 1969*c*

Suborder ELEUTHERENGONA

Bdellidae—det. Atyeo
Cyta latirostris (Hermann 1804)
Spinibdella depressa (Ewing 1909)

[1]There is no intention of describing these as new species in this work. The ecological data that follow for each of these species are not to be interpreted as purporting to give characters differentiating the taxa in the sense of making names available according to the International Code of Zoological Nomenclature. These species will be described as new by Dr. W. Hirschmann in his periodical, *Acarologie*, in 1972.

Cheyletidae—det. Smiley
**Acarocheyla impolita* Smiley and Moser 1970
" *virginiensis* (Baker 1949)
Eutogenes vicinus Summers and Price 1970
Paracheyletia wellsi (Baker 1949)
Prosocheyla acanthus Smiley and Moser 1970
Cryptognathidae—det. Smiley
Cryptognathus barrasi Smiley and Moser 1968
Cunaxidae—det. Baker
Cunaxa capreolus (Berlese 1890)
* " *taurus* (Kramer 1881)
Cunaxoides ?andrei Baker and Hoffmann 1949
Ereynetidae—det. Hunter
**Ereynetoides scutulis* Hunter 1964
Neophyllobiidae—det. Smiley
**Neophyllobius lorioi* Smiley and Moser 1968
Tetranychidae—det. Boudreaux
Bryobia sp. (*praetiosa* complex)
Raphignathidae—det. Smiley
Neoraphignathus howei Smiley and Moser 1968
Eupodidae—det. Smiley
**Eupodes* sp.
Eupalopsellidae—det. Smiley
Paraupalopis hodgesi Smiley and Moser 1968
Tarsocheylidae—det. Smiley
Hoplocheylus pickardi Smiley and Moser 1968
Stigmaeidae—det. Smiley
Ledermulleria segnis Koch 1836
Tydeidae—det. Baker
Microtydeus n. sp.
Tydeus n. sp.
Erythraeidae—det. Newell
Leptus n. sp.
Trombidiidae—det. Newell
Neotrombidium n. sp.

Suborder ORIBATEI—det. Woodring, Woolley

Euphthiracaridae
Mesotritia sp.
Neoliodidae
Liodes sp.
Cymbaeremaeidae
Scapheremaeus palustris (Sellnick 1928)
Pelopidae
Eupelops sp.
Ceratozetidae
Trichoribates sp.
Galumnidae
Trichogalumna sp.
Oribatulidae – Scheloribatidae
**Paraleius* n. sp.
Scheloribates sp.
Haplozetidae
Peloribates sp.

*Bolt study.

IV. Ecological Results

The ecological information for each species is summarized under 11 headings (A–K). Because of the abbreviated style of these descriptions, each of the headings is explained in detail prior to the descriptions. From these headings conclusions can be drawn about the impact of mites as a whole.

A. *Relative frequency.* This term denotes commonness of a mite species between rather than within trees; the latter is termed relative abundance, and discussed later. Early in the study it became obvious that some mites were present in practically every tree sampled, whereas others were observed only in occasional trees. *Ereynetoides scutulis,* for example, was found in all 31 trees of the routine bolt study and therefore had a relative frequency of 100%; *Uropodella laciniata* was seen only once, and thus had a relative frequency of 3%.

Relative frequencies of mite species observed in supplementary observations are given as figures in parentheses.

B. *Seasonal distribution.* Numbers 1–12 indicate the months when mites were present in the field in that they give the times when samples were collected. These data do not necessarily reflect the month when mites entered the tree, since bolts were cut 2–8 weeks after beetle attack.

C. *Relative abundance.* The abundance of individuals within trees was classed as rare, infrequent, common, and abundant. Rare indicates that one or two individuals were in any bolt (or sample), infrequent that the species was observed here and there, common that individuals were generally found, and abundant that bolts were literally crawling with the mite. EIB (early inner bark), LIB (late inner bark), and BD (boring dust) indicate when and where samples were examined. See Methods and Materials for further clarification of EIB, etc.

D. *Bark moisture and tightness.* Recorded here are moisture conditions of the boring dust or bark, and bark tightness when the mites were common or abundant and all instars were present. Excluded are instances where only one instar (usually the phoretic) was present, even though the species was common or abundant. Phoretic stages were usually resistant to adverse conditions, and hence did not reflect the optimum moisture environments.

E. *Height distribution.* In the routine bolt study, the sections were always cut at heights of 17 and 34 ft, and at 51 and 68 ft when beetle infestations were that high. The representative heights were noted if the mite was found at least once at that level. Some records were also taken from supplemental bolt material.

F. *Mites associated only with* Dendroctonus frontalis. All 31 sample trees were infested with *D. frontalis,* usually one or more cerambycid species (primarily *Neacanthocinus obsoletus* (Olivier) and *Monochamus* spp.) and numerous other non-scolytid associates. The middle or upper portions of 23 of them were also occupied by one or more *Ips* species; and the basal portions of some trees were attacked by *D. terebrans* Olivier and ambrosia beetles, *Platypus* spp. Of the 90 bolts examined, 47 contained *D. frontalis* and associates only, and 43 had mixed scolytid populations.

To express the possibility that a mite species may be associated with bark beetles other than *D. frontalis,* the number of times the mite was found in the 47 *D. frontalis* bolts is recorded and followed by the number of times it was observed in the 43 bolts infested by mixed scolytids.

Presence of a mite in a bolt infested with *D. frontalis* or *Ips* spp. does not necessarily mean that it was carried to the inner bark by a scolytid. Many other

insect associates such as the tenebrionid *Corticeus glaber* could have transported it, or a mite that normally inhabits the outer bark could have crawled through an opening.

G. *Mites associated with other bark beetle species.* Evidence of the occurrence of the mite species with *D. frontalis*, cerambycids, and other bark beetles and with exotic beetle species was obtained from the current study, from cooperators, and from the literature. Data from the three sources is separated by semicolons. Our data are given first without reference to collector; information from material sent is inserted next, followed by the cooperator's name; and that from literature has the author's name and reference date after it. Since more than one beetle species occurred in many sample bolts, the listing implies only that the beetle was present when the mite was found. *D. frontalis* is omitted in listings because all mites described were associated with it.

To conserve space, the scientific names of the common southern pine scolytids are abbreviated:

Dendroctonus frontalis Zimmerman	*D.f.*	*Pityophthorus annectans* LeConte	*P.a.*
Dendroctonus terebrans (Olivier)	*D.t.*	*Pityophthorus bisulcatus* Eichhoff	*P.b.*
Ips avulsus (Eichhoff)	*I.a.*	*Crypturgus alutaceus* E. Schwartz	*C.a.*
Ips calligraphus (Germar)	*I.c.*	*Gnathotrichus materiarius* (Fitch)	*G.m.*
Ips grandicollis Eichhoff	*I.g.*	*Trypodendron scabricollis* LeConte	*T.s.*

H. *Alternate niches.* Some mites are truly subcortical, whereas others may sometimes or usually inhabit other niches. Field and literature evidence that a species uses niches other than subcortical is listed. The most common niche was the outer bark. The letter "u" indicates that the species was found in trees and bolts that had not been attacked by bark beetles; "(u)" indicates species that occurred on or under bark scales of infested material.

I. *Phoresy.* Mites may be carried by the beetle very briefly, sometimes for a single ride. Once the beetle reaches the host, the mite may drop or crawl off and have little to do with the beetle until it or its progeny flies to another tree; or the mite may ride another insect associated with the niche.

Mites taken from beetles as they emerged in rearing units are listed as "lab." Mites collected from flying beetles in the field are referred to as "field." Mites collected in the field may provide better evidence of phoresy.

J. *Feeding habits.* This category includes observations and literature records of feeding habits and pertinent rearing notes.

K. *Geographical distribution.* Our collections from states other than Louisiana are cited first. Localities with collectors' names in parentheses and no dates, were obtained from specimens sent by cooperators. Localities followed by author's name and date refer to published reports.

Uropodella laciniata

A, 3%. **B**, 4. **C**, rare once in BD. **E**, 17 ft. **F**, 0/1. **G**, *I.a.*, *I.c.* **H**, tree holes (Camin 1955). **K**, Honduras (R. Wilkinson); Western Hemisphere (Camin 1955).

Ameroseius longitrichus

A, 6%. **B**, 4, 5, 9. **C**, infrequent twice and common twice in BD, common once in LIB. **D**, damp BD, wet loose LIB. **E**, 17, 34, 51 ft. **F**, 0/4. **G**, *I.a.*, *I.c.*

Blattisocius keegani

A, 6%. **B**, 3, 5, 8. **C**, rare twice in BD. **E**, 17, 68 ft. **F**, 1/1, also under bark with *D.f.* mass-reared according to the method of Clark and Osgood (1964). **H**, common in stored food and grain, and in insect cultures (Chant 1963). **I**, field, 10 females under wing of single *Xylotrechus sagittatus* (Germar). **J**, feeds readily on eggs of several beetles and mites that

infest stored products but not those of *Tyrophagus putrescentiae* (Barker 1967). **K**, cosmopolitan (Chant 1963).

Gamasellodes rectiventris

A, 6%. **B**, 4, 8. **C**, rare twice in BD. **E**, 34, 51 ft. **F**, 1/1. **G**, *l.a.*, *l.g.*

Lasioseius corticeus

A, 32%. **B**, all except 6, 10.

C,	Rare	Inf.	Com.	Abn.
EIB	—	—	—	—
BD	4	6	3	2
LIB	3	2	1	—

D, dry and damp BD, damp LIB. **E**, 17, 34, 51 ft. **F**, 9/7. **G**, *l.a.*, *l.c.*, *l.g.* **I**, lab, 4 females on single *D.f.*

L. dentatus

A, 3%. **B**, 11. **C**, rare once in BD. **E**, 17 ft. **F**, 1/10. **H**, occurs in a wide variety of habitats (Chant 1963). **K**, California and Central America (Chant 1963).

L. epicriodopsis

A, (1). **B**, 4. **H**, under bark of *Liriodendron tulipifera* L. (DeLeon 1963).

L. neometes

A, 3%. **B**, 2, 10. **C**, rare once in BD. **E**, 51 ft. **F**, 0/1. **G**, *l.a.* **H**, u.

Melichares n. sp. nr. *monochami*

A, (2). **B**, 8, 9. **I**, lab, 20 females under elytra of *Monochamus titillator* (F.) (Lindquist 1970*b*).

Proctogastrolaelaps libris

A, 19%. **B**, all except 5, 12. **C**, rare 5 times in BD and once in LIB. **E**, 17, 34, 51, 68 ft. **F**, 2/3. **G**, *l.a.* **I**, lab, females on elytra *D.f.* **K**, Mississippi, Texas; Virginia, N. Carolina (McGraw and Farrier 1969); Colorado (Woolley); Mexico (Lindquist).

Proctolaelaps bickleyi

A, (1). **B**, 1. **G**, *l.a.*; under elm bark (Lindquist and Hunter 1965). **H**, found on leaves and stems of great variety of plants to rotten vegetables and mouldy wheat (Lindquist and Hunter 1965). **J**, may feed on nematodes (Lindquist and Hunter 1965). **K**, cosmopolitan (Lindquist and Hunter 1965).

P. dendroctoni

A, 87%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD				—
LIB				—

D, damp loose EIB, dry and damp BD, wet loose LIB. **E**, 17, 34, 51, 68 ft. **F**, 29/22. **G**, *D.t.*, *l.a.*, *l.c.*, *l.g.* **I**, lab, as many as 20 females seen numerous times on body of *Corticeus glaber*, several females each under elytra of *Cylistix attenuata* LeConte, *C. cylindrica* (Paykull), *Alonium ferruginium* Zimmerman, and *Thanasimus dubius* (F.). Hence it appears that *P. dendroctoni* is usually or solely phoretic on the beetle associates. **J**, female seen feeding on tritonymph of *Histiogaster arborsignis*. *P. dendroctoni* is very similar in structure to *P. eccoptogasteris* Vitzthum, a European predator of bark beetles. Similar gnathosomal structures may indicate similar feeding habits (Lindquist and Hunter 1965). **K**, Mississippi, Texas; Alabama (E. Carter); Virginia (R. Beckwith); N. Carolina, Kentucky, Wyoming (McGraw and Farrier 1969); Honduras (R. Wilkinson).

P. fiseri

A, 13%. **B**, 3, 4, 5, 8, 9, 11, 12. **C**, infrequent once in EIB, rare once, infrequent once, and common twice in BD, common once in LIB. **D**, damp BD, under damp LIB. **E**, 17, 34, 51 ft. **F**, 0/5. **G**, *l.a.*, *l.c.* Associated with *Dryocoetes*, *Ernoporus*, *Hylurgops*, *Myelophilus*,

Pityokteines, and *Spondylis* (Westerboer 1963). **I**, lab, females on elytra *I.c.* and *G.m.* On elytral declivity of *Ips typographus* (L.) (Hirschmann and Rühm 1953). **J**, "feeds on nematodes in galleries" (Hirschmann and Rühm 1953). **K**, North America and Europe (Lindquist and Hunter 1965).

P. hystricoides

A, 39%. **B**, all except 1, 2, 3.

C,	Rare	Inf.	Com.	Abn.
EIB	1	1	—	—
BD	4	5	5	2
LIB	3	4	3	3

D, dry and damp BD. Under dry and damp loose LIB. **E**, 17, 34, 51 ft. **F**, 6/13. **G**, *I.a.*, *I.c.*, *Scolytus multistriatus* (Marsham), *Dendroctonus simplex* LeConte (R. Reed), *D. pseudotsugae* Hopkins (M. Furniss), *Orthotomicus caelatus* Eichhoff, *Dendroctonus monticolae* Hopkins, *Trypodendron rufitarsis* (Kirby), *Ips calligraphus* (Lindquist and Hunter 1965). It appears to occur with all pine bark beetles, and perhaps with a great many from other trees. **H**, birch bracket fungus (Pielou and Verma 1968). **I**, lab, females on elytra of *G.m.*, *Plegaderus transversus* Say, and *Corticeus glaber*. **K**, Ohio, Mississippi; Idaho (M. Furniss); N. Carolina and Virginia (R. Beckwith); Mexico (A. Martell); Honduras (R. Wilkinson); Ontario, California, Georgia (Lindquist and Hunter 1965); Quebec (Pielou and Verma 1968). The species thus occurs throughout North and Central America, at least.

P. hystrix

A, (10). **B**, 3, 5, 9, 10, 11. **E**, stumps only. **G**, *D.t.*, *Dendroctonus valens* LeConte, *D. micans* (Kugelann), *Hylastes ater* (Paykull), *Dryocoetes autographis* (Ratzeburg) (Lindquist and Hunter 1965). Thus the species seems to be mainly associated with the large *Dendroctonus* or "turpentine beetles." **I**, field, *I.c.*, on elytra of *D.t.* **K**, Mississippi, Georgia, California, British Columbia, Austria, Poland (Lindquist and Hunter 1965). Thus the range seems to coincide with that of the turpentine beetles in North America and Europe.

P. xyloteri

A, (2). **B**, 1, 12. **G**, *Trypodendron lineatum* (A. G. Olivier) (Novak 1960). **I**, lab, on body of *G.m.* **J**, lays eggs in newly drilled tunnels of *T. lineatum* (Novak 1960). **K**, Texas; Europe (Novak 1960).

Digamasellus brachypoda

A, 3%. **B**, 5, 6. **C**, rare twice in LIB. **E**, 17, 34 ft. **F**, 0/2. **G**, *I.a.*

D. isodentatus

A, 35%. **B**, all except 3, 4.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD				—
LIB			4	—

D, damp BD, under dry and damp loose LIB. **E**, 17, 34, 51 ft. **F**, 4/15. **G**, *I.a.*, *I.c.*, *I.g.*, *T.s.*, *G.m.*; under bark with *Scolytus multistriatus* (Hurlbutt 1967). **I**, lab, as many as 8 deutonymphs under elytra of *Monochamus titillator* and 10 under elytra of *M. carolinensis* (Olivier). **K**, Mississippi, Texas; N. Carolina (McGraw and Farrier 1969); Ohio (Hurlbutt 1967).

D. neocornutus

A, 35%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB	3	1	2	—
BD	—	5	1	—
LIB	3	1	4	—

D, under damp loose EIB, damp BD, under dry and damp loose LIB. **E**, 17, 34, 51 ft. **F**, 6/9. **G**, *D.t.*, *I.a.*, *I.c.*, *I.g.* **I**, lab, deutonymphs on *D.f.*, *Ips* sp., *Corticeus glaber*, *Tenebroides collaris* (Sturm), and *Cylistix attenuata*. **K**, Alabama, Mississippi, Texas; Virginia (Hurlbutt 1967); N. Carolina (McGraw and Farrier 1969).

D. neodisetus

A, 100%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD				
LIB				

D, under damp loose EIB, dry and damp BD, under dry loose LIB. **E**, stumps, 17, 34, 51, 68 ft. **F**, 35/33. **G**, *I.a., I.c., I.g., D.t., D. brevicomis* LeConte, *D. simplex* (Hurlbutt 1967). **I**, lab, deutonymphs on bodies of *D.f., I.a., G.m., Pissodes nemorensis* Germar, *Alonium ferruginium* (as many as 53 deutonymphs), *Cylistix attenuata, Trypodendron scabricollis,* and *Dendrosoter sulcatus* Muesebeck, under elytra of *Neacanthocinus obsoletus* and *Thanasimus dubius*; field, under elytra of *Bupresta lineata* (Fab.), *Hylobius pales* Boheman, *Temnochila virescens* (F.), and under wings of *Largus succinctus* (L.). **K**, Virginia, California, Mississippi, Texas, Alberta, Honduras (Hurlbutt 1967); N. Carolina, Tennessee (McGraw and Farrier 1969).

D. quadrisetosimilis

A, (1). **B**, 8. **G**, *I.a., I.c.* **I**, lab, 6 deutonymphs under elytra of *I.a.*, 3 deutonymphs under elytra of *Pityokteines minutus* E. Schwartz (Hurlbutt 1967). **K**, Alberta (Hurlbutt 1967); Germany (Hirschmann 1960).

D. rotoni

A, 6%. **B**, 4, 8. **C**, rare twice in BD, abundant once in LIB. **D**, under wet loose LIB. **E**, 17 ft. **F**, 1/1. **G**, *I.a., I.c.*; *Dendroctonus pseudotsugae* (Hurlbutt 1967). **K**, Texas, Idaho (Hurlbutt 1967); N. Carolina (McGraw and Farrier 1969).

D. varipunctatus

A, 13%. **B**, 4, 5, 7, 8, 12. **C**, rare once in EIB and once in LIB, infrequent once and common once in BD. **E**, 17, 34, 51 ft. **F**, 2/2. **G**, *I.a., I.c., T.s., G.m.* **I**, lab, deutonymphs on body of *Corticeus glaber.* **K**, Idaho (Hurlbutt 1967); N. Carolina (McGraw and Farrier 1969).

D. quadritorus

A, (1). **B**, 6. **G**, *I.a., I.g.*

Longoseius cuniculus

A, 6%. **B**, 4, 6, 8, 9. **C**, rare twice in BD and LIB. **E**, 17, 34, 51 ft. **F**, 2/1. **G**, *I.a., I.c., I.g.* **I**, lab, deutonymphs phoretic on bodies of *D.f., I.a., I.c., Monochamus titillator,* and *Heydenia unica* Cook and Davis; field, numerous deutonymphs under wings of *Neacanthocinus obsoletus, Monochamus carolinensis,* and *Thanasimus dubius*; a few adults and hundreds of deutonymphs with larvae of *I.c.* under loose inner bark of longleaf pine (Lindquist 1970*b*). Deutonymphs (not females) from under elytra of *Monochamus notatus* (Drury) and *M. scutellatus* (Say) (Soper and Olson 1963). **K**, Mississippi, Texas; Maine (Soper and Olson 1963); N. Carolina, Virginia (McGraw and Farrier 1969). NOTE: Contrary to previous literature, *all* phoretic specimens (including those of original description) were deutonymphs. The only known adults were collected under the loose bark with *I.c.* (see above).

Androlaelaps casalis

A, 3%. **B**, 3, 9, 12. **C**, rare once in BD. **E**, 51 ft. **F**, 0/1. **G**, *I.a., I.c., I.g.* **H**, wide variety of habitats including stored grain and nests of mammals, birds, and bumblebees (Hughes 1961), and birch bracket fungus (Pielou and Verma 1968). **J**, feeds on acarid and glycyphagid mites (Sinha and Wallace 1966), brewer's yeast, *Blattisocius keegani,* young larvae of *Tribolium confusum* Duval (Barker 1968). **K**, cosmopolitan (Hughes 1961).

Hypoaspis disjuncta

A, 3%. **B**, 7. **C**, infrequent once in BD. **E**, 17 ft. **F**, 1/0. **H**, associated with *Popilis disjuncta* (Illiger) in rotting wood (Hunter and Yeh 1969). **J**, may feed on wood fungi (Hunter and Yeh 1969). **K**, Georgia (Hunter and Yeh 1969).

H. krantzi

A, (3). **B**, 6, 9, 11. **G**, *I.c.* (Hunter 1967).

Pseudoparasitus thatcheri

A, 19%. **B**, 5, 6, 7, 10. **C**, rare once in BD and LIB, infrequent 4 times and common once in BD. **D**, dry BD. **E**, 17, 34, 51 ft. **F**, 2/5. **G**, *I.a., I.g.* (Hunter and Moser 1968). **K**, N. Carolina and Virginia (McGraw and Farrier 1969).

Macrocheles boudreauxi

A, 74%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD				—
LIB				—

D, damp EIB, damp BD. **E**, 17, 34, 51 ft. **F**, 14/20. **G**, *D.t., I.a., I.c., I.g., T.s., G.m.* **I**, lab, females on bodies of *D.f.*, as many as 15 on *I.c.*, 8 on *I.g.*, 51 on *Pissodes nemorensis*, and on *Cylistix attenuata*; field, on elytra of *D.t.* **J**, larvae do not feed, but other stages fed on digamasellids and cheyletids and probably bark beetle larvae as well as house fly eggs, but not tetranychid mites. Fertilized eggs became females, unfertilized eggs, males (Hse 1964, unpub.). **K**, Alabama, Mississippi, Texas; Virginia (R. Beckwith); N. Carolina (McGraw and Farrier 1969). Although frequent in southern pines, it appears to be absent in other areas of North America.

Gamasiphis sp.

A, 3%. **B**, 9, 12. **C**, rare in BD. **E**, 17 ft. **F**, 0/1. **G**, *I.c.*

Eugamasus lyriformis

A, 55%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD				1
LIB				—

D, dry and damp BD, under dry and damp loose LIB. **E**, 17, 34, 51, 68 ft. **F**, 9/18. **G**, *D.t., I.a., I.c., I.g., Dendroctonus simplex* (R. Reid), *D. pseudotsugae* (M. Furniss), *Ips confusus* (LeConte) (D. Kinn). **I**, lab, deutonymphs on bodies of *D.f., G.m., Corticeus glaber*, and *Cylistix attenuata*; field, body of *D.t.*; *D. simplex* (R. Reid). **J**, adults fed on larvae of *Fuscuropoda americana*. Larvae fed on nematodes, at least, and other stages fed on laboratory reared *Digamasellus*, cheyletids, uropodids, *Macrocheles boudreauxi, Histiogaster arborsignis*, and beetle larvae. Adults were cannibalistic on larvae and protonymphs (Hse 1964, unpub.). **K**, Mississippi, Texas; Arkansas (I. Brown); Alberta (R. Reid); California (D. Kinn); Idaho (M. Furniss); Virginia, N. Carolina, British Columbia, Colorado, Honduras, Mexico, S. Dakota, Tennessee, Wyoming (McGraw and Farrier 1969).

Amblyseius guatemalensis

A, 13%. **B**, 3, 4, 5, 6, 12. **C**, rare 3 times and infrequent once in BD. **E**, 17, 34, 51 ft. **F**, 2/2. **G**, *I.a., I.g.* **H**, on leaves of mango, avocado, *Podacarpus, Xanthosoma saggitifolium* Schott, and orchid (Chant and Baker 1965). **K**, Guatemala, Nicaragua, Costa Rica (Chant and Baker 1965).

Podocinum n. sp. nr. *pacificum*

A, 3%. **B**, 1, 4. **C**, rare once in BD and infrequent once in LIB. **E**, 17 ft. **F**, 1/0. **G**, *I.a., I.g.* **H**, (u).

Gamasolaelaps subcorticalis

A, 13%. **B**, 4, 5, 9, 10. **C**, rare once, infrequent once and common twice in BD, rare once and abundant once in LIB. **D**, dry and damp BD, under damp LIB. **F**, 2/4. **G**, *I.a., I.c., I.g.*; *Ips lecontei* Swaine (McGraw and Farrier 1969). **K**, Mississippi; Virginia, Mexico (McGraw and Farrier 1969).

Cercoleipus coelonotus

A, 19%. **B**, all except 3, 8, 9. **C**, rare 4 times in EIB, rare twice in BD, although frequently encountered, the mite was always rare under bark. It seems to be a species whose populations

never become locally numerous. **E**, 17, 34 ft. **F**, 1/5. **G**, *I.a., I.c., I.g.* **I**, lab, males and females frequently seen on *I.c.* only, never on other beetles. **K**, Honduras (J. Coyne); California (Kinn 1970).

Pleuronectocelaeno drymoecetes

A, 32%. **B**, all except 7, 8, 11. **C**, rare 6 times in EIB, 4 times in BD, and 3 times in LIB, infrequent once and common once in BD. **D**, dry BD. **E**, 17, 34, 51, 68 ft. **F**, 2/9. **G**, *I.a., I.c., I.g., Ips confusus, Ips cribricollis* (Eichhoff), *Orthotomicus sabinianae* Hopping, *Pissodes nemorensis* (Kinn 1968). **I**, lab, males and females on bodies of *I.a.* **K**, Alabama, Texas, California, Honduras (Kinn 1968).

Fuscuropoda americana

A, 23%. **B**, 1, 3, 4, 8, 9, 10. **C**, rare 7 times in EIB, and rare 3 times in BD. **E**, stump, 17, 34, 51 ft. **F**, 6/3. **G**, *D.t., I.a., I.c., I.g., G.m.* When common under bark, it was always associated with *D.t.*; *Dendroctonus pseudotsugae* (M. Furniss) **I**, lab, deutonymphs attached by fecal tube to *Gm.*; field, attached by fecal tube to *D.t.* **J**, one adult seen feeding on nymph of *Histiogaster arborsignis.*

Leiodinychus australis

A, 77%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD				
LIB				

D, damp, tight EIB. **E**, stump, 17, 34, 51 ft. **F**, 22/25. **G**, *D.t., I.a., I.c., I.g., Dendroctonus ponderosae* Hopkins (R. Reid); *D. simplex, Ips pini* (Say) (R. Reid); *I. confusus* (G. Boss); *Ips bonanseai* (Hopkins) (W. Rose). **I**, lab, deutonymphs on bodies of *D.f., I.a., I.c., I.g.*, often so heavily that beetles were not seen. Deutonymphs also attached to *Pissodes nemorensis* Germar, *Corticeus glaber, Tenebroides collaris* (Sturm), *Monochamus carolinensis, Roptrocerus xylophagorum* Ratz. and *Dendrosoter sulcatus*; larva of *Dioryctria* sp. (W. Neel). **J**, may be fungivorous (Hse 1964, unpub.). **K**, Mississippi, Texas.

L. hirsutus

A, 84%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB	12	2		
BD	17	16	8	1
LIB	6	6	1	

D, dry and damp BD, under damp loose LIB. **E**, 17, 34, 51, 68 ft. **F**, 19/27. **G**, *I.a., I.c., I.g., T.s., G.m., Ips cribricollis* (R. Wilkinson). **I**, lab, deutonymphs on bodies of *Monochamus titillator.* **K**, Mississippi, Texas.

Nenteria orri

A, 32%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB	3	—	—	—
BD	5	3	3	—
LIB	—	3	1	

D, dry and wet BD, under dry loose LIB. **E**, 17, 34, 51 ft. **F**, 6/8. **G**, *I.a., I.c., I.g.*; *Dendroctonus obesus* (Mannerheim) (R. Beckwith); *D. pseudotsugae* (M. Furniss); *Ips pini* (Say) (R. Schmitz); *I. cribricollis* (J. Coyne). **I**, lab, deutonymph attached by fecal tubes to bodies of *I.c., G.m., Alonium ferruginium, Corticeus glaber, Cylistix attenuata, C. cylindrica*, and *Plegaderus pusillus* LeConte. **K**, Mississippi, Texas.

Oodinychus sp.

A, (1). **B**, 9. **E**, stump. **G**, *D.t.*

Urodinychus lamellosus

A, 58%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB		—		
BD		7	2	
LIB		3		

D, damp and dry BD, under damp loose LIB. **E**, 17, 34, 51 ft. **F**, 9/15. **G**, *l.a.*, *l.c.*, *l.g.*; *Dendroctonus pseudotsugae* (M. Furniss), *Ips cribricollis* (R. Wilkinson). **I**, lab, deutonymphs on bodies of *l.c.*, as many as 3 under elytra of *Monochamus carolinensis*. **K**, Mississippi.

U. denticulatus

A, 3%. **B**, 2, 3. **C**, rare once in BD. **E**, 6, 17 ft. **F**, 0/1. **G**, *l.a.*, *l.g.*, *P.a.*, *Ips cribricollis* (R. Wilkinson). **I**, lab, deutonymphs attached by fecal tubes on bodies of *P.a.*

Uropodidae sp.

A, (2). **B**, 11, 12. **G**, *l.a.*, *l.c.*

Glycyphagus n. sp.

A, 3%. **B**, 3, 12. **C**, rare once in BD. **E**, 51 ft. **F**, 1/0. **G**, *l.a.*, *l.g.* **I**, (u)

Histiogaster arborsignis

A, 94%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD			12	—
LIB			6	

D, dry and damp BD, under dry and wet loose LIB, and dry and damp tight LIB; tolerates extremely wet (soupy) environments, but prefers dry situations (Woodring 1968). **E**, stump, 17, 34, 51, and 68 ft. **F**, 26/34. **G**, *D.t.*, *I.a.*, *I.c.*, *I.g.*; apparently found with all wood-boring insects (Woodring 1966). **I**, lab, hypopi attached to bodies of *D.f.*, *T.s.*, *Monochamus titillator*, *M. carolinensis* (as many as 50 on prothorax and 500 under elytra), *Neacanthocinus obsoletus* (under elytra), *Thanasimus dubius*, and *Temnochila virescens* (both larva and adult). **J**, yeast, wheat germ, mushroom (Woodring 1963, 1969). **K**, ranges throughout North America wherever wood-boring beetles are found (Woodring 1966).

H. rotundus

A, 29%. **B**, 2, 4, 8, 9, 10, 11

C,	Rare	Inf.	Com.	Abn.
EIB			—	—
BD			1	1
LIB			1	—

D, damp BD, and under damp loose LIB; tolerates extremely wet (soupy) environments, but prefers dry situations (Woodring 1969). **E**, 17, 34, 51 ft. **F**, 6/6. **G**, *I.a.*, *I.c.*, *I.g.*, *G.m.*, *T.s.* **J**, yeast, wheat germ, mushroom, chopped mealworms (Woodring 1969). **K**, Mexico (W. Rose).

Tyrophagus putrescentiae

A, 58%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD	3	7	9	11
LIB	3	6	2	—

D, dry and damp BD, dry and damp loose LIB. **E**, 17, 34, 51, 68 ft. **F**, 18/12. **G**, *I.a.*, *I.c.*, *I.g.*, *G.m.*, *T.s.*, *Atta texana* Buckley; stored products insects (Hughes 1961). **H**, sometimes infests our colonies of fungus-growing ant, *Atta texana*, stored products (Hughes 1961), wood- and humus-dwelling (Marshall 1968). **I**, lab,. larvae, protonymphs, tritonymphs, males and gravid females under elytra of *Neacanthocinus obsoletus* and *Thanasimus dubius*. **J**, feeds largely on fungi (Hughes 1961), wide variety of wood-decaying fungi (Sinha

and Whitney 1969). K, cosmopolitan (Hughes 1961). Since this mite was not seen in the initial bark dissections (EIB) it appears that laboratory contamination was a possibility.

Anoetus conjuncta

A, 6%. B, 3, 4, 8, 12. C, infrequent 3 times in BD. E, 17, 34, 51 ft. F, 0/3. G, *I.a.*, *I.c.*, *I.g.*; *I. cribricollis* (R. Wilkinson). K, Honduras (Woodring and Moser 1970).

A. insolita

A, 10%. B, 1, 4. C, infrequent once and common 3 times in BD. E, 17, 34, 51 ft. F, 3/1. G, *I.g.*

A. media

A, (10). B, 1, 4, 8, 9, 10. E, stump. G, *D.t.* (common in galleries). I, field, hypopi under elytra and on thorax of *D.t.*, also larvae and pupae of *D.t.* K, Florida (E. Merkel) (Woodring and Moser 1970).

A. sordida

A, 29%. B, all except 1, 2, 11, 12.

C,	Rare	Inf.	Com.	Abn.
EIB		—	—	—
BD		4	2	1
LIB		—	—	—

D, wet BD. E, 17, 34, 51 ft. F, 4/9. G, *I.a.*, *I.c.*, *I.g.* I, lab, hypopi on body of *I.a.*, *Corticeus glaber*, *Platysoma parallelum* Say; *Carconops* sp., *Corticeus* sp. (Wilkinson); *Scolytus unispinosus* LeConte (R. Reid); *Cossonus corticola* Say (W. Neel). K, Georgia, Texas, Mississippi; Honduras, British Columbia (Woodring and Moser 1970).

A. varia

A, 19%. B, all except 1, 7, 9.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD				
LIB				

D, under wet mouldy loose LIB. E, 17, 34, 51 ft. F, 1/5. G, *D.t.*, *I.a.*, *I.c.*, *I.g.* I, lab, hypopi on bodies of *D.t.*, *I.a.*, *I.c.*, *I.g.*, *G.m.*, *Trypodendron scabricollis*, *Corticeus glaber*, *Lonchaeidae* sp., *Macrocheles boudreauxi*, *Alonium ferrugineum*; *Ips cribricollis* (R. Wilkinson); *D. simplex*, *Pityokteines minutus*, *Ips pini* (R. Reid); *Orthotomicus latidens* (LeConte); *O. sabinianae*, *Ips plastographus* (LeConte); *I. mexicanus* (Hopkins); *Pityophthorus carmeli* E. Schwartz (D. Kinn). K, Virginia, Georgia, N. Carolina, Alabama, Wisconsin, California, Oregon, Alberta, Ontario, Honduras, Mexico (Woodring and Moser 1970).

Bakerdania sellnicki

A, 3%. B, 4. C, infrequent once in BD. E, 17 ft. F, 0/1. G, *I.a.*, *I.c.*, *G.m.* H, great variety of habitats (Cross 1965). K, cosmopolitan, including Antarctica (Cross, pers. comm.).

Pyemotes parviscolyti

A, (30). B, all months. E, all heights, in twigs of all sizes of trees, also in trunks of saplings. G, *I.a.*, *I.c.*, *I.g.*, *P.a.*, *P.b.* I, lab and field, *P.b.* only, usually 1 or 2, but as many as 7 females attached to hairs at coxal bases by claws on tarsi I. The mite has never been found on *P.a.* which is often in same trees, although in stem and trunk. J, in the field this mite attacks *P.b.* brood, but has also been observed to feed on larvae of *D.f.*, *I.a.*, *I.c.*, and *I.g.* where their galleries overlapped those of *P.b.* In the laboratory females readily fed on brood of *D.f.*, *D.t.*, *I.a.*, *I.c.*, *I.g.*, and *Pissodes nemorensis*, but not larvae of several other families of beetle associates (Cross and Moser 1971).

Pygmephorus bennetti

A, 42%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD				
LIB				

D, under damp loose EIB, damp BD. **E**, 17, 34, 51 ft. **F**, 2/17. **G**, *l.a.*, *l.c.*, *l.g.* **I**, lab, females attached by claws on tarsi I to hairs on bases of legs and coxae of *D.f.*, *l.a.*, *l.c.*, *G.m.*, *T.s.*, *Thanasimus dubius*, and *Corticeus glaber*; field, *l.c.*, and *l.g.* **J**, feeds on an interesting *Sebacina*-like basidiomycete (det. P. Lentz and L. R. Batra) that produces ambrosia bodies. Fungus associated with pupal chambers of *Ips avulsus*. **K**, Virginia (R. Beckwith); Georgia (Hunter and Davis 1963); Colorado (G. Boss); Alberta and British Columbia (R. Reid).

Heterotarsonemus lindquisti

A, 48%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB	1	2	—	—
BD	2	10	9	2
LIB	1	3	2	—

D, dry and damp BD, under dry and damp EIB. **E**, 17, 34, 51, 68 ft. **F**, 13/12. **G**, *l.a.*, *l.c.*, *l.g.* **I**, lab, females on bodies of *D.f.*, *l.a.*, *l.g.*, *Corticeus glaber*, *Alonium ferruginium*, *Cylistix attenuata*, *Dendrosoter sulcatus*, and *Spathius pallidus* Ashmead. **K**, Alabama (E. Carter); Honduras (R. Wilkinson); Mexico (W. Rose); Arizona, California, New Mexico, Texas (Lindquist 1970*a*).

Iponemus calligraphi calligraphi

A, 3%; because this mite is rarely seen after the eggs of the host, *l.c.*, hatch, population estimates are probably too low. Of the 90 bolts examined only 12 contained eggs of *l.c.* **B**, 2, 6, 7, 9, 10, 12. **C**, rare once in EIB. **E**, 34 ft. **F**, 0/1. **G**, *l.g.* **I**, field, as many as 28 females on elytral declivity of single *l.c.* **J**, egg predator of *l.c.* (Lindquist 1969*b*). **K**, Mississippi; Georgia (Hunter and Davis 1963); California, D.C., Florida, New Jersey, N. Carolina, Ohio, Texas (Lindquist 1969*b*).

I. confusus oriens

A, 10%; because this mite is rarely seen after the eggs of *l.g.* hatch, population estimates are probably too low. Of the 90 bolts examined, only 9 contained eggs of *l.g.* **B**, 1, 3, 4, 6, 10. **C**, rare twice and abundant once in EIB, infrequent twice in BD. **E**, 17, 34, 51 ft. **F**, 0/5. **G**, *l.a.*, *l.c.* **I**, lab, as many as 100 females on elytral declivity of single *l.g.* **J**, egg predator of *l.g.* (Lindquist 1969*b*); attacks eggs of *P.b.* when galleries of scolytids cross. **K**, Alabama (E. Carter); Georgia (R. Beckwith) (Hunter and Davis 1963); Quebec, Dominican Republic, Arkansas, Connecticut, D.C., Florida, Kentucky, Maryland, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, N. Carolina, Pennsylvania, S. Carolina, Texas, Virginia, W. Virginia (Lindquist 1969*b*).

I. truncatus eurus

A, (1); because this mite is rarely seen after the eggs hatch, population estimates are probably too low. Of the 90 bolts examined, only 8 contained eggs of *l.a.* **B**, 10. **J**, egg predator of *l.a.*; also attacks eggs of *D.f.* when galleries of scolytids cross. **K**, Georgia (Hunter and Davis 1963); Florida, N. Carolina (Lindquist 1969*b*).

Tarsonemus fusarii

A, (1). **B**, 3. **H**, probably found in any niche that supports any of the large varieties of fungi on which it feeds (see **J**). Hence it appears to be a tramp species. **J**, *Fusarium* sp. (Cooreman 1941); *Alternaria tenuis* Nees, *Botrytis cinerea* Persoon ex Fries, *Cercospora coffeicola* Berkeley (Boness 1968). **K**, Louisiana, Europe.

T. ips

A, 97%. **B**, all months.

C,	Com.	Abn.
EIB		—
BD		2
LIB		—

D, under damp loose EIB, dry and damp BD (Smiley 1967). **E**, 17, 34, 51, 68 ft. **F**, 33/28. **G**, *I.a., I.c., I.g., P.a.* **I**, lab, females on bodies of *D.f., I.a., I.g.* **J**, associated with the fungus *Ceratocystis minor* on which it may feed; *Penicillium* sp. (Terry 1966, unpub.), fungivorus (Lindquist 1969*c*). **K**, Canada, Mexico, United States, Europe (Lindquist 1969*c*).

T. subcorticalis

A, 77%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				—
BD				2
LIB				—

D, under damp loose EIB, damp BD. **E**, stump, 17, 34, 51, 68 ft. **F**, 24/19. **G**, *D.t., I.a., I.c., I.g.* **I**, lab, females on body of *C.a.* **J**, *Penicillium* sp. (Terry 1966). **K**, Canada, Mexico, United States, Europe (Lindquist 1969*c*).

Cyta latirostris

A, (1). **B**, 12. **H**, u. **K**, cosmopolitan (Atyeo 1960).

Spinibdella depressa

A, (1). **B**, 9. **G**, *I.g.* **H**, u. **K**, Mexico and United States east of the Rocky Mountains (Atyeo 1960).

Acarocheyla impolita

A, 61%. **B**, all months. **C**, rare 16 times, infrequent 12 times, common 9 times, and abundant once in BD, rare 3 times in LIB. This mite was not seen in any of the initial dissections. Perhaps it normally occupies the outside bark niche, but does well when exposed to the inner bark species such as in the boring dust (Smiley and Moser 1970). **D**, dry and damp BD. **E**, 17, 34, 51, 68 ft. **F**, 14/23. **G**, *D.t., I.a., I.c., I.g.* **J**, females seen feeding on deutonymphs of *Leiodinychus hirsutus*, hypopi of *Histiogaster arborsignis*, females of *Heterotarsonemus lindquisti*, and nymphs of *Ereynetoides scutulis*.

A. virginiensis

A, (10). **B**, 2, 5, 6, 7, 9, 11. **G**, *I.a., I.c., I.g.*; *Ips cribricollis* (R. Wilkinson). **H**, u. **I**, lab, females on *D.f., I.a., I.g.* **J**, females seen feeding on psocids which were often present in large numbers when this mite was noted. **K**, Mississippi; Alabama (E. Carter); Virginia (Baker 1949); California (D. Kinn); Honduras (R. Wilkinson, J. Coyne).

Eutogenes vicinus

A, (1). **B**, 11. **G**, *I.c.* **H**, (u). **I**, lab, males and females of *I.a.* **J**, males seen feeding on hypopi of *Histiogaster arborsignis* and *Paraleius* sp. nymphs.

Prosocheyla acanthus

A, (4). **B**, 9, 10, 11, 12. **H**, (u).

Paracheyletia wellsi

A, (4). **B**, 4, 5, 9, 11. **G**, *I.a., I.c.* **H**, in both sprayed and unsprayed orange groves under clumps of trash (Muma 1961). **J**, *Tyrophagus putrescentiae*; ambushes phytoseiids (Muma 1961). **K**, Florida (Muma 1961), from quarantine material all over the United States and Mexico (Baker, pers. comm.).

Cryptognathus barrasi

A, (1). **B**, 4 ,5. **H**, u.

Cunaxa capreolus
A, (2). **B**, 9. **G**, *l.g.* **H**, (u). **K**, cosmopolitan (Baker and Hoffman 1948).

C. taurus
A, 6%. **B**, 3, 4, 9, 12. **C**, rare once and infrequent once in BD. **E**, 17, 34 ft. **F**, 1/1. **G**, *D.t., I.a., I.c., I.g.* **H**, (u). **K**, cosmopolitan (Baker and Hoffman 1948).

Cunaxoides ?andrei
A, (4). **B**, 9, 11, 12. **G**, *I.a., I.c., I.g.* **H**, (u). **K**, North America (Baker and Hoffman 1948).

Ereynetoides scutulis
A, 100%. **B**, all months.

C,	Rare	Inf.	Com.	Abn.
EIB				
BD				5
LIB				

D, under damp loose EIB, in dry and damp BD, under damp LIB. **E**, stump, 17, 34, 51, 68 ft. **F**, 44/41. **G**, *D.t., I.a., I.c., I.g., Ips bonanseai* (W. Rose); *Scolytus ventralis* LeConte (Stark and Borden 1965). **I**, lab, males and females on *D.f., I.a., I.g.*, and *Cylistix attenuata*. **K**, Virginia (R. Beckwith); Georgia (Hunter and Davis 1963; Hunter 1964); Alabama (E. Carter); Colorado (G. Boss); California (Stark and Borden 1965); Mexico (W. Rose).

Neophyllobius lorioi
A, 3%. **B**, 2, 4, 5. **C**, rare once in BD. **E**, 34 ft. **F**, 1/10. **H**, u.

Bryobia sp. (*praetiosa* complex)
A, (2). **B**, 9. **D**, BD. **J**, diapausing stage, the other stages of which may feed on grass (H. Boudreaux, pers. comm.).

Neoraphignathus howei
A, (1). **B**, 12. **H**, (u).

Eupodes sp.
A, 3%. **B**, 2, 3, 10, 11. **C**, rare once in BD. **E**, 34 ft. **F**, 1/0. **G**, *I.c.* **H**, (u).

Paraupalopis hodgesi
A, (1). **B**, 4. **E**, 34 ft. **G**, *I.a., I.c.* **H**, (u).

Hoplocheylus pickardi
A, (1). **B**, 7. **H**, (u).

Ledermulleria segnis
A, (3). **B**, 2, 3, 12. **E**, 68 ft. **H**, u; orange tree litter (Muma 1961). **K**, Florida (Muma 1961).

Microtydeus n. sp.
A, (1). **B**, 10. **E**, 15 ft. **H**, (u).

Tydeus n. sp.
A, (1). **B**, 11. **H**, (u).

Leptus n. sp.
A, (9). **B**, 4, 5, 6, 7, 8. **E**, 5 ft. **H**, u. **I**, field, parasitic on bodies of *D.t., Xylotrechus sagitattus* (Germar), *Hylobius pales, Asemum striatum* Kirby, and *Largus succinctus*. **J**, see I.

Neotrombidium n. sp.
A, (2). **B**, 5. **E**, 5, 16 ft. **G**, *I.a., I.c.* **H**, (u).

Mesotritia sp.
A, (2). **B**, 2, 12. **E**, 68 ft. **H**, u.

Liodes sp.
A, (2). **B**, 5, 9. **G**, *I.g.* **H**, (u).

Scapheremaeus palustris
A, (9). **B**, 1, 2, 3, 4, 9, 11, 12. **E**, stump, 17 ft. **G**, *D.t., I.a., I.c., I.g., Scolytus multistriatus.* **H**, (u). **K**, Mississippi, Texas, Ohio, Minnesota (J. Woodring); Honduras (J. Coyne, R. Wilkinson).

Eupelops sp.
A, (3). **B**, 2, 9. **E**, stump, 17 ft. **G**, *D.t., I.g.* **H**, (u).

Trichoribates sp.
A, (1). **B**, 9. **E**, stump. **G**, *D.t.* **H**, (u).

Trichogalumna sp.
A, (1). **B**, 10. **G**, *I.a.* **H**, (u).

Paraleius n. sp.
A, 3%. **B**, 2, 4, 12. **C**, infrequent once in BD. **E**, stump, 17 ft. **F**, 1/0. **G**, *D.t.*; *Dendroctonus pseudotsugae* (M. Furniss); *D. simplex* (R. Stevenson, R. Reid); *D. obesus* (R. Beckwith). **H**, (u). **K**, Alaska (R. Beckwith); Alberta (R. Stevenson, R. Reid); Idaho (M. Furniss); Honduras (J. Coyne, R. Wilkinson).

Scheloribates sp.
A, (3). **B**, 1, 2. **G**, *I.a., I.c.* **H**, (u).

Peloribates sp.
A, (5). **B**, 1, 2, 10, 12. **E**, 68 ft. **G**, *I.a., I.c.* **H**, (u).

V. Conclusions

A. *Relative frequency.* Of the 96 species, 56 were found in the bolt study and 40 were taken from miscellaneous records. Twenty-two from the bolt study were in less than 10% of the trees, 11 from 10 to 25%, 10 from 26 to 50%, 5 from 51 to 75%, and 8 from 76 to 100%. The eight most frequently found were *Ereynetoides scutulis* and *Digamasellus neodisetus* (100%), *Tarsonemus ips* (97%), *Histiogaster arborsignis* (94%), *Proctolaelaps dendroctoni* (87%), *Leiodinychus hirsutus* (84%), *Leiodinychus australis* and *Tarsonemus subcorticalis* (77%). Because beetle brood development was often well past the egg stage when bolts were inspected, the three species of *Iponemus* egg predators and perhaps others may be more common than this study shows. Most Eleutherengona and Oribatei were rare and probably originated in the bark scale niche from which they crawled into the inner bark or boring dust.

B. *Seasonal distribution.* Mites apparently can be found at any season, since the 15 species with relative frequencies of over 42% were found every month of the year.

C. *Relative abundance. Lasioseius corticeus, Pseudoparasitus thatcheri, Acarocheyla impolita,* and *Tyrophagus putrescentiae,* all of which had relative frequencies exceeding 18%, were never found in the early inner bark. Their primary niche is probably not the inner bark. Of these, *L. corticeus* and *T. putrescentiae* showed some phoretic behavior in the laboratory. *T. putrescentiae* was probably a laboratory contaminant, and the rest may have originated in the outer bark niche.

Some species with high relative frequencies were abundant in early inner bark, indicating that they were able to build up populations quickly. Others that were

common or abundant only in boring dust or late inner bark apparently developed at a slower rate. Species whose populations increased quickly were *Digamasellus neodisetus, Ereynetoides scutulis, Tarsonemus ips, Proctolaelaps dendroctoni, Leiodinychus australis, Tarsonemus subcorticalis, Macrocheles boudreauxi, Pygmephorus bennetti, Digamasellus neocornutus,* and *Anoetus varia.* Those with more slowly increasing populations were *Histiogaster arborsignis, Leiodinychus hirsutus, Urodinychus lamellosus, Eugamasus lyriformis, Heterotarsonemus lindquisti, Proctolaelaps hystricoides, Digamasellus isodentatus, Lasioseius corticeus, Nenteria orri, Histiogaster rotundus,* and *Anoetus sordida.* At least one frequently observed species, *Cercoleipus coelonotus,* never was abundant. Boring dust always contained all the important mite species associated with the inner bark niche.

D. *Bark moisture and tightness.* High populations of most species developed in dry and damp environments. *Anoetus varia* and *A. sordida* tolerated only wet conditions. Three species bred in dry, damp, or wet situations—*Histiogaster arborsignis, Proctolaelaps dendroctoni,* and *Nenteria orri.* Loose bark apparently favored high mite populations, but species that also multiplied under tight bark were *Histiogaster arborsignis, Leiodinychus australis,* the three species of *Iponemus,* and *Pyemotes parviscolyti.*

E. *Height distribution.* Most mites were found at all heights infested by *Dendroctonus frontalis* and the three *Ips* species. A few species such as *Anoetus media* and *Proctolaelaps hystrix* were associated primarily with *Dendroctonus terebrans* in the lower trunk.

F. *Mites associated only with* Dendroctonus frontalis. Because *D. frontalis* always was associated with some other species of subcortical insects in the bolts examined, it was not possible to assess whether some of the mite species were restricted to living with this beetle only, in distinction to other scolytids (especially *Ips*) which commonly occur with it. In some cases, however, the opposite was evident: the ratios between occurrence in *D. frontalis* galleries and those containing mixed bark-beetle populations indicate that *Proctolaelaps fiseri* (0/5) and *Pygmephorus bennetti* (2/17) are more closely associated with *Ips* than with *D. frontalis.*

G. *Mites associated with other bark beetle species. Histiogaster arborsignis* is associated with a great variety of wood-boring insects, whereas *Ereynetoides scutulis, Proctolaelaps hystricoides, Digamasellus isodentatus,* and *Pleuronectocelaeno drymoecetes* are associated with bark beetles. *Digamasellus isodentatus, Proctolaelaps dendroctoni, Macrocheles boudreauxi, Eugamasus lyriformis, Proctolaelaps fiseri, P. hystrix, Digamasellus rotoni, Fuscuropoda americana,* and *Histiogaster rotundus* are apparently limited to the host range of *Dendroctonus* and *Ips* spp. *Melichares* n. sp. and *Longoseius cuniculus* may be associated only with cerambycids, and *Proctolaelaps xyloteri* with ambrosia beetles. Some are very specialized: *Pyemotes parviscolyti* exists only with *Pityophthorus bisulcatus,* and the three *Iponemus* species are each associated with a single species of *Ips.*

H. *Alternate niches.* Except for *Tyrophagus putrescentiae,* a laboratory contaminant, and *Proctolaelaps hystricoides,* no mites with relative frequencies exceeding 6% have been found in niches other than inner bark.

Ten tramp species, *Blattisocius keegani, Cunaxa taurus, Lasioseius dentatus, Proctolaelaps bickleyi, Androlaelaps casalis, Tarsonemus fusarii, Tyrophagus putrescentiae, Bakerdania sellnicki, Paracheyletia wellsi,* and *Cunaxa capreolus* occur in a wide variety of habitats.

The outer bark is favored by all Oribatei and most Eleutherengona, as well as *Uropodella lacinata, Lasioseius neometes,* and *Podocinum* n. sp. of the Mesostigmata, and *Glycyphagus* n. sp. of the Acaridei.

I. *Phoresy.* Perhaps all insects in the inner bark niche are phoretic hosts to one or more mite species. Table I gives the number of mite species that have been seen riding on the various subcortical insects. The list is incomplete, but is most accurate for insects which have been frequently observed—those down through *Thanasimus dubius.* It is deficient for groups such as weevils, buprestids, cerambycids, and the minor scolytid species.

Common mites in general appeared to ride any scolytid, and in many cases inquilines. Some, like *Proctolaelaps dendroctoni,* seemed to prefer inquilines over scolytids. Mites that fed on specific insect hosts (*Iponemus, Pyemotes*) rode only those hosts. The largest mite, *Cercoleipus coelonotus* was restricted to the largest *Ips, I. calligraphus.*

Many mite species rode anywhere on the body, but others were restricted to, or preferred, certain areas such as the coxae, the ventral surfaces of the elytra, or the elytral declivity of species of *Ips.*

J. *Feeding habits.* Under types of food listed below, a question mark preceding a scientific name indicates circumstantial evidence only. Some mites appear in more than one category.

Food type	Mite species
Saprophytes	*Histiogaster arborsignis, ?H. rotundus*
Fungi	*Tyrophagus putrescentiae, Tarsonemus subcorticalis, T. ips* (feeds on *Ceratocystis minor*), *T. fusarii, ?Leiodinychus* spp., *?Histiogaster arborsignis, ?H. rotundus, Pygmephorus bennetti*
	Blattisocius keegani, Proctolaelaps dendroctoni, Androlaelaps casalis, Macrocheles boudreauxi, Eugamasus lyriformis, Fuscuropoda americana, Acarocheyla impolita, Eutogenes vicinus, Paracheyletia wellsi
Nematodes	*Proctolaelaps fiseri, ?P. bickleyi*
Psocids	*Acarocheyla virginiensis*
Bark beetles	*Eugamasus lyriformis, Pyemotes parviscolyti, Iponemus calligraphi, I. confusus oriens, I. truncatus eurus, Leptus* n. sp., *?Blattisocius keegani, ?Proctolaelaps dendroctoni, ?P. xyloteri, ?Macrocheles boudreauxi*

None of the mites associated with bark beetles fed solely on *Dendroctonus frontalis. Pyemotes parviscolyti, Iponemus t. eurus,* and possibly the other two species of *Iponemus* attacked *D. frontalis* when galleries of their usual host scolytids crossed its galleries. *B. keegani, P. dendroctoni, P. xyloteri, M. boudreauxi,* and *Leptus* n. sp. are believed to attack *D. frontalis. Eugamasus lyriformis* seemed to show a preference for mites, but devoured beetle larvae under experimental conditions. At least 15 more common mites are potential bark-beetle predators. *Tarsonemus ips* and possibly other mite species feed upon *Ceratocystis minor* and may be important vectors of this pathogen. Moller and DeVay (1968) showed that *Tarsonemus* sp. is a vector of *Ceratocystis fimbriata* Ellis and Halsted.

K. *Geographical distribution.* Of the subcortical mites with relative frequencies exceeding 6%, only the European species *Proctolaelaps fiseri* has been found outside of North and Central America. Most others are widely dis-

TABLE I. Number of mite species hosted by various subcortical scolytids and their insect associates

Number of mite species	Insect hosts
14	*Dendroctonus frontalis*
13	*Ips avulsus, I. calligraphus*
11	*Corticeus glaber*
8	*Ips grandicollis, Gnathotrichus materiarius, Cylistix attenuata*
7	*Dendroctonus terebrans*
6	*Thanasimus dubius*
5	*Monochamus titillator*
4	*Monochamus carolinensis, Neacanthocinus obsoletus, Alonium ferruginium*
3	*Pityophthorus bisulcatus, Trypodendron scabricollis, Pissodes nemorensis, Dendrosoter sulcatus*
2	*Hylobius pales, Xylotrechus sagittatus, Cylistix cylindrica, Tenebroides collaris, Temnochila virescens, Largus succinctus*
	Pityophthorus annectans, Crypturgus alutaceus, Platysoma parallelum, Plegaderus transversus, P. pusillus, Buprestа lineata, Cossonus corticola, Heydenia unica, Spathius pallidus, Roptrocerus xylophagorum, Lonchaeidae sp., *Asemum striatum*

tributed in North America. Five species, *Proctolaelaps dendroctoni, Macrocheles boudreauxi, Heterotarsonemus lindquisti, Digamasellus neocornutus,* and *Histiogaster rotundus,* appear to be generally limited to the range of *Dendroctonus frontalis.* All but one of the 10 tramp species were cosmopolitan.

VI. Summary

Ninety-six species of mites were associated with southern pine bark beetles during an outbreak of *Dendroctonus frontalis* Zimm. on *Pinus taeda* L. in Allen Parish, La. Eight species were found in 76–100% of the trees examined, 5 in 51–75%, and 10 in 26–50%. Like the scolytids, these common mites were active all year. Populations of some mite species increased quickly under bark in the presence of the beetle; others became abundant only after beetle emergence.

The common mites were particularly abundant in beetle boring dust. Eighteen species bred in dry or damp environments; three tolerated either dry or wet situations, and two were found only under wet bark. Most mite species were at all heights in the stem where beetles existed. Many are not restricted to southern pines or to scolytids; some species are distributed from Canada to Honduras in association with other beetles and wood-boring insects. Only one common species is known outside North and Central America. Mites occurring in the southern United States were phoretic on 10 species of pine scolytids and other insects associated with the inner bark niche. *Dendroctonus frontalis, Ips avulsus* (Eichhoff), *Ips calligraphus* (Germar), and *Corticeus glaber* LeConte (a tenebrionid associate) were the most frequent hosts. Some mites attached to practically any insect species, some to a limited number, and some restricted themselves to a single host. Favorite riding places on beetles were the coxae, under the elytra, and on the elytral declivity of *Ips.* Most species seemed to feed on other mites.

Known predators of bark beetles included three species of *Iponemus* egg parasites; *Pyemotes parviscolyti* Cross and Moser, a predator of *Pityophthorus bisulcatus* Eichhoff; and *Eugamasus lyriformis* McGraw and Farrier, which preyed on a large number of subcortical mites. Several others were suspected predators. *Tarsonemus ips* Lindquist probably fed solely on the fungus *Ceratocystis minor* (Hedgc.) Hunt.

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